SPECIFIC CONDUCTANCE IN THE EVERGLADES AGRICULTURAL AREA

FINAL REPORT

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Executive Summary

The Everglades Forever Act of 1994 mandated a research and monitoring program on the evaluation of water quality standards in the Everglade Agricultural Area (EAA) (Chapter 40E-63). The goal of this research was to evaluate the constituents that have been previously identified as elements of water quality concern that will likely not be significantly improved by the Storm Treatment Areas (STAs) and current Best Management Practices (BMPs) being widely implemented throughout the EAA; and to identify strategies needed to address such parameters (40E-63.301(2)). These parameters were identified by Florida Department of Environmental Protection (FDEP) as specific conductance, particulate phosphorus (P), and the pesticides Atrazine and Ametryn. This report deals with the issue of specific conductance. Particulate P will be addressed in a separate report. The Everglades Agricultural Area-Environmental Protection District (EAA-EPD) and the South Florida Water Management District (SFWMD) are responsible for the monitoring of Atrazine and Ametryn.

The objectives of this work as stated by Chapter 40E-63, Part III: "the farm-scale research shall be expanded to include monitoring for specific conductance at all points where total phosphorus is currently being monitored. The expanded research program shall include the development, testing, and implementation of BMPs to address reduction of specific conductance".

Specific conductance was monitored at ten EAA farms (12 discharge sites: 72 months at UF9200A and UF9206A&B, 61 months at UF9209A, 50 months at UF9202A, UF9203A, UF9204A, UF9207A&B, 44 months at UF9208A, and 24 months at UF9201A and UF9205A). All data were collected using Hydrolab DataSonde (series 3, 4, and 4a) multi-parameter water quality data loggers. In order to identify the specific ions and ion ratios that comprise specific conductance, weekly grab samples were taken in 2001 and 2002 from eight farms (10 pump structures) and analyzed for ionic composition.

Summary statistics showed that mean specific conductance above 1.275 mS/cm occurred at only two out of the ten farms monitored. The farms with conductance above 1.275 mS/cm were UF9206A&B and UF9208A. Higher concentrations of sodium (Na^+) and chloride (Cl^-) were also observed at these two farms. Of the two farms, UF9208A, also showed high levels of sulfate (SO_4^{2-}). Determination of ion compositions in grab samples at the ten pump structures indicated that the major anions are bicarbonate (HCO_3^-), Cl^- and SO_4^{2-} and the major cations are Na^+ and calcium (Ca^{2+}) in farm canal water of the EAA farms.

Potential sources of specific conductance were evaluated. These included geological influences, drainage pumping, irrigation water and fertilizer application. Comparing average specific conductance data points of the study sites to historical Cl^- concentration maps of shallow groundwater (Parker et al., 1955 and Jones et al., 1948) revealed that the current elevated farm conductance readings of UF9208A coincided with historically high Cl^- concentrations in 20-50 ft ground water wells. UF9206A&B also is located in an area that has wells of high Cl^- concentration. The Na/Cl ratio in the farm canals ranged from 0.57 to 0.78. The Na/Cl ratio in seawater is 0.55. It has been reported that connate seawater underlies the area and exchanges with the surface water where canals are cut into the limestone (Parker et. al., 1955; Gleason, 1974; Waller and Earl, 1975; CH2M Hill, 1978). Shallow ground water hydrology and quality has a major impact on specific conductance in the EAA.

The effect of drainage pumping on specific conductance was variable and site specific. There was a low correlation between drainage pumping and conductance when all the sites were combined. Irrigation had a low negative correlation with specific conductance. Statistical analysis of the daily average specific conductance at three intensively monitored farms indicated that drainage pumping increased specific conductance at UF9200A and UF9209A, but not at UF9206A&B. Irrigation decreased specific conductance at all three farms, UF9200A, UF9206A&B and UF9209A. Drainage event analysis on the two elevated specific conductance farms (UF9206A&B and UF9208A) also demonstrated the variable effect of pumping. For example, out of six selected drainage events on UF9206A, three were observed to have increased conductance with volume pumped. Specific conductance had no relationship with drainage pumping to rainfall ratio. One farm that had the lowest drainage pumping to rainfall ratio, showed the highest specific conductance. This strengthened the conclusion that farm conductance is strongly influenced by underlying ground water composition.

The irrigation water utilized by the farms with the highest specific conductance (UF9206A&B and UF9208A) was also characterized by higher specific conductance. Farm UF9208A received irrigation water via a secondary canal that connects to the Hillsboro canal. Farm UF9206A&B received irrigation water from a secondary canal that connects to the Ocean canal. The Ocean canal may source its water from either the West Palm Beach Canal to the east, or the Hillsboro Canal to the west. Both the Ocean and the Hillsboro Canals have historically had relatively high specific conductance compared to other major district conveyance canals in the EAA.

Previous research in the EAA indicated that potassium chloride (KCl) fertilizer application contributed less than 3% to the total dissolved solids (TDS) concentrations in canal waters. It is also reported that a sugarcane crop at harvest takes up more P and K from the soil than that applied by fertilizers. Our results show KCl fertilizer application in one of the high conductance farms with mixed cropping systems contributed less than 6.5% of the TDS in drainage water. This was calculated assuming that all the KCl fertilizer ended up in the drainage water which is highly unlikely as crops take up Cl^- in large quantities.

To assess the impact of current P load reduction BMPs on specific conductance, non-parametric Mann-Kendall trend analyses and Sen's slope analysis of specific conductance at different pump structures in the EAA were conducted. Both of these analyses indicated that downward trends were statistically significant at structures UF9202A, UF9205A and UF9207B during the study period. One farm UF9208A showed an upward trend using the Mann-Kendall trend analysis, however there was no significant trend using the Sen's slope analysis. So the current P load reduction BMPs have had a positive impact on 30% of the farms monitored.

In conclusion, specific conductance in the EAA canals is strongly influenced by the composition of the shallow ground water, historically reported to be high in Na^+ and Cl^- due to connate seawater entrapment and the mixing of surface and ground water. The effect of drainage pumping was variable and site specific. Canal specific conductance is governed mainly by the quality and the hydrology of the underlying shallow ground water, which is farm specific. Fertilizers contributed a very small percentage to the total dissolved solids in the drainage water therefore had no substantial contribution to specific conductance in the EAA. Current P load reduction BMPs have reduced specific conductance in some locations in the EAA. It is the conclusion of this study that no further BMPs can be identified by additional research that would provide abetment of specific conductance in the discharge in the EAA. The issue of specific conductance in the EAA is a geological one, and shallow ground water is the major factor controlling the level of specific conductance in the EAA farm canals.