Accommodating Coastal Growth Panel
Nonpoint Source Pollution

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1. Introduction

Florida's coastal environment is especially vulnerable to nonpoint source pollution for two reasons. One, the extent of the karst nature of the platform allows great interaction between ground and surface waters. Second, the low gradient of the land results in high water tables. Both of these factors result in poor attenuation of contaminants in the subsurface, and the release of nutrients and pathogens to surface waters.

2. Rapid transport and transmissivity in the karst Florida terrain.

Florida's limestone subsurface is highly porous and transmissive. A recent survey reported that the State contains over 700 springs; when the last survey was conducted in the 1970s, only 300 springs were known (Scott et al., 2002). More springs will undoubtedly be found, and most new spring discoveries will likely be submarine springs, as shown below. While springs funnel large amounts of freshwater and dissolved constituents into small areas, slow and more diffuse seepage of groundwater into coastal waters may be volumetrically more important (Burnett et al., 2001; Cable et al., 1997). Since groundwater ultimately discharges into the coastal ocean, any groundwater that is contaminated by industry, agriculture or domestic usage may become a marine problem, leading to poor water quality, algal blooms, or shellfish and fishery closings.

Figure 1. Aerial image of Feather Sound Submarine Groundwater Discharge Point in Tampa Bay, as indicated by the dark spot to the right of the point of land (Peter Swarzenski, USGS, St. Petersburg). New technologies such as thermal imaging and subsurface resistivity surveys will be instrumental in finding coastal areas of high submarine groundwater discharge.

In an effort to reduce surface water discharges, a large volume of wastewater in Florida is now injected underground. When wastewater is released into the subsurface, the extreme permeability and porosity of Florida's limestone (illustrated in the core sample to the I can result in rapid horizontal and vertical rates of wastewater transport. Using chemical (SF6) and viral tracers, horizontal transport rates in the subsurface have been observed to be as rapid as 100 meters per day. Rapid vertical transport has also been observed (Table 1). This rapid transport does not allow sufficient time for degradation of many contaminants in the subsurface and results in their delivery to surface waters.

Table 1. Fluid transport rates in the karst subsurface of the Florida Keys.
Reference Location HTR (m/d) VTR (m/d)

Dillon et al. (1999) Key Largo 5 – 79
Big Pine Key 3 – 32
Dillon et al. (2000) Long Key (KML) 1 – 41 0.1 – 52.8
Dillon et al. (2002) Key Colony Beach 0.2 - 190 4 – 72
LaPointe et al. (1990) Big Pine Key 0 – 1.2
Paul et al. (1995) Key Largo 14 – 580
Paul et al. (1997) Key Largo 60 – 840
Long Key 5 – 48

The karst nature of the Florida landscape also means that groundwaters are particularly vulnerable to contamination. Buried sinkholes and solution pipes, evidenced in this ground-penetrating radar image, can result in easy and rapid contamination of the aquifer from the land surface (Figure 3). Buried sinkhole Solution pipes

Text Box: Figure 2. High porosity of Florida's limestone illustrated in a core sample.
Text Box: Figure 3. Ground-penetrating radar image of karst terrain in Manatee Springs State Park. Image from Collins, 2001.

3. Low gradients and high water tables.

The low gradient of the land in Florida means that the water table is often close to the surface. Proper treatment of wastewater is best achieved by a thick vadose zone, something Florida soils often lack (Corbett et al., 2002, 2000). Also, development can affect the position of the water table, raising it relative to pre-development conditions, making onsite disposal practices less functional.

Stormwater is the largest single delivery mechanism of nonpoint source pollution, but it is not known how much of the nutrients and pathogens derived from stormwater are derived from flooding of sewage treatment facilities. Inventories in the Florida Keys (Figure 4, Monroe County Stormwater Plan, 2001) show that subsurface nutrient delivery by wastewater and by urban stormwater runoff are of similar magnitude. Sources of contaminants in stormwater runoff include fertilizers, insecticides and herbicides applied to agricultural fields, lawns, gardens, and golf courses, animal waste, septic systems and runoff from cars and impervious surfaces.

Rain and storms are the main drivers of microbial pollution of coastal waters (Lipp et al. 2001a,b, Fig. 5). While coliphage have been used to show the relationship between fecal sources and rainfall, researchers have also been able to predict the presence of human pathogenic viruses with 95% concordance using rainfall and water temperature. (J. Rose, personal communication).

4. Recommendations

A. Public Education

Public education is a critical factor. Scientists and policy-makers must impress upon the public the importance of properly treating wastewater and changing actions that contribute to contaminants in stormwater runoff. Currently it takes a lot of money for science and data gathering to convince people that changes are necessarily. The technology exists to clean up wastewater but it is expensive. An educated public is more likely to support the costs that need to be borne. Excellent examples of such education efforts are the "Waterfront Property Owner's Guide" recently revised by the Florida

Text Box: Figure 5 demonstrates that there is a relationship between coliphage number and rainfall in Charlotte Harbor, Florida

Text Box: Figure 4. Department of Environmental Protection and two recent brochures by Florida SeaGrant on "Submarine Groundwater Discharge" and "Nutrients and Florida's Coastal Waters."

These publications are listed with the references. But it is not enough to distribute brochures and hope people read them and take them to heart. Scientists and policy makers need to explain and defend the ideas within them. There needs to be incentive for scientists, in particular, to do this.

B. Research needs

There is a need to support research to improve our knowledge of:

1. Interaction between groundwaters and surface waters;

2. The behavior of contaminants in the subsurface;

3. Approaches to track the sources of contaminants and groundwater discharge such as
–Molecular techniques, genetic fingerprints (such techniques have the potential to tell if pathogens are derived from a bird sanctuary, manatees or human waste);
–Stable isotope tracing, 15N to detect sewage inputs of nitrogen;
–Natural and Artificial Tracers- Rn, Ra, SF6 to detect groundwater discharge and to trace movement water in the subsurface.

4. Linkage of Airsheds with Watersheds. Atmospheric deposition of nutrients is not unique to Florida, but is an important pathway for the dispersion of non-point source pollution.

5. Models that allow prediction of contaminants derived from stormwater runoff depend upon knowledge of nutrient loading to discrete landscape classifications. For most landscape classifications, these loading factors are well constrained. However additional research is needed to determine loading factors associated with agricultural activities.

C. Groundwater protection

1. Homes in coastal areas should be connected to centralized sewer systems as much as possible.

2. Onsite sewage disposal systems such as septic systems don’t work well in karst areas like the Florida Keys or in areas where the water table is high. Water can wick up into mounded septic systems, reducing their efficiency.

3. Where onsite sewage disposal systems must be used, advanced secondary levels of treatment are preferable to aerobic units. Aerobic units are certified to reduce total suspended solids (TSS) and biochemical oxygen demand (BOD) to 30 mg/l respectively. There are no assurances that pathogens or nutrients are removed. Advanced secondary standards get BOD and TSS down to 10 or less mg/l, total nitrogen down to 20 mg/l or less, total phosphorous down to 10 mg/l, and fecal coliform down to less than 200 colony forming units per 100 ml. This is a vast improvement. Additional treatments, such as absorbents, can remove phosphate and recirculation of wastewater into an anaerobic chamber can promote denitrification.

4. Agriculture must develop and use best management practices to reduce fertilizer usage. Animal waste management from chicken houses and concentrated animal feedlot operations must also be addressed.

D. Reduce the impact of groundwater on coastal waters

1. Increase setbacks of septic systems from the shoreline to 50 m (from 23 m).

2. Raise septic system drainfields to 1 m above the position of the water table at the site following development (older systems only required 6 inches). Grandfathered septic systems should be upgraded in older developments.

E. Reduce the impact of stormwater runoff on coastal waters

1. Limit urban development along shorelines, particularly limit the amount of impervious surfaces. Parking lots can be designed to percolate.
2. Preserve and construct wetland and riparian buffers and submersed aquatic vegetation

3. Limit use of fertilizers, herbicides and insecticides on residential and commercial lawns and landscaping. Encourage best management practices in agriculture.

4. Educate the public regarding the ecological values of natural landscapes. Discourage picture-perfect manicured lawns. Encourage the use of native vegetation that will need less fertilizing, watering, and spraying. Great examples are offered by the Florida Yards and Neighborhood Program.

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