



Pollutant Dynamics of Pond Muck

Historically, most research on stormwater ponds has focused on the movement of pollutants into and out of the pond. This is quite understandable, as knowledge about inputs and outputs of pollutants helps to estimate pollutant removal performance. An impressive amount of input/output monitoring data has been collected: nearly 65 pond monitoring studies have been conducted in the U.S. and Canada.

Most of the monitoring studies have shown that stormwater ponds and wetlands are quite effective in trapping pollutants carried in urban stormwater. Much less is known, however, about the fate of stormwater pollutants once they are trapped in a pond. It is generally assumed that most of the pollutants eventually settle out to the pond bottom and form a muck layer. (The term **muck layer** is used here to distinguish newly-deposited bottom sediments from the older parent soils that formed the original pond bottom.)

The muck layer deepens as the pond ages. Pollutants may remain trapped within the muck layer until the entire layer is excavated during a pond clean-out. In most cases the muck is eventually dewatered, excavated, and applied back to the land surface. Research on bottom sediments in other shallow water systems, however, suggests that the muck layer may not be so inert. Figure 1 illustrates how a given pollutant can follow a number of diverse and complex pathways into and out of the muck layer.

Some runoff pollutants are transformed within the muck layer, while others are decomposed through chemical and microbial processes involved in sediment diagenesis. Indeed, diagenesis is often a key pathway for decomposition of organic matter and some nutrients. Alternatively, pollutants can migrate further below the muck layer and into the original soil profile. In some extreme cases, pollutants can travel into groundwater.

Alternatively, pollutants might enter the food chain while in the muck layer, either through uptake by wetland plants or by bottom feeding fish. Under the right conditions, some pollutants could also be released from the muck into the water column (where they could exit the pond during the next storm).

In this article, we examine the internal dynamics within the muck layer of stormwater ponds, based on an extensive review of research studies on the physical, chemical, and biological nature of the muck layer of over

50 stormwater ponds and wetlands. While it must be admitted that the study of muck is somewhat lacking in glamour, it can have many important implications for the design and operation of stormwater ponds and wetlands. Typical questions include:

- What is the average deposition rate of muck in ponds?
- After how many years of deposition will muck need to be removed?
- Can the deposition rate be used to calculate the size of the sediment forebay for a pond?
- How tightly are pollutants held in the muck layer?
- Is there any risk that pollutants could be released back into the water column? Or migrate into groundwater supplies? Or enter the aquatic food chain where toxicity might be magnified?
- If pollutants do remain in the muck layer, should muck be considered hazardous or toxic?
- Can muck be safely applied back on the land surface after it is cleaned out from the pond? Or are more exotic and expensive methods needed to safely dispose of muck?
- Finally, the depth of accumulated muck generally represents the long term work of a pond in trapping pollutants. Can the characteristics of pond muck allow us to infer anything about the pollutant removal processes operating in ponds or the land uses that drain to it? Can muck pollutant concentrations “fingerprint” upstream land uses?

To answer these questions, we reviewed bottom sediment chemistry data from 37 wet ponds, 11 detention basins, and two wetland systems, as reported by 14 different researchers. Although the studies covered a broad geographic range, almost 50% of the sites were located in Florida or the Mid-Atlantic states. Analysis was restricted to mean dry weight concentrations of the surface sediments that comprise the muck layer (usually the top five centimeters). The stormwater ponds ranged in age from three to 25 years.

The Nature of Pond Muck

The muck layer can be easily distinguished from the parent soils that comprise the pond’s original bottom.