8. Detention / Retention ponds and wetlands

Urban development tends to reduce the rate at which rainwater percolates into the soil, whilst at the same time, the harder, smoother surfaces tend to increase overland flow velocities. As a result, flood flows may be substantially increased over that which pertained prior to the development. This in turn increases downstream flood levels and average channel velocities. Natural channels may now have inadequate conveyance and erosion may result, or alternatively larger pipes or canals may be required to prevent flooding.

In consequence of the above, detention and retention ponds are frequently constructed along urban drainage systems to provide temporary storage for upstream stormwater peak flows, thereby reducing the downstream peaks. Definitions vary from country to country, but in South Africa a “detention pond” generally refers to a pond that is dry between flood events, whilst a “retention pond” generally refers to a pond that always has some water in it. Clearly a lake, whether natural or man-made, is a form of retention pond. Detention ponds often have a secondary role eg. as sports fields or parking areas.

“Wetlands” are also a type of “retention pond”, except in this case the implication is generally that aquatic plants are allowed to grow across a major portion of the surface. These plants, particularly those of the reed family, play an extremely important role in trapping sediments, taking up excess nutrients, and holding back flood flows. They are also very efficient litter traps. Although in the past, most wetlands developed naturally, there are increasing moves to construct “artificial” wetlands to reduce pollution loads in streams or even to “polish” the effluent from waste water treatment works.

The design of detention / retention ponds and wetlands will not be discussed here. There are many texts available that deal with this, and it falls outside the scope of this report. What should be obvious however, is that these structures provide excellent opportunities for litter removal. The large flow sections generally reduce the average flow velocities to a point where the litter will segregate almost completely into bed-load and flotsam. The bed-load settles out, whilst the flotsam is easily trapped behind virtually any type of screen.

The biggest problem with using a pond system as a litter trap is usually the removal of the litter material. Litter (and silt) deposited on the floor of detention ponds can be extremely unsightly, and can interfere with alternative usage of the land if not promptly removed. Furthermore, because of the large plan area associated with detention ponds, the litter (and silt) tends to be spread out and removal takes some effort.

The same goes for retention ponds and wetlands where the removal process is complicated by the presence of water. Clearly it is a help if the ponds can be drained for cleaning. This is the principle of the Canberra type Gross Pollutant Traps (see Section 6.4). In these structures, the floor of the sedimentation basins are concrete-lined. When the structures are cleaned, the basins are drained and flotsam falls off, or is raked off, the vertical screen onto the floor. It is removed from here at the same time as the sediment deposits in the basin by a front-end loader or similar.

The minimum area of basin required, from the point of view of bed-load removal, depends on the settling velocities of particles required to be removed. For the design of the Canberra GPTs, Willing & Partners, 1989(a) used the method of Pemberton and Lara, 1971, which in turn was based on the work of Einstein, 1965, and is summarised by Equation 8-1:

$$P = 100\left(1 - e^{y}\right) \qquad \textbf{Equation 8-1}$$

where:

$$y = \frac{-1{,}0548.L.u_{ss}}{q}$$

and where:

P	=	percentage of sediment deposited over total basin length (%),
L	=	basin length (m),
u_{ss}	=	settling velocity of the design particle (m/s).
q	=	basin discharge (m^3/s/m), and

The daily runoff and sediment export predicted by a rainfall / runoff model and sediment export model is computed on an hourly basis in proportion to the rainfall falling in any one hour on a given day. The deposition of individual size fractions of a designated grading curve in a GPT of known dimensions on an hourly basis is then calculated from Equation 8-1.