RETENTION PONDS

SITE CONTROL

City West Retention Pond

PRIMARY CONSIDERATIONS	
Construction Cost	HIGH
Maintenance Requirements	LOW
Land Take	HIGH

BENEFITS	
☑Water Quality Control	YES
☑Water Quantity Control	YES
☑Amenity Value	YES
☑Habitat Creation Value	YES
☑Biological Treatment	YES

DESCRIPTION

Retention ponds are permanent water bodies which hold water for a couple of weeks allowing particles to settle and biological treatment. Retention ponds are regional controls which serve large scale developments, such as industrial estates and major housing developments. They are one of the most effective storm water management installations for removing storm water pollutants. Sedimentation of solids occurs in the open water and wetland bench. Nutrients are removed in the open water by photosynthesis and by bacteria attached to wetland plants. Since retention ponds have the capability of removing soluble pollutants, they are suitable for sites where nutrient loadings are expected to be high. These systems also provide flood control, when designed to allow fluctuations in water level above the permanent pool of water.

Roadside Retention Pond, Scotland

DESIGN

General Design Criteria / Features

- Design to have a minimum permanent pool of 4 x Vt (Wallingford Procedure).
- Design to hold water for 14 - 21 days.
- Typically ponds are comprised of a sediment forebay, a permanent pool of open water and an outlet structure.
- Wetland and aquatic vegetation are planted mainly around a shallow benched edge.
- A minimum contributing area of 5 ha is desirable.
- The inlet should be designed to minimise the velocity of flow entering the system. The inlet and outlet should be remote from each other. The inlet should not be fully submerged at normal pool elevation.
- Pre-treatment is achieved in the sediment forebay: a small pool (typically about 10% of the volume of the permanent pool). Coarse particles should be trapped in the forebay.
- Open water in retention ponds should occupy 50-75% of the permanent pool surface area. The remaining area should be used to create a shallow bench about 3m wide (CIRIA, 2000).
- This shallow bench should be planted with appropriate native aquatic vegetation which will:
  - enhance the removal of soluble nutrients and sediment trapping,
  - prevent sediment re-suspension,
  - provide a wildlife habitat,
  - act as a safety bench to prevent children reaching deeper water,
  - help to conceal any litter or debris which may accumulate
  - help stabilise the soil at the edge of the pond, preventing erosion,
  - enhance the aesthetic value of the facility, helping to make an asset to the community.
- Side slopes should be limited to 1 in 4.
- Flatter slopes also help to prevent erosion of banks, make routine bank maintenance tasks easier and provide for public safety.
- The original design volume of the pond should take into account gradual sediment accumulation.
- The average depth of water in the permanent pool should be between 1m and 2m, with a limit of 2.5m to prevent anaerobic conditions. This should also be deep enough to minimise algal blooms and re-suspension of previously settled materials.
- Some flood storage is also available above the permanent pool which is limited to 2m above the normal water level to prevent inundation of the vegetation.
- Wet ponds need a sufficient drainage area to maintain the permanent pool.
- During large flood events it may be necessary to divert runoff round the pond.
- The water should be retained in the pond for 14 to 21 days during the wettest months to allow for biological treatment and allow settlement of fine solids.
- A liner may be required to retain a permanent pool where soils are permeable.
- In pollution hotspots, such as industrial estates, ponds should be lined to prevent groundwater contamination. A liner should also be used where groundwater levels are high or require protection, to prevent interaction with the polluted run-off.
- The design should incorporate features to lengthen the flow path through the pond, such as underwater berms.
- Length to width ratio should be 5:1 preferably, with a minimum of 3:1 (Horner et al, 1994).
- The use of multiple ponds in sequence improves treatment.
- Fencing of ponds is generally not desirable but may be required in some situations.
- Signs may be posted during cold periods, to warn of the dangers of ice.

MORE OVERLEAF - 1 of 4

RETENTION PONDS

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DESIGN

Habitat Enhancement

- Locate ponds near (but not directly connected to) other wetland areas e.g. (natural ponds, lakes, floodplains) to allow plants & animals to colonise.
- Create habitat mosaics with sub-basins of permanent, temporary and semi-permanent ponds, varied in size (from 1ha down to 1m^2) and depth (1m down to 5cm).
- Maximise the area of shallow and seasonally inundated ground dominated by emergent plants which are generally more tolerant of pollutants than submerged aquatic plants.
- Create undulating 'hummocky margins' in shallow water, which mimic the natural physical diversity of semi-natural habitats. Avoid smooth finished surfaces, as they provide less physical diversity for plants & animals.
- Encourage development of open, lightly shaded and densely shaded areas or pools.
- Encourage a mosaic of marginal plants (rather than single species stands).
- Use native water plants, trees, shrubs or grass species.

DESIGN

Volumetric Design Criteria

The volume required is defined by a matrix of parameters which are summarised as:

1) Depth / Area Storage Relationship:

- This is largely dictated by topography and outfall levels. Volumetric allowances for vegetation of up to 25% should be provided.

2) Head / Discharge Relationship:

- The pond/basin should be designed to a maximum discharge rate, achieved when the structure is full but consideration must be given to outfall conditions, e.g. receiving water levels.

3) Throttle Rate:

- Throttle sizes are generally a minimum of 150mm. For smaller developments, the volumetric requirement is likely to be achieved by other drainage components such as lined or unlined permeable pavement car parks or soak-aways.

4) Effective Contributing Area:

- This is the paved and pervious catchment surfaces which contribute runoff after various losses.

The relationship between contributing area and throttle rate will define the critical duration of the design rainfall events. Events will be longer for tighter throttle rates and storage volumes

5) Rainfall Characteristics of the Area:

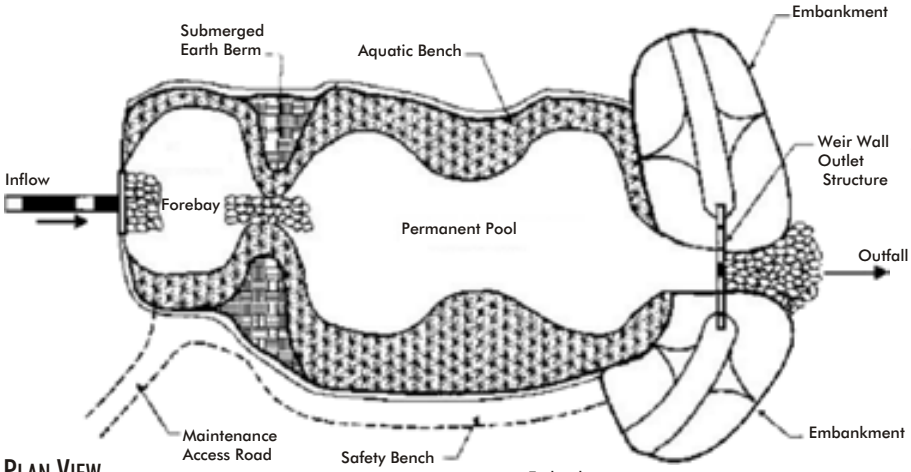
- Ireland has been analysed for hydrological characteristics. These have been processed to enable appropriate design storm events to be produced for any location, duration and return period. This is based on the Flood Studies Report undertaken in the 1970's.

6) Level of Service:

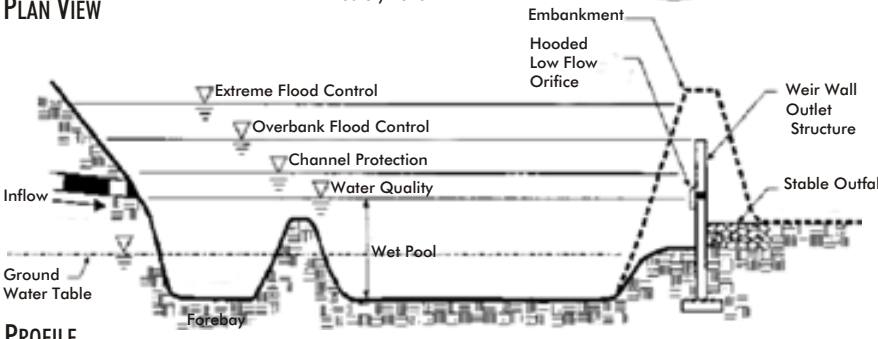
- Design should be for a range of return periods (1 to 100 years). It is unlikely that one structure will serve the needs of the various criteria. Temporary flooding of car parks and public space areas are likely to be acceptable on occasions. The hydraulic implications for loss of volume due to sediment or vegetation should also be considered.

7) Safety:

- This should be considered for all stages of construction, operation, maintenance and decommissioning.
- In the case of extreme events an appropriate design criteria should be applied to protect against overtopping.
- Large storage areas may have to consider not only the freeboard and reinforced spillway but the fetch for wave development.
- Very large storage reservoirs would have have regard to dams regulations and risk of failure should be examined in all cases.
- Blockage of the pass forward structure must be catered for and an alternative method of drawing down the storage system must be provided.



PLAN VIEW



PROFILE

Retention Pond, Scotland

FROM PREVIOUS & CONTINUES - 2 of 4

RETENTION PONDS

SITE CONTROL

POLLUTANT REMOVAL

The effectiveness of wet ponds has been estimated through a wide range of research, producing variable results. However, it is believed that proper design and maintenance may help to improve performance. Research reported by Schueler suggests the following typical removal rates (USEPA Factsheets):

Pollutant	Removal (%)
Total Suspended Solids	67
Total Phosphorous	48
Total Nitrogen	31
Nitrate	24
Metals	24-73
Bacteria	65

Details of other studies are available from the (US) National Stormwater Best Management Practices Database. (www.database.org)

A Retention Pond in Scotland

MAINTENANCE CONSIDERATIONS

- Readily visible facilities tend to receive more and better maintenance than those less visible, more remote locations.
- Inlets and outlets should be inspected quarterly or after large storms for evidence of clogging or accumulation of debris.
- Other potential problems that should be checked include subsidence, nuisance plants, erosion and litter accumulation.
- Regular mowing can be carried out around the margins. However, this adds to the maintenance costs, reduces the habitat potential and is not always required.
- Maintenance costs may be higher in the first few years after construction, until the vegetation becomes established.
- Typically sediment may have to be removed from the forebay once every 10 years or after 50% of total forebay capacity has been lost.
- Adequate maintenance access should be provided.
- Sediment should be removed from the pond, as required, when the pool volume has become reduced significantly or the pond becomes eutrophic. US EPA factsheets suggest this is required once every 20 years.

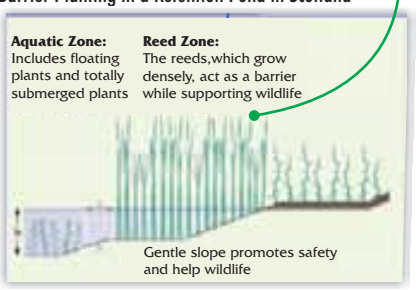
COST CONSIDERATIONS

- Ponds are long-life facilities (typically longer than 20 years).
- The construction costs associated with these facilities vary considerably.
- In addition to the water resource protection benefits of wet ponds, evidence suggests they may provide an economic benefit by increasing property values, where they add to the overall amenity. This is supported by experience in the USA and Australia.

OTHER CONSIDERATIONS

- Existing wetlands or natural ponds should not be used as SuDS facilities.

Barrier Planting in a Retention Pond in Scotland



INTERNATIONAL EXPERIENCE

In Scotland, monitoring of retention ponds has highlighted the importance of bank stabilisation at an early stage. Erosion, due to wave action has been a problem in systems which are not adequately sheltered from the prevailing westerly wind. In Dunfermline, retention ponds have provided an added amenity to the local area. Recently, educational initiatives have been set up to encourage school children to make supervised visits to the ponds and assist with planting. Competitions have been held in the local press for local children to invent names for the ponds. Display boards are to be positioned around the ponds to explain their purpose.

Retention ponds have also been used to control runoff from a motorway service station on the M40 in Oxford, England. The drainage of the site is based on the treatment train concept. Permeable paving and filter drains have been used as source control measures. Regional facilities consist of retention ponds and a stormwater wetland.

Retention Pond, Scotland

CONTINUES - 3 of 4

RETENTION PONDS

SITE CONTROL

International Experience

U.K.

A suite of SuDS options has also been used at the Hopwood motorway service station on the M42. SuDS measures include permeable paving and retention ponds.

M42 Motorway Services

Advantages

☑Capable of removing solid and soluble pollutants.

☑Provides biological treatment of run-off.

☑Suitable for sites where nutrient loadings are expected to be high.

☑Can be used in residential, commercial and industrial sites.

☑Can provide flood control.

☑Habitat creation.

☑Provision of an amenity to local residents.

☑Educational opportunity.

☑Can increase property values when planned and sited properly.

Limitations

☒Safety concerns.

☒Requires relatively large land area therefore may not be suitable for high density urban areas.

☒Requires contributing area greater than 5 hectares, typically.

☒Liners may be required when soil conditions are permeable or where groundwater levels are high.

Construction Stage...

Retention Ponds, Construction Stage, M74, Scotland

Operational Stage

Retention Ponds, Operation Stage, M74, Scotland

FROM PREVIOUS - 4 of 4