

Dyffryn Gardens Flood Management Project

using natural flood management to provide affordable protection compatible with the listed building and grounds

by Raff Whitehead BSc (Hons) CEng MICE MEPS and Bethan Young BSc (Hons)

Dyffryn Gardens is a National Trust property of 22 hectares in the Vale of Glamorgan. The 19th century grade II* listed building, visitor centre, grade I registered landscape and grounds are open to the public all year round. There were over 66,000 visitors in 2013; over 100,000 visitors per year are expected by 2017 and 150,000 by 2020. Designed by eminent landscape architect Thomas Mawson, the gardens are the early 20th century vision of industrialist John Cory and his son Reginald. The threat of flooding is something to be constantly borne in mind and prepared for at this property and natural flood management techniques are being explored to reduce the impact of future flooding.



Top (L): Dyffryn House - Courtesy Waterco Consultants Top (R): 2008 flood - Courtesy National Trust
Bottom (L): Gardens south of the house (2008) - Courtesy National Trust Bottom (R): Flood cascading onto Great Lawns (July 2007) - Courtesy National Trust

Recent flooding history

The grounds include a world-class croquet lawn and the lavender court pools which are breeding grounds for a Great Crested Newt metapopulation. Two ordinary watercourses flow through the site: the River Waycock and its tributary, Nant Bran. The River Waycock is culverted through the site from just downstream of the confluence with Nant Bran.

The building and grounds have been flooded seven times in the last twelve years despite the installation of two attenuation ponds in 2007. Part of the cellar under the building has flooded more often. Although the flood water is generally not deep, it can be fast flowing and therefore a hazard as well as an inconvenience to visitors, staff and volunteers. Key objectives are to protect the grade II* listed building and the visitor centre.

Are you protected from flooding?

FloodProof™ Doors

The solution wherever flooding is a problem

FloodProof™ Doors (Automatic Flood Defence): Suitable for many residential and commercial buildings offering a wide choice of materials including; UPVC, aluminium, steel, wood-like composites, seasoned timbers & hardwoods, making them suitable for all applications including historic & listed building work.

FloodProof™ Garage Doors (Automatic Flood Defence): Suitable for many residential and commercial buildings offering a wide choice of both colours and styles to protect your garage from flood infiltration. When the flood sensor detects rising water, a unique pneumatic seal automatically inflates to shield a garage door.

Shop & Commercial FloodProof™ Doors: FloodGuard UK's patented commercial Shop Doors include our 'FloodSafe' FloodProof™ door system, which offers a high degree of flood protection to shop and commercial premises. The 'FloodSafe' Door System allows the entire doors to seal against flood without the need for threshold plates.

Hydraulic Flood Barriers: FloodGuard UK's range of automatic (or manual) Hydraulic Flood Barriers, are designed and manufactured to protect vulnerable open entrances in a perimeter wall for vehicular or pedestrian traffic. They offer immediate protection against flooding, including flash floods, and are able to withstand the many tons of force that flooding can create.

FloodProof™ Gates: FloodGuard UK manufacture a range of manual and automatic flood prevention gates to provide entrances with secure and decorative protection. These gates can be up to 6m wide. Larger sizes can be manufactured subject to design requirements.

**flood protection : flood prevention : flood management
for home floods & commercial property flooding**



FloodGuard UK Ltd

3 - 7 Ormskirk Road, Newtown, Wigan, WN5 0XD

Website: www.floodguarduk.co.uk

E-mail : admin@floodguarduk.co.uk

FreePhone: 0800 073 5455



One of the existing attenuation ponds - Courtesy of Waterco Consultants

The consequences of flooding for the gardens are greatest for the Great Crested Newt breeding ponds and protection should be considered for these areas.

It is understood that the fish in the ornamental ponds on the low-lying great lawn have previously been washed away by flood water and the croquet lawn has also been affected by flood-borne debris.

Properties in Dyffryn village, immediately downstream of Dyffryn Gardens have also been flooded. Reducing the peak flood flow to protect Dyffryn Gardens should also benefit Dyffryn village.

Flood management action

The main flood management actions will concern routing and storing the fluvial and surface water flows. In addition, the surface water drainage system is being investigated and cleaned to ensure it operates at full capacity and backflow to the cellar is prevented.



Nant Bran and the visitor centre - Courtesy of Waterco Consultants

Natural flood management (NFM) is gaining credibility throughout the UK. Instead of the traditional approach of increasing the capacity of the existing system to prevent flooding, NFM seeks to reduce peak flows at source, so that the existing system can cope. NFM is typically a fifth of the cost of the traditional 'hard engineering' approach and also provides important benefits such as water quality improvement and increased biodiversity.

The National Trust is currently managing a scheme to alleviate flooding and improve the wider environment in a 5,000 hectare area around the National Trust's Holnicote Estate on Exmoor.

This is a scheme that started in 2009 and is being monitored and maintained for ten years, to record evidence for future similar schemes. Flood water is attenuated in the landscape to reduce the flood risk in the downstream villages of Allerford and Bossington. This is the approach that is being explored for Dyffryn Gardens.



Nant Bran joining the River Waycock - Courtesy of Waterco Consultants

Waterco Consultants formed a two year knowledge transfer partnership with Liverpool University in 2013 to focus on natural flood management, including case studies in St Helens and Cheshire. Management techniques, collaboration, flood alleviation, environmental benefits and cost are recorded and assessed with the aim of improving flood risk management

Flood sources

The house at Dyffryn Gardens is situated in a rural area 50m south of the confluence of the main river the River Waycock and its tributary the Nant Bran. Approximately twenty metres north of the house, the River Waycock flows into a 450m long culvert beneath the site which outfalls at the southern boundary of the site.

During recent flood events, the culvert capacity has been insufficient causing flood waters to overflow. The overflow of water then proceeds to flow south in line with the submerged culvert and floods the central low-lying part of the site.

As well as the fluvial source of flooding from the north, surface water flood waters flow onto the site from the hill to the west. A review of the permeability of the soils and bedrock in this area has shown that the ground is highly impermeable compared to the rest of the catchment causing much of the flow to run overland. The ground in this location is also very steep and therefore does not allow water to stand and sink into the ground.

It is understood that both the surface water and fluvial flood waters are directed towards the River Waycock in its culverted state and are collecting on the low-lying area of gardens.

Simulating the flooding on site

Waterco Consultants has been engaged to simulate the existing flooding on site. A 1D/2D hydraulic model is being built to simulate



The world-class croquet lawn (2008) - Courtesy of National Trust

the River Waycock and Nant Bran during a range of fluvial flood events in conjunction with the surface water model of the western hill.

The hydraulic model is composed of surveyed river cross-section data for the two watercourses on site and represents the 1D element. Also included will be the existing attenuation ponds and culverts to simulate and assess the existing drainage solutions on site.

Light detection and ranging data (LiDAR), which is 3D terrain mapping on a 1m grid with levels within 150mm, will be used to represent the surrounding topography. Finally, both parts will be linked to allow for free movement between the watercourse and the floodplain.

One of the most important parts of this assessment is calculating the flows (hydrographs) in the River Waycock and Nant Bran as accurately as possible. The catchments are much more permeable in the upper reaches than the downstream areas.

Geographical information systems (GIS) including watershed analysis based on coarse terrain data has been used to estimate the catchment boundary. GIS has also been used to overlay the catchment boundaries onto soil and geological maps to area-weight the permeability of the catchments (image included above).

Once the catchment descriptors are estimated accurately, the revitalised flood hydrograph (ReFH) method is used to estimate the hydrographs as well as the net rainfall rate for the surface water model. Ground permeability will be taken into consideration.

On-site solutions

Once the model is shown to be a good representation of the flood mechanism on site, mitigation measures can be modelled

and assessed. Firstly, on-site solutions will be investigated such as attenuation ponds and low level bunds diverting the flood waters away from the building and the most vulnerable parts of the gardens.

Potential solutions will be discussed with the National Trust staff before modelling, to ensure they are compatible with the registered landscape and do not impede access for the increased number of visitors in the future. The objective is to manage potential flooding to reduce its impact on site without worsening flooding downstream or having an adverse effect on the landscape.

The advantages of on-site solutions are that there is no need for landowner agreements and they are easily accessible and visible for routine inspection and maintenance. It is expected that the agreed and modelled solutions could be implemented within the year.

Catchment solutions

Once as much as possible has been done on site to manage flooding, it is likely that additional solutions will be required outside the site boundary further up in the catchment. The model will be extended upstream and natural flood management techniques such as tree planting and debris dams will be modelled.

These options are the most compatible with the natural environment and cost effective for the client. Suitable locations will be identified, surveyed and discussed with the landowners before being modelled.

An update on the progress and solutions is planned to be published next year.

The Editor & Publishers thank Raff Whitehead, Associate Director, and Bethan Young, Hydraulic Modeller, both with Waterco Consultants, for providing the above article for publication.

www.waterco.co.uk



Water

Hydrology and Water Quality Modelling, Security, Asset and Strategic Planning, Pipelines and Distribution systems (including self lay)

Drainage

Pre Planning Assessment, SuDS, Groundwater Modelling, Sewerage and Sewage Treatment

Flood

Risk and Consequence Assessment, Hydraulic Modelling, Natural Flood Management, Coastal and Breach Assessment, Flood Risk Management, Flood Hazard Maps, Response Plans

Tel: +44(0)1824 702220

Waterco Ltd, Eden Court, Lôn Parcwr Business Park, Ruthin, Denbighshire, LL15 1NJ