Bilton School Sustainable Drainage Systems

SuDS project to reduce the volume of water entering the combined sewer system exemplifies excellence in sustainable design and construction

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This Sustainable Drainage Systems (SuDS) at Bilton School, Hull, aimed to reduce the volume of water entering the combined sewer system by providing storage during rainfall events. The project adhered to the CIRIA SuDS Manual and ensured that the features installed would disconnect flows going directly into the network and slow the return of stormwater back into the network, thereby ensuring controlled discharge into the sewer network while providing essential storage during rainfall events. Mott MacDonald Bentley (MMB), in collaboration with Yorkshire Water, Living With Water, and Stantec, undertook the detailed design and construction of the initiative.

SuDS pond and swale - Courtesy of Mott MacDonald Bentley

Project overview

The scheme involved the installation of various SuDS features due to previous flooding in the local area in previous areas. Installations included underground attenuation storage in the playground area, new perimeter channel drains in the car park area, and a 75-meter-long swale to convey flows to an attenuation pond. Additionally, four planters were installed throughout the school to slow flows from the school roofs. The playground and car park surfaces were redesigned to direct flows into underground storage and to the adjacent pond, with the playground completed with fun and educational surface markings.

Tree pits with permeable paving

Tree pits are an integral component of Sustainable Urban Drainage Systems (SuDS), designed to manage stormwater runoff in urban environments. At Bilton School, tree pits were installed to provide storage for stormwater underneath the playground. Tree pits are engineered structures that integrate trees into urban landscapes while providing a means to manage stormwater. These systems typically consist of a subsurface storage area filled with soil and structural crates that support the tree and store water.

The primary purpose of tree pits is to capture, store, and slowly release stormwater, thereby reducing the volume and rate of runoff entering the sewer system. The operation of tree pits involves several key processes:

- ***Stormwater capture***: During rainfall events, stormwater is directed into the tree pits through permeable paving. The water infiltrates the soil and crate system, which acts as a temporary storage reservoir.
- ***Storage & filtration***: The soil within the tree pit filters pollutants from the stormwater, improving water quality. The structural crates provide additional storage capacity, allowing the system to hold a significant volume of water.
- ***Slow release***: The stored water is gradually released into the nearby drainage system. This slow release helps to mitigate the impact of flooding by reducing peak flow rates and volumes.
- ***Tree health***: The stored water also benefits the tree by providing a consistent source of moisture, promoting healthy growth and enhancing the urban environment.

The system was designed to store water in the soil and crate system from Polypipe Civils before releasing it back into the sewer network.

A Controflow flow control chamber was installed to restrict the flow of water to 1 litre per second, as per the instructions of the Internal Drainage Board. The Controflow flow control chamber regulates the discharge rate of stormwater from the tree pits. By restricting the flow to 1 litre per second, the system ensures that the release of water is controlled and gradual, preventing overwhelming the sewer system during heavy rainfall events.

Geosynthetic clay liners

Ground investigations at Bilton School revealed high groundwater levels, necessitating the use of a liner for the pond and swale to prevent the pond from being filled with groundwater and not having the required storage capacity during a storm event. The swale and pond system were designed with a geosynthetic clay liner (GCL), which offers several advantages over traditional liners.

GCLs are factory-manufactured hydraulic barriers consisting of a layer of bentonite clay sandwiched between two geotextiles or bonded to a geomembrane. Bentonite clay is known for its high swelling capacity and low permeability, making it an effective barrier against water infiltration. The geotextiles provide structural support and protect the clay layer from damage during installation and operation.

GCLs offer several advantages over traditional liners such as compacted clay liners (CCLs) and geomembranes. These benefits include:

- ***Self-healing properties:*** One of the most significant advantages of GCLs is their self-healing capability. When bentonite clay comes into contact with water, it swells and fills any voids or cracks that may develop, effectively sealing the liner. This property reduces the need for future repairs and maintenance, ensuring long-term performance.
- ***Ease of installation:*** GCLs are lightweight and easy to install compared to traditional liners. They are supplied in large rolls that can be quickly deployed over the prepared surface. This reduces installation time and labour costs, making GCLs a cost-effective solution.
- ***Environmental benefits:*** The use of GCLs significantly reduces the project's carbon footprint. Traditional compacted clay liners require extensive excavation, transportation, and compaction, which contribute to higher carbon emissions.
- ***Reduced water usage:*** Compacted clay liners require a significant amount of water for proper compaction and hydration. GCLs, on the other hand, require minimal water for activation, conserving valuable water resources.
- ***High performance:*** GCLs provide superior hydraulic performance compared to traditional liners. The low permeability of bentonite clay ensures effective containment of water and other fluids.

Tree pit installation - Courtesy of Mott MacDonald Bentley

Vegetated headwall system

A vegetated headwall system from Geogrow was chosen over a conventional concrete headwall for the outlet from the attenuation pond, where it discharges into the watercourse. This decision was driven by the need to limit carbon emissions from cement production and to enhance the aesthetic and ecological value of the site. Geogrow bags were also used for the headwall at the inlet of the swale.

Installation of the vegetated wall system
Courtesy of Mott MacDonald Bentley

Vegetated headwall systems are engineered structures that use geotextile bags filled with soil and planted with vegetation. These systems are designed to provide structural support while integrating seamlessly into the natural environment. The vegetated facade not only enhances the visual appeal but also offers several ecological and environmental benefits.

Traditional concrete headwalls require significant amounts of cement, the production of which is a major source of carbon emissions. By contrast, vegetated wall systems use geotextile bags and soil, which have a much lower carbon footprint. They also provide a natural and visually appealing alternative to concrete structures. The vegetation helps the wall blend into the surrounding environment, enhancing the site's aesthetic value. Additionally, the vegetated walls support local biodiversity by creating habitats for various plant and animal species. This ecological integration

Geogrow vegetated wall system - Courtesy of Mott MacDonald Bentley

promotes sustainability and contributes to the overall health of the ecosystem. The use of vegetated headwall systems supports environmental sustainability by reducing the reliance on non-renewable materials and promoting the use of natural resources.

The installation of vegetated headwall systems eliminates the need for heavy lifting and placement of precast concrete units, which can pose significant health and safety risks. By using geotextile bags and soil, the construction process becomes safer and more efficient, reducing the risk of injury associated with handling and installing large concrete structures.

Bilton School SuDS: Supply chain - key participants

- **Principal designer & contractor**: Mott MacDonald Bentley
- **Outline design**: Stantec UK
- **Geosynthetic clay liners**: Naue Geosynthetics Ltd
- **Planters**: Bioscapes®
- **Tree pits**: Polypipe Civils & Green Urbanisation
- **Vegetated headwalls**: GeoGrow Ltd
- **Channel drain**: MEA Water Management
- **Flow control chamber**: Controflow from SuDSstore

Enhancing biodiversity with Bioscapes planters

A number of Bioscapes planters were installed at the school. These planters are designed to capture and hold water during storm events by connecting on existing rainwater downpipes, reducing the flow rate and input to the drainage network. By managing surface water runoff, the planters mimic natural processes and improve water quality before it enters sewers or rivers. Bioscapes planter was specifically chosen as they also support a wide range of habitats.

The planters provide essential habitats for wildlife, supporting Biodiversity Net Gain (BNG) by integrating ten wildlife habitats within a compact space, creating microhabitats that cater to various plant and animal species. These planters include features such as houses for hedgehogs, butterflies, bees, amphibians, and birds. This initiative not only enhances the local ecosystem but also contributes significantly to environmental sustainability.

Bioscapes planters also offer significant educational benefits. At Bilton School, Bioscapes provided teaching and planting sessions with the children, engaging them in hands-on learning experiences. These sessions included planting a wide range of plants, such as spring bulbs and winter flowers, ensuring a vibrant display throughout the year.

The educational activities associated with the planters help to raise environmental awareness among students, teaching them about the importance of biodiversity and conservation. By involving children in the planting process, they gain a deeper understanding of ecological principles and the role of sustainable practices in protecting the environment.

Community engagement & educational initiatives

The project included several community-focused initiatives, such as the creation of a woodland path for pond dipping activities, a bug hotel, and various educational activities with the school. These initiatives promote environmental awareness and foster community engagement. Tours of the grounds were conducted with staff and children to explain the project's benefits, and children were involved in the design process by completing sketches of the playground.

Educational signage was installed to explain the various sustainable features of the project, helping to educate the public about the benefits of SuDS. Collaboration with Hull University involved installing testing and monitoring equipment to assess the project's effectiveness.

The data collected will be shared with the school, furthering educational opportunities and demonstrating the project's long-term sustainability and societal impact.

Summary

The SuDS project at Bilton School exemplifies excellence in sustainable design and construction. Through innovative features, community engagement, and effective project management, the initiative has significantly benefited the school and its surroundings. The project's success demonstrates the potential for SuDS to enhance environmental sustainability and provides valuable data to support future initiatives in sustainable urban drainage.

The editor and publishers would like to thank Thomas Atkins, Project Leader, Jade Toulson, Lead Engineer, and Neil Shepherd, Contracts Manager, all with Mott MacDonald Bentley, for providing the above article for publication.

Bioscapes planter - Courtesy of Mott MacDonald Bentley

Bug hotel - Courtesy of Mott MacDonald Bentley

Educational signage - Courtesy of Mott MacDonald Bentley