BELVEDERE SPLASH PARK

Water Quality Issues Report

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Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
Final	04/06/2015	Chris Welch	Keith Kennett	Keith Kennett

Comments	Final Issue

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Content

1. INTRODUCTION

Waterman Building Services have been engaged by the London Borough of Bexley to produce a report highlighting the issues associated with the Belvedere Splash Park facility that have led to reports that at times the water quality is not adequate enough for the children using it, and leading to the splash park closures.

This report sets out to understand how the splash park equipment operates and how the park is utilised and the suitability of the installation for the demands placed upon it.

To this end Waterman Building Services attended site on the 11th February 2015, together with Paul Newland, a representative of Sun Safe Play Systems, the original installation contractor, a member of the splash park`s maintenance team and Bob Smith a member of the councils engineering team. The splash park was closed, usual winter shut down, and the plant and equipment not in use. The bulk water storage tank had been emptied.

The purpose of the visit was to provide Waterman Building Services with an insight into the history of the splash park, the issues associated with the splash park and to gain an understand of how the splash park operates and an appreciation of how the onsite drainage and water systems operate.

2. BRIEF HISTORY OF THE SPLASH PARK

The splash park is situated within a depression in the land and was previously used as a boating lake. The splash park play area is circled by tarmacked paths, grass banks, grassed seating areas and established trees. The entire park is edged with fencing and has three gates for entry. The play area has a concrete base covered in a coloured EPDM surface and the area is graded to a number of recirculating drain points. At the high end of the splash park there is a drinks and snacks facility and the pool equipment plant room both housed with a single storey building.

The splash park equipment was installed in the early part of 2005 to provide a free, engaging and varying water play facility for children to enjoy and use throughout the warmer spring and summer months and beyond. There are a number of different attractions such as tilting buckets, jet sprays of various styles and a splash pool at one end for the younger children to enjoy and play in.

2.1 Brief Description of the Splash Park Equipment

There is a single GRP storage tank, buried below the splash park, which provides the bulk storage of water for the splash park equipment. The tank has an estimated storage capacity of around 18,000 litres which is filled initially from the local authority potable water mains supply and topped up as and when required by the same supply. During periods of operation treated water keeps the tank levels topped up from a circulated return line from the plantroom which returns the treated water into the "treated" water end of the tank.

At the opposite end of the tank "dirty" water is collected from the splash park drainage system. At the water features end of the splash park water is drained back constantly to the storage tank via a network of drainage gullies and runs through a filter before entering the tank. At the pool end of the splash park water is drained, after the splash park has closed, via a network of drainage gullies which can be opened or closed as required to create a depth of water providing the pool when the splash park is in operation. In addition to these gullies there are additional gullies around the top level of the pool which drain water constantly to prevent water from spilling onto the surrounding area. Drainage from all of these gullies also pass through a filter before entering the tank at the "dirty" water end.

There is currently no division between the "treated" water and "dirty" water ends of the tank.

"Dirty" water, from the drainage inlet end of the tank, is drawn from the tank by a duplicate pump set located within the plant room. Within the plant room the drawn water passes through bucket filters, duplicate stainless steel bodied sand filters, is chlorine dosed with a granular feeder system and the PH levels are controlled by calcium and sulphuric acid, before the "treated" water is returned into the tank via the circulated return. During the open periods of the splash park water is circulated 24 hours a day.

From The "treated" water end of the storage tank a separate display pump draws water which provides a suitable high flow rate and high pressure feed the water jet features.

3. REPORTED ISSUES, HISTORICAL COMMENTS AND GENERAL OBSERVATIONS

From the site visit a number of issues and theories were brought forward by the operating staff. Paul Newland from Sun Safe and Bob Smith of Bexley Council, regarding the upkeep of the splash park and the possible reasons why water quality has been poor. Waterman Building Services made comments, noted observations and took note of the plant installation and site conditions. Subsequent information provided by various interested parties has been received and incorporated into the findings. This information has been very helpful and open and indicates a combined effort to resolve the outstanding issues.

3.1 List of Comments, Issues and Observations

3.1.1 Overcrowding

It has been noted that at times, especially during the summer holidays and when the weather has been fine, there have been very large numbers of children in the park at any one time. This may only have been on limited occasions, but very large numbers will have a detrimental effect on the water quality as more people bring more soiling and puts the water treatment system under extreme pressure and would be well beyond the envisaged number of users, that the splash park was originally designed for.

It is unknown what the designed maximum number of users should be or what the current filtration system can accommodate, but typically for a park of this size and utilising the PWTAG figures for a re-circulating system, the numbers would be around 475.

It is understood that during the summer, in an attempt to limit the number of users at any one time, during operating periods (typically between the hours of 11am and 5pm, 7 days a week) that access into the water park is limited to a single point of entry with all other gates being locked. This has not always proved to be effective.

3.1.2 Human Soiling

There are no feet wash trays or facilities for showering before entering the EDPM area and therefore no ways or removing dirt and debris from the children. Also in hot weather conditions the children would be covered in sun tan lotion and not being able to remove excess sun tan lotion would possibly result in more being removed once playing within the water features and pool areas.

It was reported that soiling from smaller children and babies, especially from the pool area of the splash park, had resulted in the closing of the facilities to enable the Council to undertake an emergency clean, water dump and total replacement of the water. This action is necessary as the Council have no other way to remove the risk of Cryptosporidium.

3.1.3 Rainwater Collection

Rainwater falling onto the EDPM surface can obviously not be separated from the circulatory system serving the water features as the drainage system discharges to the storage tank buried beneath the splash park. In the main this rainwater would be reasonably clean containing only minimal fines or dirt. The issues are rather from the rainwater that falls onto the surrounding grass banks and

tarmacked paths. Even though these areas are separated from the EDPM surface by floor gullies sited near the entrances to the EDPM area and drainage channels that run across the entrances they are ineffective and poorly maintained, and will require regular maintenance, such as cleaning of loose debris and jetting clear as and when required.

The drainage channels and gullies have become blocked with dirt and silt and rainwater cannot run into them, and therefore runs across them to spill onto the EDPM area. This in turn delivers more silt and dirt onto the EDPM surface. It was reported by Bob Smith that the gullies and drainage channels run to a number of soak-a-ways around the perimeter of the EDPM area but it would be best to assume that these are blocked and not performing any benefit.

3.1.4 Trees, Grass and Dirt

As already mentioned above there is little to prevent grass and dirt entering the EDPM surface and therefore being washed down into the storage tank via the drainage system. There is currently grass verges on all sides of the EDPM area and large grass areas surrounding the whole park. There are many mature trees close to the EDPM area in the surrounding grassed areas which contribute year round leaves debris and pollen onto the surface, which again eventually finds its way into the storage tank.

3.1.5 EDPM Surface

The EDPM coloured in-situ formed resin bound rubber surface provides a comfortable and soft play surface for the children`s wet play environment. This was laid and bonded to the concrete surface below and provided good service for a number of years.

In 2013 the surface was re-laid with a new one. The surface was re-laid by Redlynch Installations Ltd, guaranteed for five years and the installation was supervised by Mr Bob Froud from Materials Science Ltd, an industry expert in these type of surfaces.

The EDPM surface has performed well since its installation in May 2013.

An EDPM (rubber) surface reduces risk of injury, particularly traumatic head injuries, however the disadvantage of an EDPM surface, especially now as there are two layers, is that it acts as a `large sponge` retaining dirty water. In the pool end of the water park this water is in contact with the standing water in the pool and will aid transference of any bacteria, making it difficult to remove. Constant cleaning of the surface is required.

3.1.6 Water Treatment and Filtration System

Water treatment within the plant room consists of “dirty”, water from the buried storage tank, being drawn by duplicate pumps into the plantroom and passing through duplicate bucket filters, for primary filtering of organic matter. The main filtration is currently provided by two stainless steel bodied sand filters. The operating staff believe that the filters are constructed of three trays of sand and require recharging. It is also believed that the filters are arranged in parallel and that they are Shallow Bed, high rate filters and not Deep Bed, medium rate units which are now recommended for this type of application. As shallow bed filters they lack the efficiency to remove Cryptosporidium oocyts. Replacing only the sand filter media will not reduce the risk of infection from Cryptosporidium, and Cryptosporidium is resistant to chlorine.

There are currently no Ultra Violet (UV) filters fitted on the system which would provide an effective control of both legionella and cryptosporidium.

The circulated water is then chlorinated by utilising a granular feeder system and the PH levels are controlled by calcium and sulphuric acid, before the “treated” water is returned into the tank via the circulated return.

The turn-over rate of “dirty” water is unknown but current regulations call for a turn-over rate of better than 15 minutes.

3.1.7 Ponding Water

As already indicated the ponded water area is provided for the babies and younger children to play in, but does provide an area where water can be trapped all day, before it is discharged to drain after the closing of the park in the evening.

This can provide a breeding ground for bacteria and absorption and retention into the EDPM matting can only assist in this process.

3.1.8 Maintenance and Testing Regime

No O&M manuals were available on the day of the visit. Subsequently a copy of the O&M manual has been provided by the Council.

It would appear, from talking to the operating staff, that they are competent in what they do and that regular maintenance is undertaken. They informed us that the water quality in the tank, at the end of the day, is often found to be turbid, where it should be clear.

To alleviate this the tank water is often dumped to drain and the tank filled with fresh and clear potable water. This we understand has been taking place for some time now and would add considerable costs to the operating of the facility. It is not environmentally acceptable and would not comply with general water conservation measures.

The tank was shut for cleaning twice a week and for emergency clearing prompted by either a soiling incident or heavy rain. Pre and post cleaning samples were taken weekly (around four occasions per week) from the tank and the tap on the water feature header pipe and sent for laboratory testing and monitoring against PWTAG guidelines. These results often showed levels of bacteria in between cleaning regimes that gave rise to concerns and prompted further investigation.

3.1.9 Latest Regulations

When the facilities at the splash park were designed they would have been in line with PWTAG (The Pool Water Treatment and Advisory Service) guidelines current at the time, changes to Splashpad/Spraypark design by PWTAG were published in March 2005 as a technical bulletin. This was to aid designers and has since been included in the latest edition of the PWTAG-Swimming Pool Design guidelines and should be referred to for any and all future works to the facility. Certain areas such as filter types, water turn-over rates and storage tank design have all been revised in the current edition.

3.1.10 Life Span of Equipment

Generally and in accordance with CIBSE guidelines all equipment has a life span of a number of years, which can be influenced by a number of factors such as general maintenance, site conditions and usage patterns. As the splash park has been operating since 2005 and the equipment has been in use for 10 years, it would be appreciated that further investigations should be carried out to establish what condition the equipment is in. The original installation, installed by Sun Safe Play Systems Ltd was compliant with the Council`s use The JCT Standard Form of Building Contract, which at Section16, Practical Completion and Liability Period, stipulated that a 12 month defects (guarantee) period applied, rather than the standard minimum of 6 months.

3.1.11 Adjacent Below Ground Drainage

Before the site visit, there had been an uncertainty as to the extent and condition of the existing foul water drainage at the site and if it, in part, was contributing to the poor water quality. The council provided the services of a contractor to undertake a CCTV inspection and despite a number of blockages it was proved that the foul water system was totally separate to the splash parks water system. The only areas where the two systems are connected is for a backwash discharge and drain down facility and neither of these were compromised by the foul drainage.

4. CONCLUSIONS AND RECOMMENDATIONS

From the information provided within this report, Waterman Building Services would conclude that poor water qualities can be attributed to a number of issues, rather than to any single issue.

Further investigations, where appropriate, would be necessary and suitable actions highlighted below would be required, to ensure the parks water quality is maintained to the required level.

- A key issue would appear to be effectiveness of the shallow sand filters, but all the other issues highlighted do have an adverse effect on the overall system.
- The current regular usage of clean potable water to replace turbid dirty water in what should be a recirculating system should not be continued from an environmental water conservation stand point and ongoing cost implications. With the current levels of water consumption a once through system could be considered with the replacement of the existing water features with some new low flow units.
- The water treatment system is generally in need of updating and overhauling and bringing into line with current legislation. To what level the system is updated to, is dependent partially on what other actions are taken and put into place. Generally the single storage tank is enabling the “dirty” and “treated” water to mix and dilute the effectiveness of the current treatment. Separate “clean” and “dirty” water storage tanks would improve the effectiveness of the water treatment process.
- The shallow sand filters are not in accordance with current guidance and are in need of replacement with appropriate deep bed sand filter to meet current PWTAG guidance. Replacing the shallow filter beds with a medium rate deep filter bed in combination with a current PAC dosing system should eliminate the risk of infection from Cryptosporidium and would improve the quality of the water and efficiency of the plant. The replacement deep bed sand filters would require additional space to what is currently available in the compact plantroom. An extension to the current plantroom would in all probability be required and this may prove costly and would require planning consent
- For peace of mind, and where budgets allow, recirculating systems can be installed with UV filters working in conjunction with deep filter beds and PAC dosing to ensure elimination of Cryptosporidium. This is considered a ”belt and braces” approach and is not included on all facilities.
- The duties of all pumps would need to be considered to ensure turnover rates are in line with the current PWTAG guidance.
- As already stated it is impossible to prevent rainwater from falling onto the surface of the splash park and entering into the underground storage tank. However with the installation of either a two tank recirculating or a once throughput system it would no longer be considered a problem.
- The pool area, however appealing to the smaller children and babies, is an area that causes concern. With the obvious ability to trap and retain standing water it provides an area where dirt, debris and whatever else comes into contact with it can be exposed to high temperatures on hot sunny days. Warm water can be a breeding ground for bacteria and should be avoided wherever possible. The Council need to establish the importance of this specific facility as it is the recommendation of this report that the pool area is removed from the park no matter what upgrades or system is agreed upon.

- The depth of the EDPM surface and how it affects water quality is difficult to gauge and without further investigation Waterman Building Services cannot provide a definitive answer. It is however the recommendation of this report to remove the existing paddling area on both water consumption and water quality grounds. This being the case it provides a suitable opportunity to remove the entire EDPM surface and provide an alternative coloured hard surfacing in accordance with the latest guidance.
- Human soiling cannot be prevented due to the nature of the facility, but the introduction of pre showering and foot trays at the entrances onto the pool surface itself would improve water quality by limiting the amount of dirt, debris and sun tan lotion being carried into the facility. Only better signage, education and policing would be effective in reducing the instances of personal fouling and enforced closures of the park.
- Currently there would appear to be three options available to the Council, which are:

1. Updating of current water treatment plant and facilities

The Council need to consider and decide on how they want to run the water park and consider what facilities they provide. With the appropriate measures instigated as outlined in this report, comprising both redesign, maintenance and operating procedures, the park can continue to operate and provide the current service for the local community. There will be a financial cost to providing these measures and to developing the solutions. These can only be priced in detail when the remedial works and the parks future are established. This would form part of any further design development of the treatment system and general park facilities.

To retain and upgrade the water treatment plant and facilities it will require some ongoing level of park management and maintenance on a daily basis. However, with an appropriate recirculating system installed the water quality would be dramatically improved and water usage would be reduced. It would also require a reduced level of management and control compared to the current inadequate system.

2. To make the park a mains water only fed system

This option would do away with the water treatment/recirculating system entirely and could be achievable provided the water usage was limited by removing the pond area, reducing the number of features and providing new low flow features as appropriate. To remove the current water treatment system would alleviate the water quality issues, overcome a number of the other issues highlighted above and reduce management and maintenance of the park to a minimum. Water usage and drainage discharge would be constant and not affected by numbers of users.

Thames Water Utilities would place restrictions on the volume of clean water supplied to the park and discharges from the site but new low flow rate features may alleviate those concerns and water treatment equipment backwash would no longer be an issue. Initial discussion with Thames Water indicate that a grey water tank would be required to reuse a proportion of the parks water. Thames Water restrictions on clean water supply and use of grey water may restrict the park to a size that eliminates a once through system as a feasible alternative but this will need to be investigated as part of the ongoing design. They will not permit direct connection of their potable water supplies to the parks equipment and will only guarantee a maximum working pressure of 1bar (10 metres). It is anticipated that a higher pressure, in excess of the 1bar will be required to operate the low flow features therefore storage of mains water and pumping of it to the water features would still be required, especially as Thames Water will not permit boosting of pressures directly off an incoming

mains water supply. To ensure adequate flow rate and pressures a nominal size cold water storage tank and booster pump set will be required, and subject to a detailed design may possibly be located within the current plant room. Ongoing maintenance of the tank and pump set would still be needed, but on a greatly reduced basis and the new equipment could be provided with remote monitoring to alleviate on site attendance. This option would remove any issues relating to water quality and reduce maintenance and operating costs to a minimum.

3. Remove the facility altogether

Should the Council decide that the park is not cost effective and remove it from its leisure portfolio, then the plant, play surface facilities and associated drainage would need to be decommissioned and removed. As the current play surface drainage system discharges to the below ground storage tank a new system of rainwater removal, draining all the hard standing areas would need to be designed and installed to replace it. This system would need to discharge to the Local Authority or public sewer system.

5. HEADLINE COST ESTIMATE

5.1 Budget options

Following the initial water quality investigation headline construction costs were prepared to evaluate the three proposed solutions highlighted in the conclusions and recommendations of the report:

Following preliminary consultation the following estimates were prepared:

Option 1. - Update the Existing Recirculating System

Option 2. – Replace the Existing with a Once Through System

Option 3. – Replace the Existing Splash Park with a Non Water Play Facility

Option 1. Upgrade the Existing Recirculating System

ITEM DESCRIPTION	Cost
Capital Cost Items	
Install a modified road container for housing the additional filtration equipment or construct a permanent extension to the existing plant room Remove existing shallow filter beds and Install new deep bed medium rate sand filter. Supply and install PAC (Powdered Activated Carbon) dosing system Provide additional clean water tank to provide a separate two tank system Additional pipework and connections into the spray park to connect the new filtration system	
Planning Permission and Fees	
Remove existing pond area and replace EDPM surfacing with coloured concrete to entire wet play area.	
New play feature nozzles to reduce water usage or provide new features	
Vegetation clearance and one off park maintenance	
Maintenance of existing drainage (not related to the aquatic play facility)	
Supply and Install UV Filter	
Estimated Total Capital Cost	**£230,000 - £380,000**
Revenue/Running costs (per annum)	
Re-Commissioning	
De-Commissioning	
Utility Costs - Water	
Utility Costs - Electric	
Water Quality Testing	
Tank Cleaning costs	
Parts and Equipment	
Chemical costs	
Staff Costs	
Estimated Revenue Cost per Annum	**£42,000**

Comments:

- The system proposed is designed to act as a partial replacement for the existing system bringing it up to current PWTAG standards
- There are no remaining warranties on the existing plant or water play features
- All warranties on new equipment is to be agreed during the procurement process
- Provides a permanent extension to the existing plant room which will retain its value as a future asset.
- The revenue cost do not account for the remaining serviceable life of the existing features which will be addressed in the next stage of the feasibility report.
- Estimated revenue costs include staff costs for running the café, as 1 person for 7hrs per day during the 3 month operating period
- Estimated revenue costs do not allow for any offsetting of profits from the café.

Option 2. Replace the Existing System with a Once Through System.

ITEM DESCRIPTION	Cost
Capital Cost Items	
Above ground clean water tank and concrete base	
Convert underground tank to grey water tank for recycling used water	
New pipe work and reconstruction of the existing concrete base.	
Installation, labour and M&E	
New nozzles to reduce existing flow rates ($45m^3$-$100m^3$ per day depending on phasing) or Replace existing water features with low water consumption products including: 3no water journeys, 18 misting jets & 18 directional jets. ($102m^3$/day)	
New pumps (Duty and Standby)	
Remove existing pond area and Replacement of the existing EPDM with coloured concrete	
Maintenance of existing drainage (not related to the aquatic play facility)	
New supply from Thames Water main	
Vegetation clearance and one off maintenance	
Estimated Capital Cost	**£175,000 - £330,000**
Revenue/Running costs (per annum)	
Re-Commissioning	
De-Commissioning	
Utility Costs - Water	
Utility Costs - Electric	
Water Quality Testing	
Tank Cleaning costs	
Parts and Equipment	
Chemical costs	
Staff Costs	
Estimated Revenue Cost per Annum	**£35,000**

Comments:

- The system proposed is to replace the treated recirculating system with a mains fed once through system
- Although this is being put forward as an option it is reliant on Thames Water agreeing to the increased water supply and waste water discharge demands. From previous experience we believe that Thanes water are unlikely to approve this on environmental grounds but may approve a reduced volume scheme. Thanes Water have been contacted, but will not provide a definitive steer until they are able to review the detailed design proposals.
- Thames water have been approached to comment on their guidelines but stated that each park is assessed on an individual basis and application needs to be made for an engineer to look at the proposals. This has been completed and we are awaiting for a project engineer to be assigned
- Even with Thames Water approval the existing water main supply is insufficient for the proposed 45m^3- 105m^3/day requirement however, with a larger sized tank (additional £15K) it would allow the park to function using the existing water supply. This would still be subject to Thames Water approval.
- There are no remaining warranties on the existing plant or water play features
- All warranties on new equipment is to be agreed during the procurement process
- The revenue cost do not account for the remaining serviceable life of the existing features which will be addressed in the next stage of the feasibility report.
- Estimated revenue costs include staff costs for running the café, as 1 person for 7hrs per day during the 3 month operating period
- Estimated revenue costs do not allow for any offsetting of profits from the café.

Option 3. Replace the Existing System with a Non Water Play Facility

ITEM DESCRIPTION	Cost
Capital Cost Items	
Remove existing pond area and EDPM surfacing to entire park.	
Decommission all aquatic water play features and treatment facility and remove from site	
Renovate existing pump room for change of use	
New gravity drainage system to drain the park following its change of use	
New kids play features, non-aquatic, to include approximately 10 Items: aerial runways, monkey bridge, balance beams, pirate ship etc.	
Estimated Capital Cost	**£150,000-£200,000**
Revenue/Running costs (per annum)	
Parts and Equipment	
Staff Costs	
Estimated Revenue Cost per Annum	**£10,000**

Comments:

- It is proposed to replace the splash park with a traditional non water play adventure park
- Although there is no requirement for renewing or replacing the system the decommissioning and replacement with traditional features still incurs high initial capital outlay.

Cost Comparison.

SYSTEM DESCRIPTION	CAPITAL COST ESTIMATE	ESTIMATE OF ANNUAL REVENUE COST
OPTION 1 Upgrade The Recirculating System	£230,000 - £380,000	£42,000
OPTION 2 Mains Fed Once Through System	£175,000 - £330,000	£35,000
OPTION 3 Non Water Play Facility	£150,000 - £200,000	£10,000

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UK and Ireland Office Locations