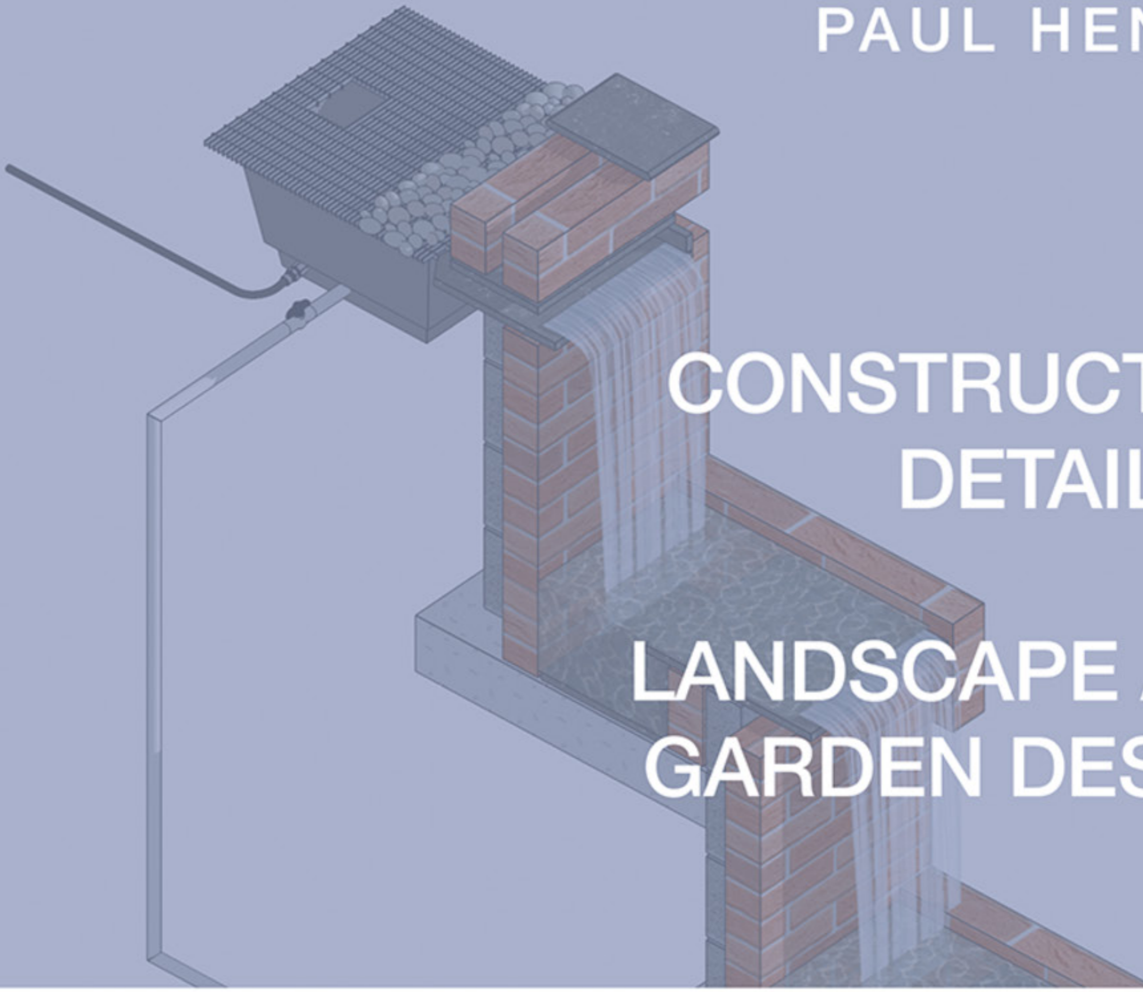
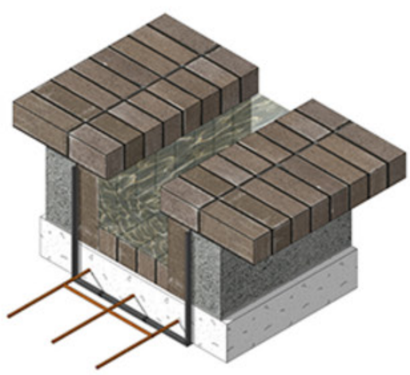
PAUL HENSEY



CONSTRUCTION DETAILING FOR LANDSCAPE AND GARDEN DESIGN



URBAN WATER FEATURES

ROUTLEDGE

CONSTRUCTION DETAILING FOR LANDSCAPE AND GARDEN DESIGN

Following on from the author's previous book, *Construction Detailing for Landscape and Garden Design: Surfaces, Steps and Margins*, this book, *Construction Detailing for Landscape and Garden Design: Urban Water Features*, provides clear instruction for the construction of small to medium scale water features.

With over 130 black and white CAD designs, Hensey provides guidance on a range of different water features such as drainage, water bowls and containers, walls and edges, structures and crossings, and rills, channels and cascades. This book offers technical references and a general knowledge of the basic principles, materials and techniques needed when engineering with water.

This practical guide would be beneficial for garden designers and landscape architects seeking accessible and relatable materials for designing water features.

Paul Hensey is a practising Garden and Landscape designer, a Fellow of the Society of Garden Designers (FSGD) and a previous vice chair. This role provided an insight into the quality and experience of Garden and Landscape designers wanting to become members of a professional Society and what their needs are. Paul mentors new designers and lectures on CAD, construction techniques and materials at several colleges. Originally trained as an industrial designer, Paul has used CAD systems for over 20 years. Early in his career he was the head of industrial design for an international building products manufacturer, giving invaluable insight into construction detailing and an appetite for understanding manufacturing techniques and the use of novel materials in gardens and landscapes. Between 2010 and 2017 Paul was the technical journalist for the *Garden Design Journal*, writing their monthly feature on best practice and construction. Paul has won numerous design accolades and awards, including several medals from The Royal Horticulture Society, and is acknowledged for his contemporary and innovative gardens.

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URBAN WATER FEATURES

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Contents

Introduction

There is duality with water; it can be in a moment one thing and then its opposite:

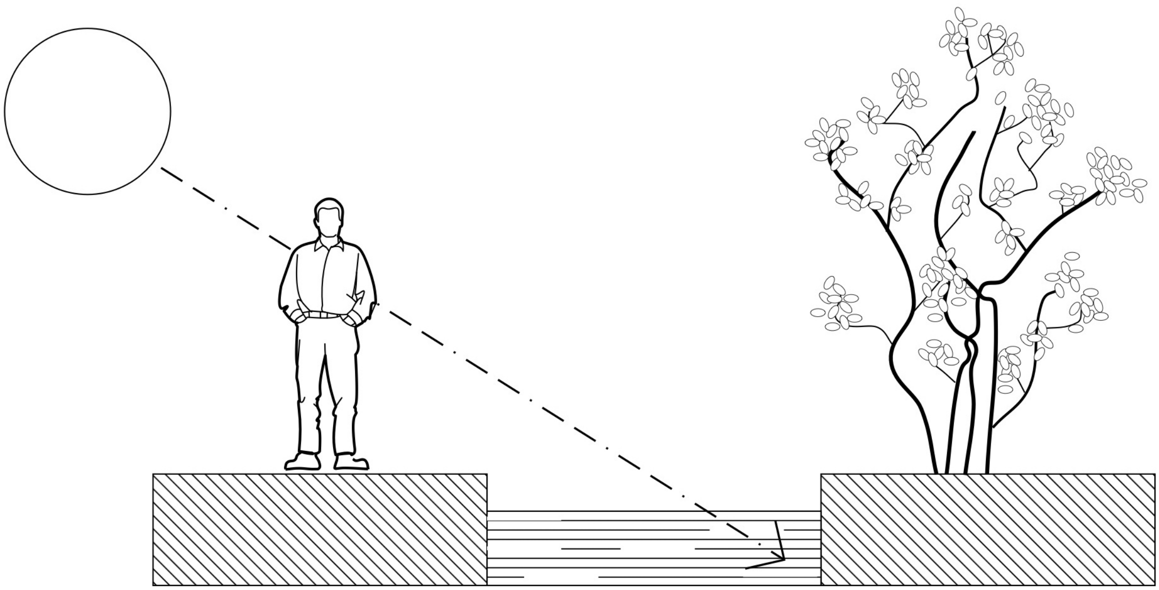
> Simple and complex, smooth and rough, transparent and then almost opaque, silent and noisy. It can be both calming and exciting, still or in motion.
>
> It offers opportunities to attract our attention, to divert or to distract.
>
> Water will attract wildlife, regardless of how it is intended to function. Insects will migrate towards it and birds will utilise it for bathing. We may choose to create our own ecosystem through the introduction of plants and even fish and that in itself will attract an even wider diversity of wildlife.
>
> Water has a gravity. Physically, emotionally and metaphorically we are drawn to it.

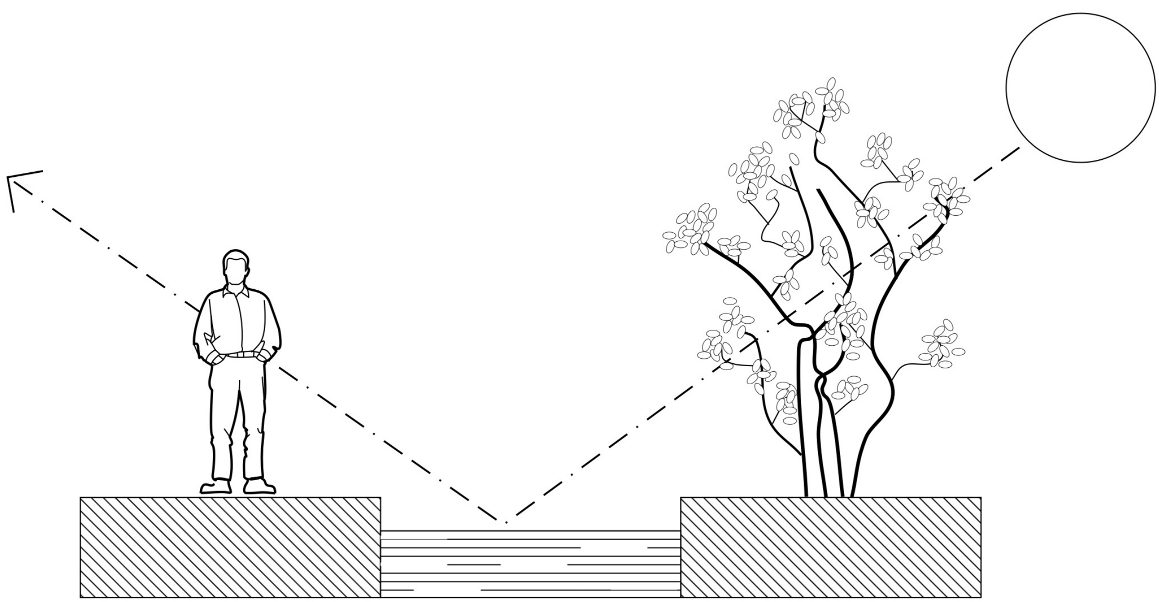
Water is not an element that can be designed, or forced to conform as the hard materials in a designer's palette are. Water needs to be coerced and controlled and therefore any water feature is fundamentally concerned with the design of the container and the transition into and away from it.

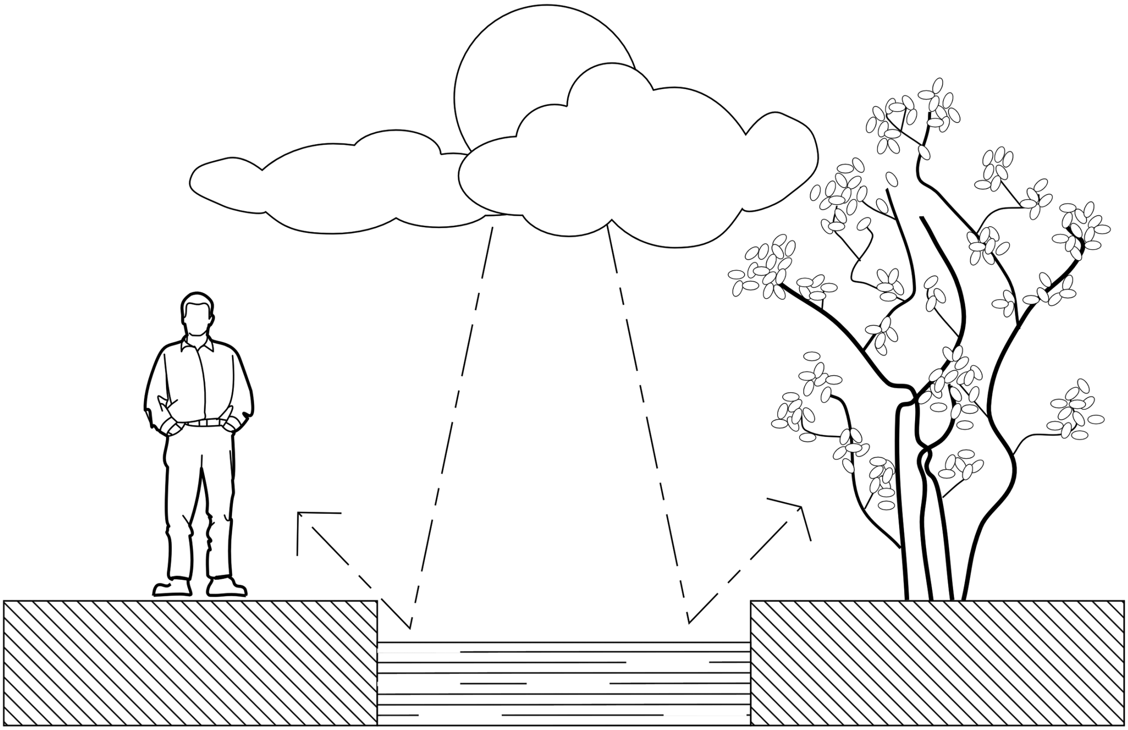
Water is universally regarded as one of the principal elements of creation. It has historically played an important role in gardens and the wider landscape. Its presence has formed and enhanced the greatest to the humblest of gardens regardless of faith, function, form or fashion and its presence remains as desirable now as in any period previously.

The introduction of water is a major inclusion in any garden or landscape, financially and for the effort that will be needed in its creation. It is worthwhile rationalising why water is required and what its purpose is. It will create a concentrated focus and attract wildlife and people. How should it be seen and experienced, and from where. It may be heard more than it is visible, whether intentionally or not for instance; it can be worthwhile establishing the desires and disturbances that those in close proximity are willing to experience. Still water is silent but lapping, cascading, bubbling effects can generate sound well beyond a murmur. What might seem insignificant amongst the early morning cacophony of traffic and pedestrians might be more than an irritation in the middle of the night.

All water features should start with the presumption that they will be a tactile experience, whether with fingers, hands or feet. Even if this is not the most influential criterion, that it has been considered will enrich the experience and enjoyment.







1. With the sun behind the viewer: water appears almost invisible, with few reflections.
2. Facing into the sun: water reflects both the sun and close proximity plants/trees/structures.
3. Overhead sun/overcast days: water reflects the sky and can seem opaque.

Figure 0.1 Reflectivity of water

A fundamental influence on the position and design of a body of water can be the relative position and transition of the sun. Whilst full sun is not always desirable, in practice the sun position will move and have different elevations throughout the year. What might look good in summer may become problematic in winter when the sun might be low enough for there to be extended periods of shade over or around the water.

It is worth remembering the experience of reflected light on water. Illuminated from behind a viewer, water can appear invisible. Every detail in the pond or pool is resolved and water to a depth of well over a meter can appear to almost not exist. Conversely, when the viewer faces the sun and the water is between them, the surface is highly reflective and almost nothing can be seen below. This can lead to some interesting effects and added appeal as the experiences of water will change throughout the day and year. Equally the experience can be one of frustration or annoyance when reflections prevent prize fish from being seen, for example. The experience need not be limited to the viewer. A well, or poorly positioned water body can reflect beyond its own surface, bringing light into a dark room or cooling a warm terrace in summer.

It may be that the design is already established and that it is easy to proceed towards more detailed design and consideration of construction details.

However, clients should be questioned on their requirements for any features and their choices may influence the direction of the design. There are some basic, but key decisions that need to be made early in the design process. These will direct the designer towards certain solutions, materials and construction techniques. Once installed it can be very difficult, if not impossible to successfully change the function of a water feature (e.g. a shallow pond, originally intended for plants, may not be deep enough to support fish if they are unexpectedly required).

Landscape and garden design are the disciplines and art forms that seek to organise external spaces to meet the needs and desires of those that will use them. No solution can meet the aspirations, needs and desires of all users but the duty of the designer is to create the best possible response to the cultural, social, aesthetic and environmental requirements of the users, whether for an intimate or public space.

The simplest effect with water requires consideration and understanding, not only of how to control it, but decisions as to what construction techniques and materials might be used to achieve the desired effect.

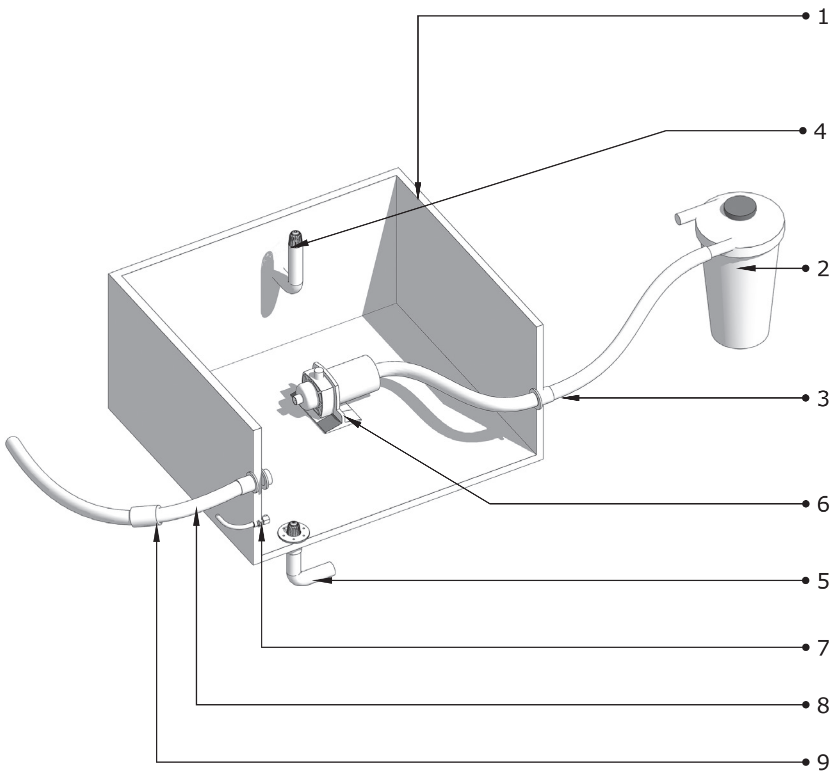
Whilst simple is always best, the most mundane feature can often be supported by complex and extensive components and systems.

There is a duty of protection to both those who construct and those who will benefit from the completed project. The designer should consider all stages of a water feature's life and make appropriate decisions regarding materials, construction techniques as well as maintenance and ultimately removal or refurbishment. Guidance for these aspects of the design process are given (in the UK) by the Construction Design Management Regulation 2016 (**CDM** – see Glossary).

USING THIS BOOK

The use of this book can be approached in several ways.

- It offers a technical reference to the construction of small to medium scale water features.
- It is a starting point for the development of designs, to allow the designer to start a conversation with those who will supply and construct the features and its elements.
- It introduces some of the more common elements typically found in water feature design.
- It provides a general knowledge for the basic principles, materials and techniques encountered when engineering with water.



Common components found in water features. Not all elements are used in all water features.

1. Liner/waterproofing
2. Filter unit (not always required)
3. Flange connector (seals pipe work through pond wall)
4. Overflow
5. Bottom drain (plug)
6. Pump (for small features the pump and filter can be a combined unit)
7. Tank connector (seals electrical cables through pond wall)
8. Water return pipe
9. Non-return valve (prevents water draining out of pond when the pump is switched off).

Figure 0.2 Components of a water feature

This book does not cover or advise on wildlife or planting. While the inclusion of plants and fish is considered in some of the detailing, consideration of marine species and their management is better covered elsewhere.

This book offers details and notes to aid in the construction detailing of small-scale water features, typically for urban gardens or spaces where there are restrictions. Many of the details can be scaled up with appropriate consideration to increased areas, depths and details to suit the specific project.

Large water bodies or spaces, such as lakes are not dealt with in this book.

They have a significant impact on the surrounding typography and to create or modify a water body of scale requires the support and frequently permission of many individuals and organisations.

Small-scale water features and their associated detailing should be within the capabilities of the professional designer. The detailing given aims to educate and illustrate some of the common construction techniques used to create typical water features. There are often several alternative approaches and techniques to constructing garden and landscape features. This is even more exaggerated for water features. The underlying materials of blocks, bricks and concrete may be common but when the methods for sealing and lining holes and troughs are included the permutations are multiplied.

The illustrations are intentionally simple and unspecific and without any particular aesthetic. They are also far from exhaustive. Options for the construction of the side wall of a pond, for example can easily be treated with a contemporary or rustic approach, it is the underlying detailing that is important.

Some simple pool designs are illustrated but the emphasis is towards robust construction, usually as part of a wider garden or landscape development. The simplest water features might be no more than a scraped or dug hole in the ground with the exposed soil compacted and lined. These are typically informal and naturalistic features and often undertaken as DIY projects. They are well covered by numerous books on the creation of such water features.

WHAT THE DESIGNER SHOULD KNOW

- Waterproofing: options and effects
- Base construction
- Side wall construction
- Water top up
- Overflow and drainage
- Regulations that might apply
- How to move and direct water
- Achieving appropriate water clarity.

Advice should always be sought. Sometimes to explore alternative approaches other times to be introduced to developments in pump and filter technology, new materials for waterproofing or best practice. Manufacturers of materials and devices (pumps, filters etc.) and specialist distributors are often invaluable sources of expertise and can demystify the selection process based on any given design or scheme. It is usually necessary to have a strong idea of the final design, if only aesthetically and dimensionally; advice can then be directed and specific to the proposed scheme.

VISUALISING DESIGN

Like all design professions, for those involved with creation and imaging of landscapes and gardens, visual reference is essential. This is primarily a guidebook to designing with water. There are explanations and notes that expand on ideas and direct the designer towards specific details but the value and effort lie predominantly in the visual explanations of what are frequently complex arrangements of materials in three dimensional space.

It can help to initially visualise a water feature as if it were a bath tub. It needs to be located so that it is accessible and convenient, and being water tight is essential. There needs to be an overflow and a means of draining down the pond, perhaps even with a simply stopper release or a bottom drain, much like a plug. Ponds, like baths can be sunken, enclosed or free-standing. The water can enter a pool in a variety of ways and with a spectrum of effects, much like a bath with an overhead shower. A bath can be filled manually, but usually this is from mains water and we hope we remember to switch it off before it overflows. Ponds are likewise frequently filled or topped up from mains with a manually operated tap.

More than any other aspect of a garden, water requires serious consideration and forethought. The infrastructure required to deliver mains water and power, as well as the drains to prevent overflow, will be amongst the first elements constructed in a garden. Their location will be to some extent determined by several factors, not least the context of the site as well as limitations imposed by existing ground conditions and structures. In much the same way as plant choice is influenced by the location, so too is a water feature.

Figure 0.3 Bath tub

SITING A WATER FEATURE

The positioning of a water feature, of any scale or design is critical for its performance and enjoyment.

It is important that the context of the garden or proposed site for a water feature is carefully considered as part of the design process.

POSITION

Sunny locations may seem ideal but can introduce problems later on. Full sun encourages weed growth. Whilst most lilies will require a sunny location the majority of pond plants will thrive away from prolonged sun and in some shade.

Locating a water feature close to or under trees may require some autumn leaf clearing or the installation of a temporary net system to catch the leaf fall. Unless filtered, pond water with excess leaf debris can become polluted and problematic. However trees, especially smaller types can work well close to a pond, especially if the feature is designed to reflect or take advantage of their proximity. Elevated boughs and perches are essential for birds and it is not uncommon to see several species queuing up on tree limbs to gain access to a water feature for drinking and bathing.

It is worth fabricating a frame or laying out a simple perimeter of stones to approximate the position of a proposed water feature. The visibility of the feature from important vantage points can then be assessed, for example from rooms within the house, or from the patio.

It is easy to move and resize things at this sketch stage as, once the feature foundations are poured, there is no scope for alteration.

A water feature does not have to be prominently located, it could be discreetly placed only teasing its presence, perhaps through a partial glimpse or the sound generated from a waterfall.

The wider landscape can be an important factor. The water might be used to reflect sky, or trees from beyond a boundary. It might be important or desirable for the water to be used to reflect a sunrise or sunset and so its location will be engineered, perhaps through trial and error.

Water loss is an important consideration. It is not simply restricted to evaporation through heat. A prevailing wind can cause a considerable loss, especially if there is water moving from one level to another (e.g. water blade or fountain). Winds will also be responsible for driving leaf debris into the pond. If the site does not have a wind break then one might be considered as part of the design, whether natural, such as trees or structural, as with fencing, walls or screening.

Frost pockets can be problematic. The bottom of a slope can be several degrees cooler than surrounding areas and so the water may be faster to freeze and slower to thaw in cold weather. The bottom of a slope should also be tested for its suitability to construct into. It is a natural place for the water table to be higher than elsewhere in a garden.

The location of a water feature, especially one set below ground level, should be considered as part of the landscape beyond the boundaries of the site. If there are surrounding gardens or even agricultural land it is essential to consider the movement of surface water and run-off. Water arriving from neighbouring properties may contain substances (fertilisers, toxins and chemicals) that may prove detrimental to some styles of water feature.

TEST HOLES

It is fundamental to the success of any garden design that the site is analysed and understood. This involves more than simply noting the direction of the prevailing wind, sun movements and what good or poor views are present. The composition of the ground will allow a designer to appreciate the suitability of soil for planting and the subsoil for construction. Deep sandy soils will require more excavation and larger foundations than a clay or chalk sub base. A series of test holes should be dug across the site. When a water feature is being considered as part of the overall design, additional holes will be necessary to appreciate the suitability of the area for any excavations and construction.

Test holes should be dug to a depth that extends through the top soil. The division between top and sub soil is often evident, top soil being darker and damper, whereas subsoil is lighter and drier. A depth of a spade and a half is good starting point, but deeper can sometimes be required. Establish the location of any underground services before making any test holes.

RESTRICTIONS AND REQUIREMENTS

The single biggest obstacle to overcome with a water feature is Planning. Not all water features require Planning permission but the fact that some do should be something that the designer needs to consider early in the development of the design. Small free-standing features will not require permission, but ponds, rills and features that are constructed into or onto the ground may need approval. The rules concerning what is permissible, or not, will vary between properties and local authorities. In the UK a property usually has a degree of permitted development associated with it, by which small alterations to the property or free-standing additions (e.g. conservatory or garage) can be undertaken without permission. Certain property types (e.g. flats and apartments) may be excluded from such permitted development. In addition, the location of the property may prohibit development or require the approval of the local authority; for example, if a property is located in a Conservation area, Area of Outstanding Natural Beauty, National Park, or if the garden is in the curtilage of a Listed Building. A water feature is considered an "engineered structure" and as such it is essential that advice from the local planning department is sought. Some authorities will offer a "Do I need planning permission?" service, whereby they will (frequently for a small fee) respond to a general enquiry. This service usually promises a response within a short period of time (frequently less than 2 weeks). It may be possible to include a simplistic schematic of the proposed design with the enquiry. The planning authority will be particularly interested in the location of the feature (vicinity to properties, boundaries and highways) the scale of the feature and the proposed materials. It is prudent and diligent for a designer to ensure that the correct advice and permissions are considered before the client makes any financial commitment to the construction of the proposed design. Whilst the initial fee for Planning may irk, it is far better to be able to proceed with surety. If Planning permission is required, further detailed information will be required; the local authority will be able to advise on what documents are necessary in support of the application. They typically consist of:

- Block plan (a 1:1500/1:1000) of the area centred on the garden with the property boundaries outlined in red.
- A site plan at a specified scale (e.g. 1:200), with the property boundaries outlined in red.
- A plan and/or elevation of the garden as it is currently.
- Elevations and plan/s of the proposed feature at a suitable scale.
- Illustrations/visualisations of the proposed design are not usually permissible.

The planning process typically takes 8 weeks from the acknowledgement of the receipt of all correct and required documents. It can take a few weeks to ensure that all drawings are as requested/required.

Water features that are part of an existing stream or watercourse cannot be redeveloped, altered or isolated without permission from the controlling environment agency. There may be other authorities, such as rivers and waterway authorities that may be required by law to be consulted.

THE CHAPTERS

The book is divided into five chapters. These are representative of common areas and types of construction details for water features.

Each chapter has an introduction where the key aspects and critical components are outlined, followed by detailed illustrations. Some elements of retaining and controlling water are common across several types of construction (e.g. creating waterproof surfaces). To allow for ease of use, all necessary details are included in each chapter, even at the expense of occasional repetitions.

CHAPTER 1

Drainage

Without considered detailing water will eventually find its own way under, around or out of any container. Left to its own devices the risk of damage is considerable and can be devastating to parts of a garden or landscape beyond the feature itself. Anticipating and managing the flow of water that is in excess or undesirable requires an appreciation of a site in three dimensions. Drains need not be hidden or intrusive. Typical drainage solutions for small spaces are shown as well as management for severe rainfall events.

CHAPTER 2

Water bowls and containers

Vessels of water, whether still or brimming, planted or reflective have always been desirable and fascinating. They bring wildlife, and reflect the mood of the environment and colour of the sky. There is a place and space for a water bowl in any garden. The essential effects water can create through movement and apparent stillness are shown.

CHAPTER 3

Walls and edges

The methods for moving water both in and away from the feature are detailed along with the most common methods of waterproofing and edging.

Details of the thresholds between the garden proper and the water's edge are given, whether for a formal pool or one that embraces a more naturalistic style.

CHAPTER 4

Structures and crossings

The inclusion of water frequently requires the addition of structures and points of access. Jetties or decks, boardwalks around a wet perimeter, or stepping stones. These features extend the margins and ability to interact with water.

CHAPTER 5

Rills, channels and cascades

Creating a landscape or garden by introducing a slot creates definition, whether of division or direction or both. Channels can be consistent or pulse with areas of expansive water. They can be symbolic, or expressive of rituals and referencing ancient techniques of irrigation. Features should consider not only how water flows but how it arrives and is recirculated or used in turn to feed further water bodies.

Detailed information, is given in the appendices relating to some of the more specific requirements a designer might have.

There are many suggested methods for constructing a pond or pool, from simply scraping a hollow in the ground and lining it through to fully cast and constructed sides with reinforcing.

The type of construction largely depends on local ground conditions and the slope of the site. Sandy soils will be easier to shape than clay soils but will have less integrity, stony ground will require a different treatment from lighter loams. The details contained in this book are intended for the creation of robust and permanent water features, that are generally part of a larger landscape or garden being constructed at the same time. As such the style of construction is biased towards engineered methods. These methods allow for a huge range of styles and shapes. Simply excavating a hole, blinding with sand and adding a liner, can work well for small pools and ponds in some circumstances, and particularly suits larger water features and ponds. The focus of this book is towards water features of a scale suitable for small and medium gardens and, as such, some types and methods of construction are not included.

THE ILLUSTRATIONS AND HOW TO USE THEM

The drawings presented are, by necessity, generic. Every water feature is a unique combination of materials and sizes, responding to both the context of the site and the demands of the design brief. It would be impossible to address every scenario or combination of requirements. Rather than illustrating entire structures the details are given as typical details of the key areas of structures. This allows the designer to apply the principles to their own solutions. The details shown are based on typical UK construction techniques and common materials. The sizes and suitability of the materials available in other countries are for the designer to establish and are beyond the scope of this book to advise on.

All illustrations in this book have been created using only SketchUp software.

WHERE TO START

The type of water feature appropriate to the site or project will be determined by the designer and some basic decisions should be established early in the design process:

1. Is it an ecological feature or sterile?
2. What impact will it have on the site?
3. How will the water level be managed?
4. What are the principle aesthetic considerations?

Table 0.1 Questions to address when considering a pond

Site	Inground	Above ground
Ecology	Plants	Fish
Top-up	Manual	Automatic
Style/ aesthetics	Formal	Informal
Internal walls	Black	Material clad
Water entry	Obvious (from outside the feature)	Discreet (e.g. below the waterline)

Answering these simple questions will direct the designer to certain construction options and make the selection of appropriate detailing considerably easier. It might not be clear in the early stages of a design whether plants or fish are to be added and the automatic answer might be that they should not. Designing a pond to be 300mm may answer the brief but will

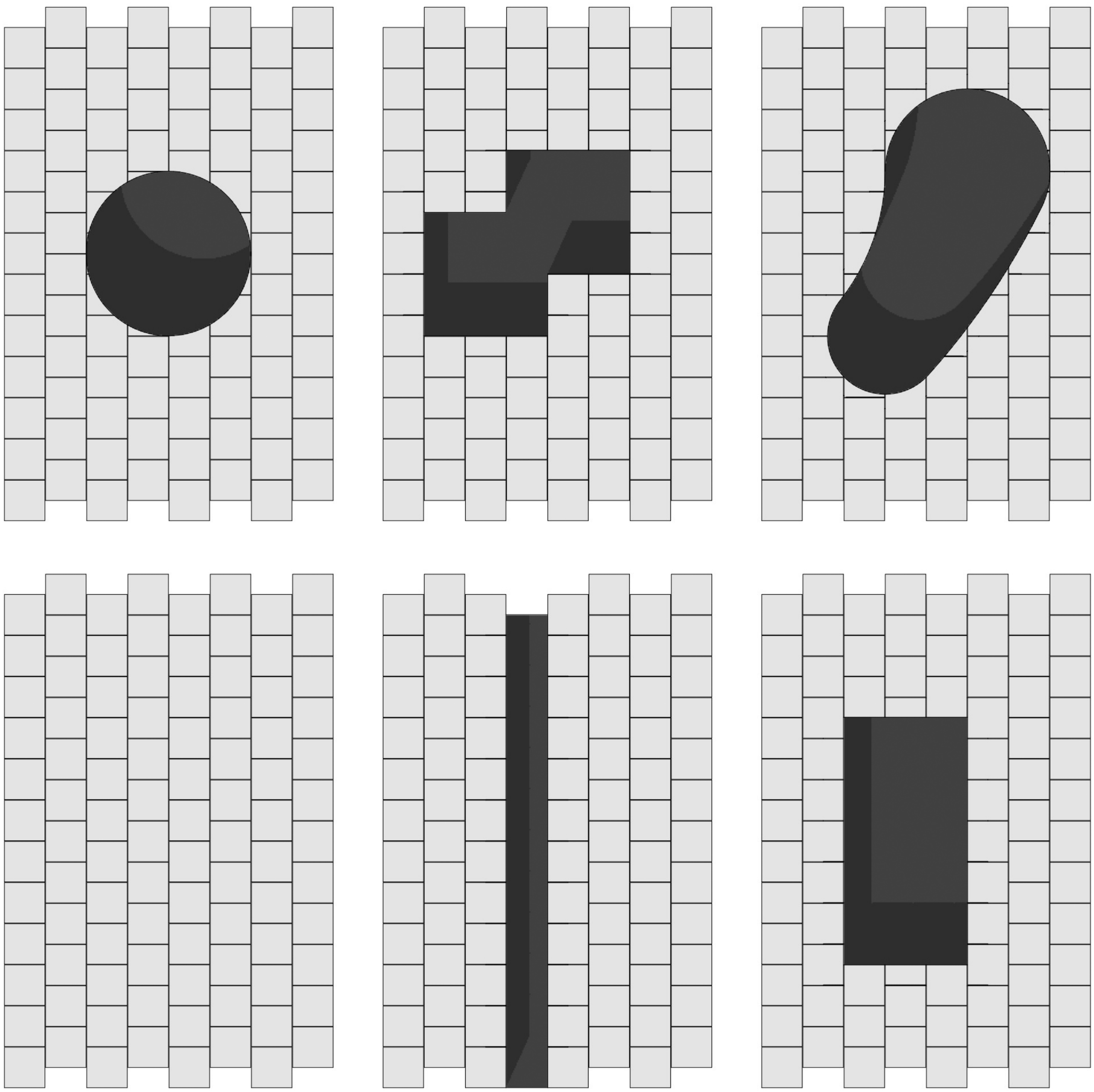


Figure 0.4 What size to make a water feature?

forever exclude the possibility of fish and certain plants (e.g. lilies). It can be prudent to design bigger or deeper than is initially thought necessary so that such things can be added perhaps even several years after construction is complete. The effort and expense for increased capacity or depth will be minimal.

Where a water feature is to be designed as part of a wider landscaping or garden project it can be useful to use the materials selected for an adjoining paved area or terrace, for example, to refine the final dimensions and location of the water feature. A rill might be any width, but if 300mm or 450mm width paving is to be used, there would be a logic in using the paving grid to determine the width and length of the rill. A width of anything else would introduce cuts that should be located away from the edge of the rill and may themselves create poor alignments and awkward junctions elsewhere.

POND SIZE

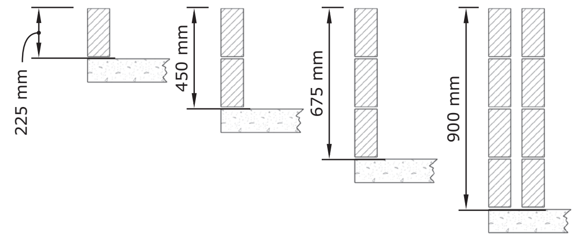
Whilst the site and existing structures may aid in determining the scale of a water feature, the exact sizes will be a balance of several considerations.

It is always worth marking out and representing the proposed design on the ground. This “sketched” version might be created from a sand line, hosepipe or a series of pegs and rope. It need not be a temporary “sketch”. If time permits, allowing the client “live” with the pond to experience it over a period of time can establish whether it is indeed in the best location or whether additional criteria emerge. In particular, is it large enough?

Pond depths can be consistent or vary in depth to allow for some marginal planting, through ledges.

Formal ponds are usually geometric and typically have vertical internal faces, even if they step in height. It is worth considering the contractor when specifying the depths of the pond and any marginal areas. Arbitrary depth dimensions will require materials to be cut to size. This can extend the duration of the build and certainly the labour required. It can be easier to simply use the unit of a standard concrete block or brick, for instance as a module. Making the pond the depth of say x3 blocks keeps the construction simple. Blocks and bricks can of course be laid in different directions so there will be a combination that is pretty close to the initial approximation.

A natural pond or pool ought to appear effortless and almost casual. Its informality seemingly the result of natural processes and with no apparent guiding hand. It can therefore be the hardest to achieve, where the influence of the designer is subtle, almost invisible. Rather than something that is contrived, the skill of a designer lies in their ability to mimic the natural world, incorporating their observations but with a lightness of touch. The appearance of simplicity is often



Water feature depths created by using a standard unit concrete block
(shown UK concrete block 7.3kN 100x215x440mm).

Smaller unit increases can be achieved by using engineering bricks on top of concrete blocks

(a metric brick in the UK, is 65x102.5x215mm, which would incrementally add 75mm over a concrete block, using a 10mm mortar joint).

Whilst ponds deeper than 675mm (x3 blocks) will require double skin wall or 215mm thick hollow blocks, the wall design should be determined by local ground conditions.

Figure 0.5 Pond depth

belied by the rigour and consideration behind its construction. Even a natural pool will require careful detailing.

The formality, or lack of, of a pool or pond can be its defining characteristic. It can exert an almost magnetic desire to be touched and so the design of access points, margins and thresholds, as well as managing the views of the water itself, are all critical components in a successful design. The waterbodies that we mostly experience in nature, and certainly in the more northerly countries, are almost exclusively dark. The base might be deep, or rich in sediment, and the inkiness can perfectly reflect the surrounding canopies and skyscapes. Water features are best when they reference those aspects that we are most familiar with, not only in their colour but in how the topography is arranged, plants positioned and reflections managed.

Pond sizes will also be somewhat determined by their function. Simplistically ponds can be divided into three categories. The minimum size and depth for these is given by most suppliers of pump and filter equipment. Table 0.2 gives a general overview.

It is important to consider whether to construct a water feature either in and level with the ground or to raise it. In-ground features can be both contemporary and naturalistic. Raised walls can be used as a convenient seat or perch and are less of a hazard to children, pets and unsuspecting pedestrians. They are also more comfortable to tend, seated alongside without the effort of bending down. Ground conditions may exclude the construction of anything too deep below ground level so a raised pond may be the only solution in some instances.

Table 0.2 Basic sizes for ponds

Pond function	Surface area (min/msq)	Depth (min/mm)
Planting only	1	300
Fish (small) + planting	5	600
Fish (large)	15	1200

CHAPTER 1

Drainage

OVERFLOW

On small free-standing water features an overflow is often not necessary; the water will brim over the top of the feature and the small amount of overflow will not create any more problems than the actual rainfall for the area covered. The consequence of an overflow for a larger body of water is more significant.

For example, a pond with a surface area of $4m^2$ subjected to a torrential downpour (25mm or 1"/hr) will receive over 100L of water add (std rainfall, UK is 0.014L/sec/msq, Approved Documents Part H sec3). If the pond is already full this volume of water will be what leaves the overflow. Without management of the outflow such volumes, when dissipated into the same area after every downpour can cause damage and erosion, and undermine foundations and base work. The presence of an overflow is critical in any system that utilises an automatic water top-up system. Should it fail, the potential for damage to the water feature and surrounding area is considerable.

There are several types of overflow that can be easily incorporated into a water feature. There are practical considerations

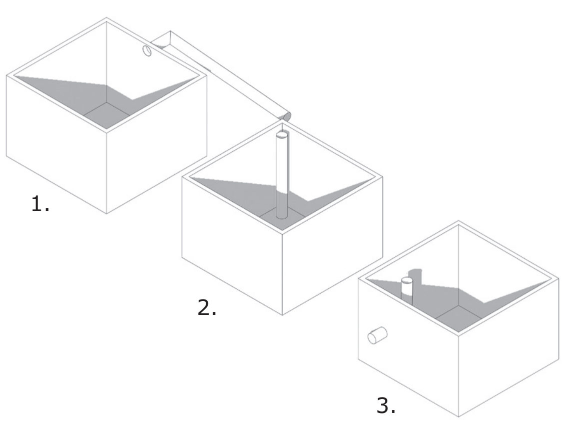


Figure 1.1 Types of overflow

but often aesthetics will determine the type and position of any visible pipework.

1. A horizontal outlet set at the high water mark
2. A vertical outlet set at the high water mark
3. A hybrid, which has a vertical outlet connected to a horizontal pipe.

SIZE OF OVERFLOW

With small water features (less than 1m^2) that are topped up manually, the overflow can be 25mm diameter. The amount of rainwater falling on the pond area will not overload the outlet pipe's ability to carry it away. For larger area ponds or where there is an automatic top-up, it

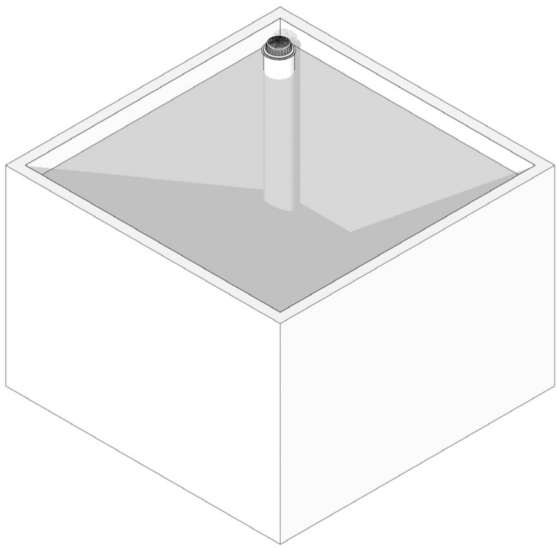


Figure 1.2 Vertical overflow cap

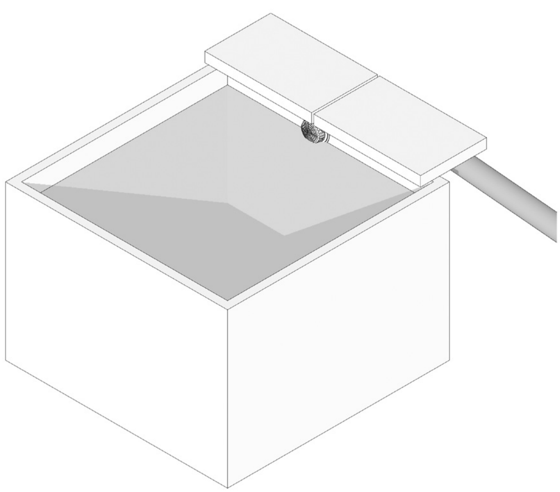


Figure 1.3 Horizontal overflow cap

is good practice to have the overflow outlet larger than the inlet pipe or to a maximum of 50mm diameter. If a small diameter pipe is used there is the risk that the water volume trying to flow out cannot be accommodated by the outlet and the result will be an ever increasing water level. The overflow pipe must be guarded with a screen or perforated device (such as a strainer or perforated screen) to prevent leaves and large debris from entering it and creating a blockage. Large-scale water features employ a skimming device, which can be as simple as a local recess in the pond wall where water falls into an external chamber with a basket. The basket can be removed and the debris cleared.

HORIZONTAL OUTLET

This is the most common design to be specified in ponds and water features. In principle it works well and is an easy design detail to add. The water enters the outlet at the same level as the water surface and so it will have the maximum "**head**" or flow through the discharge pipe. This method is useful where the discharge point is situated at a level lower than the pond surface but higher than the pond base. In practice this is not always the neatest solution and for some types of pond waterproofing it can be prone to leakage, if designed or constructed without care.

For features proofed with a flexible material that is applied in situ, such as **GRP** or a pond paint, the outlet can be very close to the junction of the mortar line (supporting the surrounding paving) and underside of the paving (e.g. 25mm). Before the GRP or waterproof coating is applied the overflow would be created and the surrounding cavity or notch in the pond wall sealed. A black uPVC pipe will make the opening as discreet as possible. A large overhang (e.g. +50mm) by the surrounding paving will make the opening almost unnoticeable.

A different detail is necessary where a flexible sheet liner is used. A flexible sheet material, such EPDM or Butyl

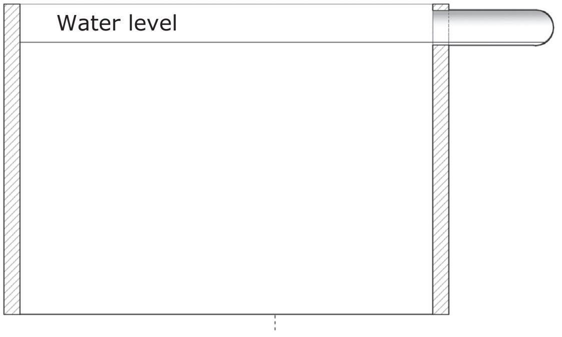
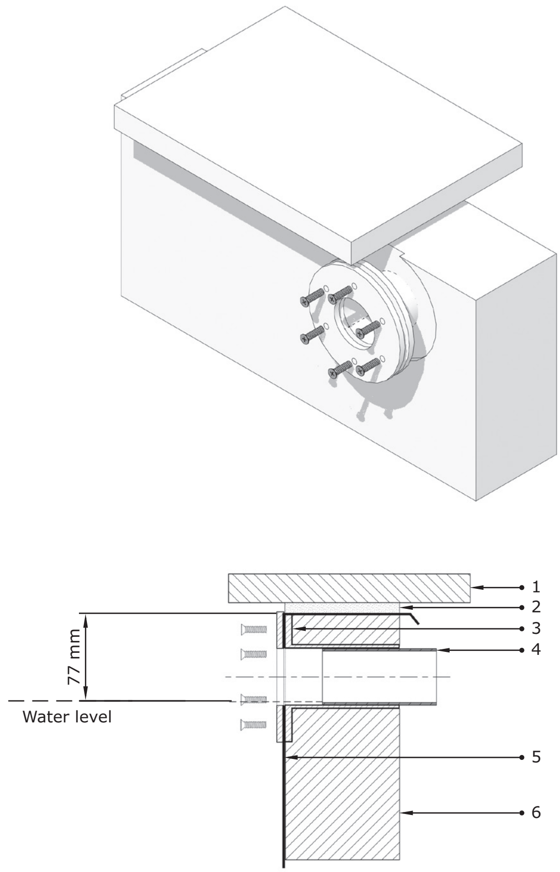


Figure 1.4 Horizontal overflow section



1. Paving
2. Mortar/adhesive typically 10mm
3. Flange body 50mm
4. 50mm uPVC overflow pipe, solvent welded
5. Pond liner/membrane
6. Pond wall.

Figure 1.5 Horizontal overflow flange detail

cannot be cut or sealed into a small hole in the pond wall, neither can it be pushed down into a notch in the top of the pond wall. It would be a very messy connection to the outlet pipe and one that is likely to fail. Where sheet liners are used a flange transition through the pond wall should be used. Flanges are supplied in two parts; a flange body and an additional ring the same diameter.

The pond wall is drilled to take the flange tube and the water-facing wall of the pond wall is recessed to allow the flange to lie flush with the surface. While this is not necessary, not doing so will cause the liner to be stretched over the raised surface of the flange, making it more distinct and potentially obvious. The flange is set into the drilled wall and can be secured with a foam adhesive.

The overflow discharge pipe is solvent – welded into the rear of the flange. This arrangement keeps the liner flat and creates a mechanical seal around the hole in the liner. It is neat and reliable. However, due to the external diameter of the flange the outlet hole has to be moved down to allow the flange to sit at least level with the constructed pond wall. Where a GRP outlet can sit 25mm below the paving underside, a flange outlet will have to sit about 85–90mm. Where retaining screws are used, these can be painted with an enamel paint to make them more discreet.

VERTICAL OUTLET

The vertical style outlet is simplistically an elevated plug. A modern use for these style devices is for catering sinks where deep sinks will have continuously running water and the elevated overflow manages both the water and any debris it contains.

The outlet can be placed in any location. Historically, the outlet often features within the centre of water features. Its position must be decided in advance of the feature being constructed as the pipework will need to be installed in advance of the base being built, unlike the horizontal outlet which can be placed as the feature nears completion.

A simple design would require no more than the outlet pipe extending up and beyond the intended level of the pond, the final overflow position being decided when the water feature is filled and the pipe cut as required. The outlet pipework would be cast into the concrete base of the pond. uPVC pipe is better than polythene as it can be solvent welded and lining materials such as GRP will adhere to it. As with the horizontal outlet, a cap or strainer should be used to prevent debris entering the outlet pipe. If a flexible sheet liner is to be used then a

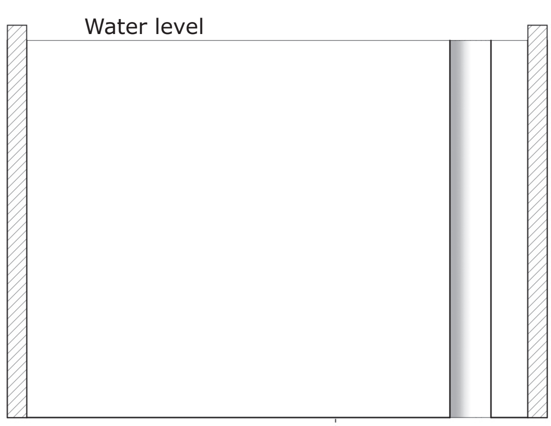
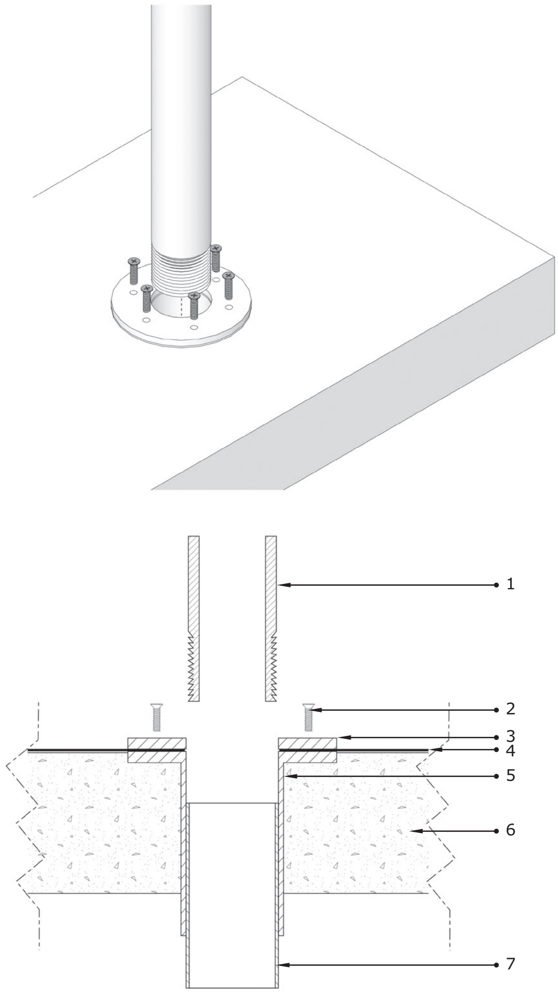


Figure 1.6 Vertical overflow section



1. Threaded 50mm overflow outlet pipe cut to length
2. Stainless steel retaining screws (heads painted black)
3. Outer flange PVC
4. Flexible liner
5. Flange body PVC (internal diameter for 50mm pipe)
6. Pond base (e.g. in situ concrete)
7. 50mm PVC overflow pipe, solvent welded to flange.

Note the overflow pipe sizes will be determined by the size of the water feature.

Figure 1.7 Vertical overflow flange section

flange connector is required. This will mechanically clamp and seal the liner to the pipe connection, in the same way as it does for a horizontal outlet.

Threaded flanges are available. This allows a pipe to be screwed into the flange, creating a seal. The pipe is cut to the required water level. It permits replacement pipes to be installed but the real advantage of this assembly is that the pipe can be unscrewed and the pond drained down fully as it acts exactly like a plug in a bath. If an installed pipe is to be used to drain down a pond it is helpful to first clean debris from around the pipe base and as soon as the pipe is removed, by placing a simple sieve or strainer (e.g. a stainless steel kitchen sink strainer) over the hole. This will catch large debris, gravel etc. and prevent blockages within the overflow pipe.

The overflow can be located very close to the wall or corner of a pond but it must still stand off from the walls by the diameter of the flange (114mm for a 50mm PVC pipe flange). The overflow top will still be visible even with a 50mm overhanging of the surrounding paving or copings. A discreet installation would be to locate the vertical pipe as tightly into the corner as possible. In front of the pipe a simple shield (e.g. of folded steel, aluminium painted black) can be mounted to the pond walls to disguise its location. The top of the panel can be extended to virtually touch the underside of the paving or copings as the water level will still rise and fall in line with the main pond. This detail also has the benefit of being a convenient location to bring an electrical cable over the pond wall without it being seen. Pond connections can be made through a wall during construction for any powered devices such as lights and pumps. Sometimes additional or alternative equipment is required as the pond evolves or needs to be enhanced – additional lights or a fountain pump, for example. This is the neatest and simplest way to bring those additional cable runs into a pond. There will still be cable runs visible across the base of the pond and these might be disguised by the addition of decorative aggregates or stones.

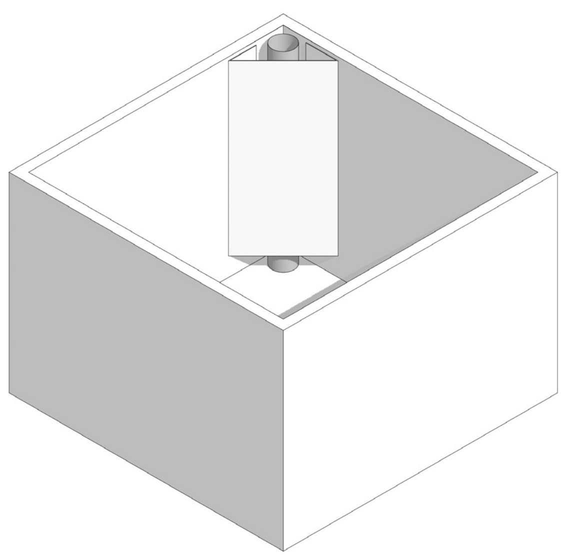


Figure 1.8 Vertical outlet corner shield

VERTICAL OVERFLOW WITH A HORIZONTAL OUTLET

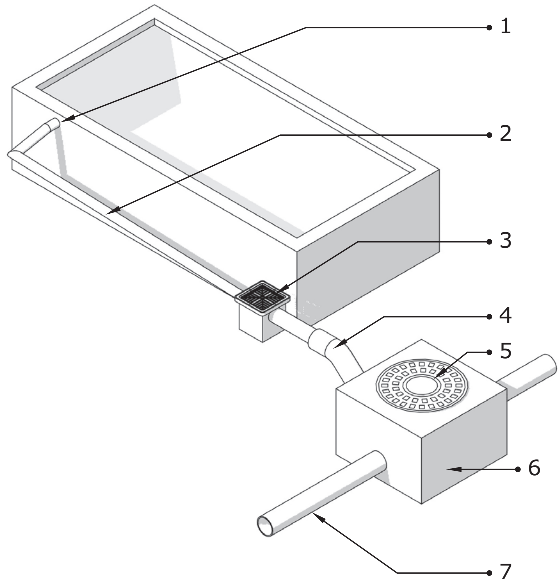
This is a hybrid overflow solution. The principle advantage is that the overflow can be mounted at any location in the pond wall sides, maintaining the simplicity of a vertical overflow outlet. The outlet connector through the wall can either be a simple solvent welded PVC pipe and elbow or a threaded elbow connector (e.g. 50mm) that allows the pipe to be replaced or removed for a partial drain down. As with all outlets, the pipe opening should be protected by a perforated cap or meshed material.

OUTFLOW PIPE

The overflow from a water feature can be directed to a variety of locations. A small feature can deposit excess water (from rain or a drain down) close to the feature if the ground conditions permit, e.g. a planted bed or gravel area. Larger bodies of water with considerable surface area or volume are likely to overwhelm any area in particular and cause damage to plants or materials. The management of the dissipated water from a pond should be considered and managed, taking into account the local site, soil conditions and any regulations that apply. Sustainable Urban Drainage (**SUDS**, UK) is a hierarchy of measures that attempts to attenuate water that arrives on or leaves a built-up environment. Water from a pond overflow cannot simply be connected into the water drainage system of a property. This adds to the burden of the drainage system and adds to the risk of it becoming overwhelmed further downstream. Where possible, excess water should be held within the garden, this may be by connection to a soakaway or directing it into an area of soil where it can infiltrate the ground. Ground conditions do not always permit infiltration. Where there is no option other than to connect the overflow to a property's drainage system, permission should be sought from the local Planning office (in the UK the management of wastewater is controlled by Building Regulations and they should be approached for advice). In some instances, additional advice or permission may be required from the Water Utility provider (who handles water waste). Permission is not always a foregone conclusion and there may be conditions attached; for instance, the attachment of a suitable silt trap within the overflow/drainage pipe run before it connects to the water drainage system, or that any water drained down is undertaken during periods of low demand, e.g. after 8pm.

Domestic properties in the UK are connected to one of two types of water drainage systems:

a. A combined system, where rainwater and house foul water are combined into a single system. This is a common solution for older properties.



1. Overflow connection to pond
2. Overflow pipe
3. Silt or "P" trap with accessible grate
4. Connection pipe to sewage/foul outlet (subject to permission)
5. Inspection cover
6. Inspection chamber
7. Main foul water outlet system for property.

Figure 1.9 Gulley connections

b. A separated water system collects surface rainwater and sewage (known as foul) separately. It is prohibited to connect a pond overflow to a rainwater outlet and a connection can be made to the foul system only with permission.

The overflow pipe should fall towards the outlet. This can be as low as 1:80 (1mm drop in 80mm run, 62mm in a 5m pipe run). The steeper the pipe is inclined the more effective it will be, although too steep an incline may cause any debris to become trapped (see Appendix 5: Pipe falls and gradients).

Where a bottom drain is separate and in addition to an overflow, it should be connected to the same gulley outlet as the overflow. An inline valve should be included to easily allow the pond to be drained down. This should be accessible, perhaps located in a simple chamber or even within a secondary gully so that it remains away from contact with soil.

Overflow pipes that are laid prior to a water feature being constructed (e.g. set in or through a concrete base) should be rigid PVC. They can be solvent welded and easily set to the required fall. Where an overflow or drainage system is created after the feature is constructed

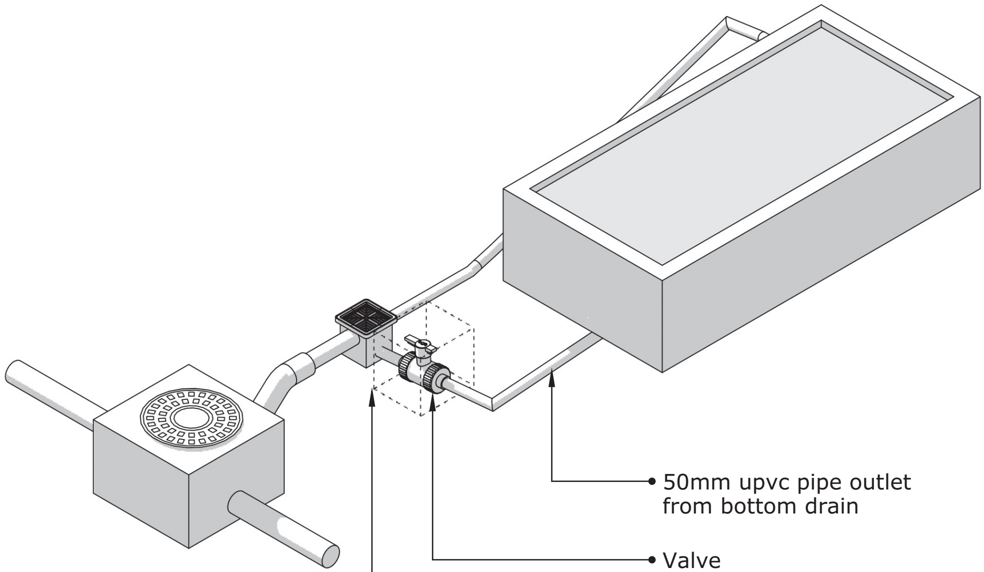


Figure 1.10 Bottom drain valve

(e.g. a horizontal overflow) there can be a temptation to use a flexible hose. It can be supplied in lengths up to 100m and so might seem to be an easy solution for taking the drain around and through the garden. Unless the pipe is laid to a straight and consistent fall there is a potential for an airlock to form in the overflow pipe. This will reduce the effective head of the water in the pipe and can in some cases prevent water travelling down the pipe at all. Syphoning from the outlet end may remove an airlock but the system will be prone to repeat problems. A flexible pipe can be a good solution, but it should be mounted through a rigid uPVC pipe. This will ensure that the flexipipe maintains the correct fall and has no airlocks. A benefit to this system is that it adds a protective sheath to the flexipipe. It is easy for the position of pipe runs to be forgotten, and subsequent excavations might easily pierce or sever a flexi or PVC pipe if it is unprotected. Adding a sheath will give warning of the pipe location and minimise damage. Whilst winters in the UK are rarely so severe to cause subterranean water pipes to freeze, it is prudent and a minimal expense to add

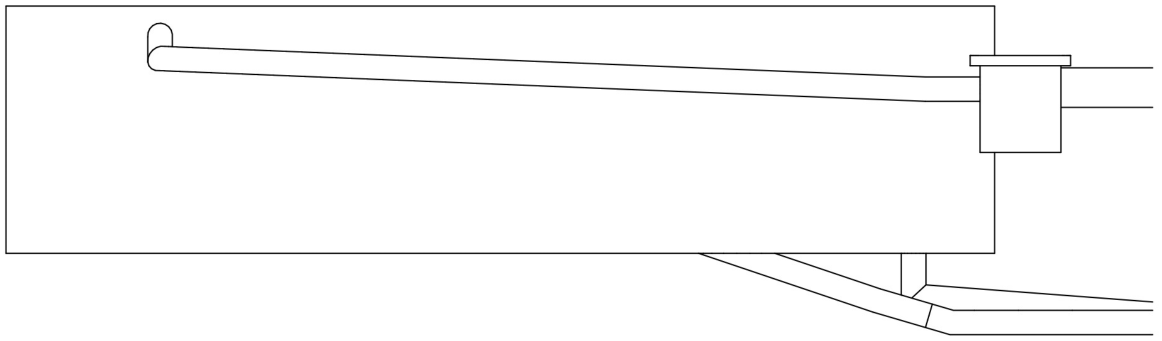


Figure 1.11 Straight pipe connection

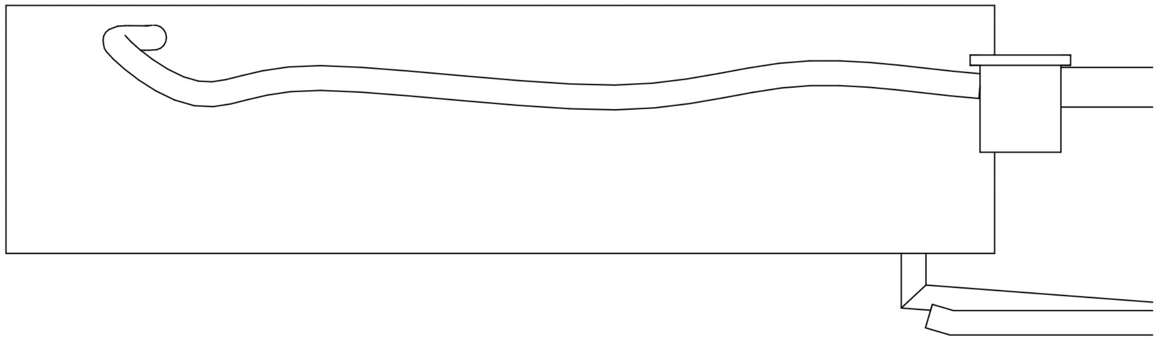


Figure 1.12 Flexipipe connection

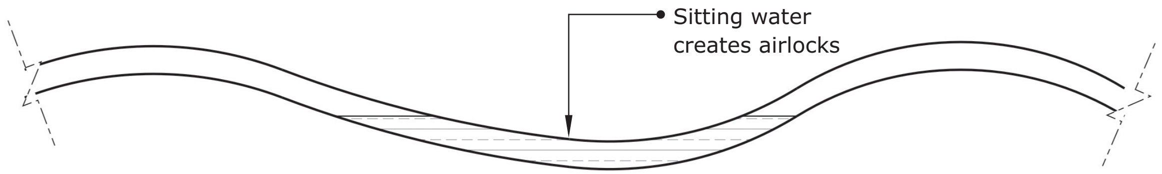


Figure 1.13 Flexipipe airlock

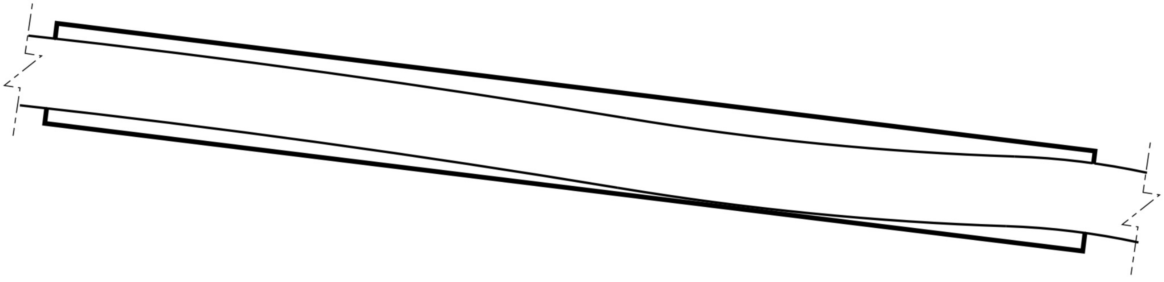


Figure 1.14 Flexipipe straightened

lagging to all water inlet and outlets to a water feature, particularly if the pipes lie close to ground level.

PERIMETER DRAIN

Where a water feature is excavated either to sit entirely or only partially below ground level it is possible that the features or its foundations may sit within the water table. Even if the ground conditions are free-draining, during periods of high rainfall the excavated hole can act as a soakaway and draw groundwater in.

Water features with a large footprint or that are long, such as a rill, may require a subterranean drainage system.

The drain is a simple perforated pipe (100mm) laid at the same level as the feature foundation. It is laid over a **geotextile** membrane and covered with free draining gravel, the geotextile wrapping over the top to filter soil particles. The top of the gravel drainage material should be set no less than 300mm from the finished ground level above; this allows space for planting or the installation of sub base for paving or hard landscaping. The purpose of the drain is to capture groundwater and direct it away from the structures supporting the water feature. The overflow can be connected into this drain. The perimeter drain outlet should be directed towards a soakaway or foul water system, where permitted, with a silt trap installed before the foul water connection.

Where there is any concern about rising or high water tables it can be prudent to install a sub-foundation drainage pipe. There may be more than one, depending on the size or length of the feature foundation. It will be necessary to build the feature foundation over a free draining sub base (e.g. DTp3 or clean angular gravel 6–20mm) up to 300mm deep over a

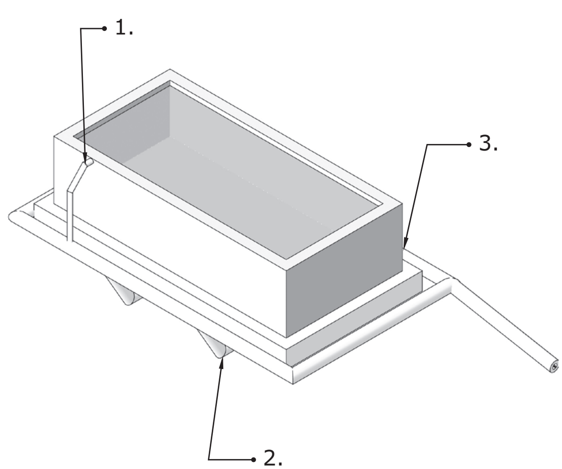
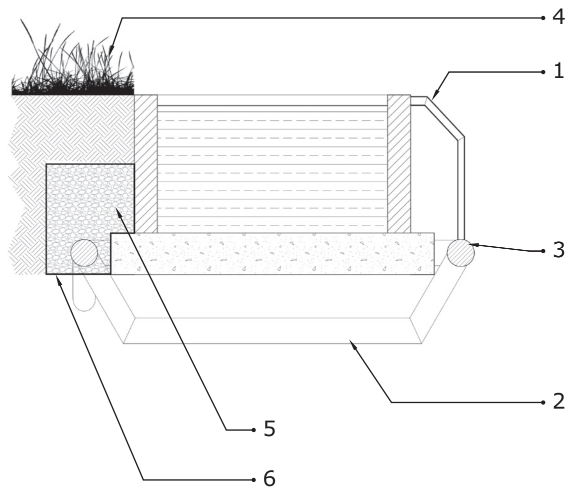


Figure 1.15 Perimeter drain



1. Overflow
2. Sub-foundation drain 100mm perforated pipe
3. Slab perimeter drain 100mm perforated pipe
4. Paving or planting as required
5. Clean free draining gravel
6. Non-woven geotextile (e.g. Terram 1000) wrapping to drainage material.

Figure 1.16 Perimeter drain section

geotextile membrane. The sub-foundation drains are laid into this granular layer. Water under the foundation will enter the drainage pipes and eventually flood them. When the level reaches the perimeter drains the groundwater will be taken away. This ensures that the water has a means of dissipation and will not exert catastrophic pressure to the underside of the foundation. Foundation level drainage relies on the final outlet being lower than the base of the pond. Where this is not possible, a sump (in a waterproof chamber) can be built that acts both as a silt trap and housing for a submersible pump. As the sump fills, the pump is activated and pumps water to the permitted foul outlet. The base of the sump must be below the base of the pond and it is best to locate the sump away from areas where the noise of the pump might become an irritation. Alternatively, the water feature can be raised above ground level to achieve the required fall to the required outlet.

SURFACE WATER DRAINAGE AROUND A POND

The location of a water feature, whether above or below ground, can cause an interruption to the flow of surface water that might be expected over the area had the feature not been present. It is necessary to consider drainage either around or away from ponds, rills or large water features. Small structures or bowls are unlikely to create problems, other than where overflow may damage or stain surrounding materials.

Features that are level with surrounding paved areas should have a detail that directs water away from the edge to prevent surface water from entering the pond. This is a necessity for wildlife ponds or where there are fish. Surface water can carry contaminants from surrounding planted areas, paving cleaning agents or pet waste, for instance, and should be prevented from entering the pond.

The simplest solution is to "kick" the paving units closest to the water feature

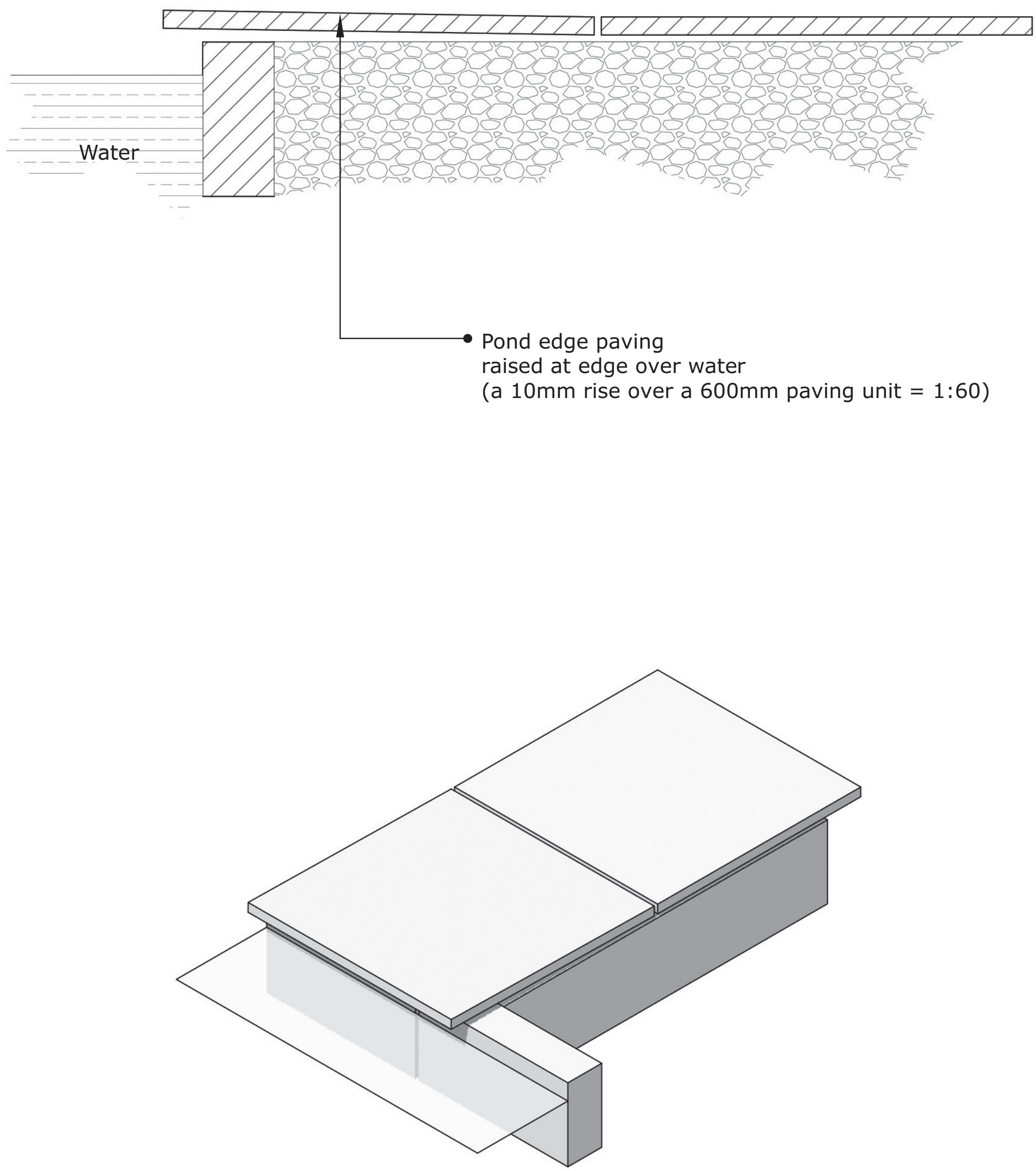


Figure 1.17 Perimeter surface kicked paving

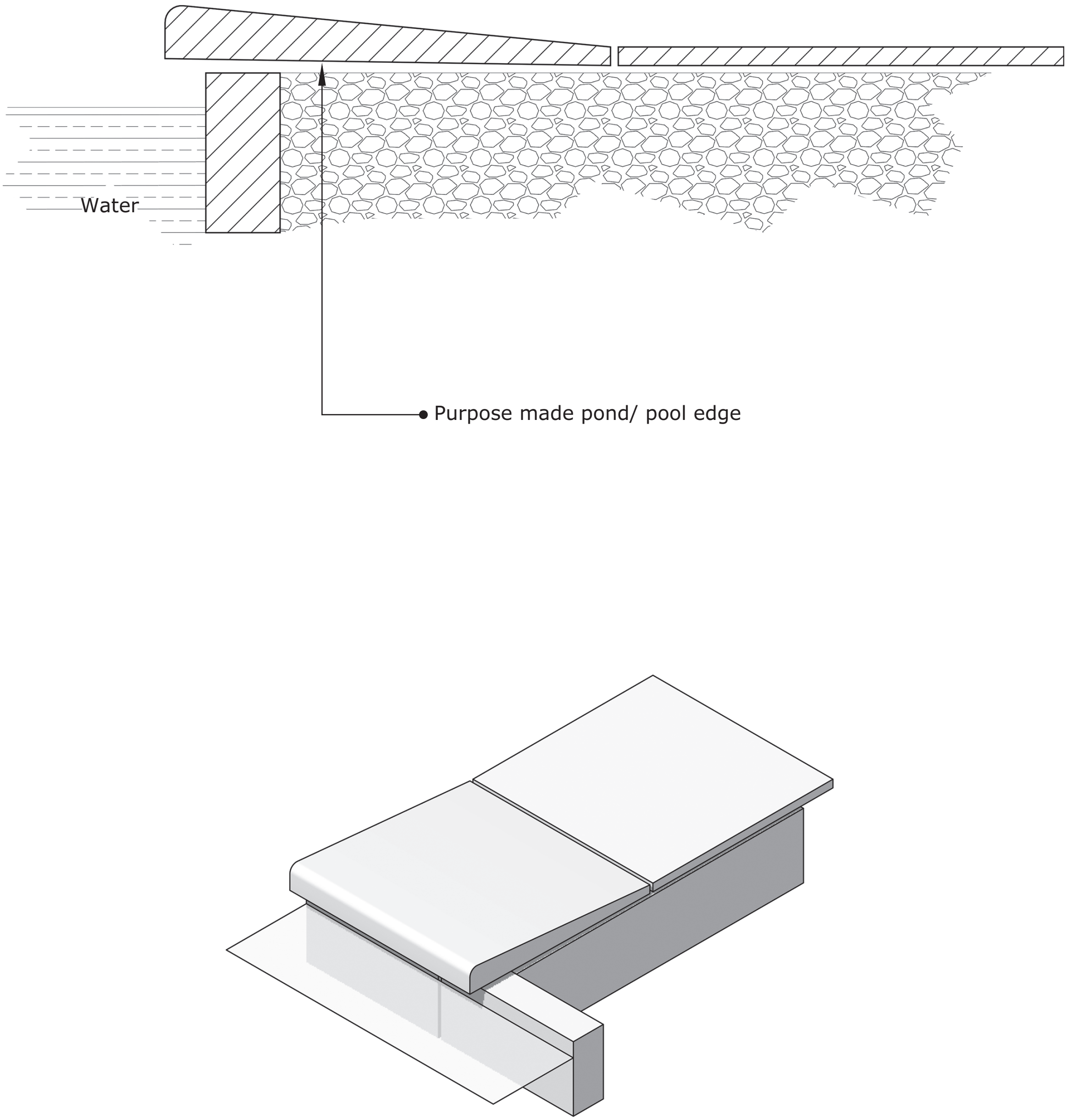


Figure 1.18 Perimeter surface purpose paving

up at their overhang with the pond. If large format paving is used, a 10mm tip would equate to approximately 1:60 fall away from the pond edge. This should prevent surface water from entering the pond in all but the severest downpours. Note the corner intersection of two raised pavers will require a triangular or mitred cut.

Alternatively, a purpose made pool edge can be used; these are designed with a bull nosed camber away from the pool. The range of sizes and colours will be limited.

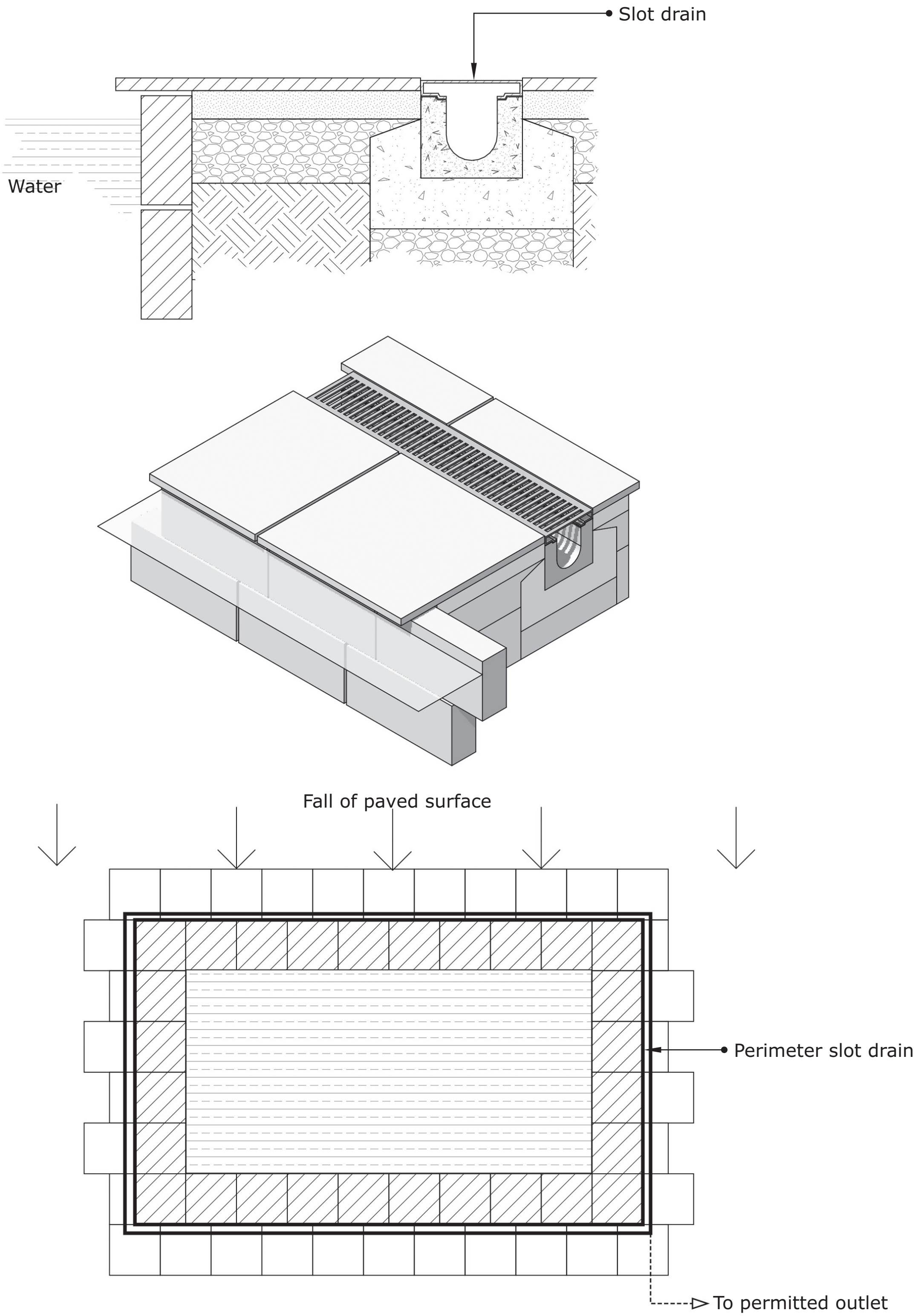
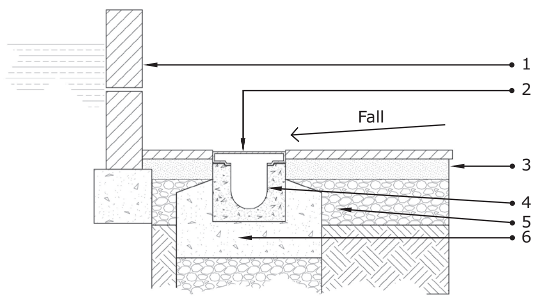
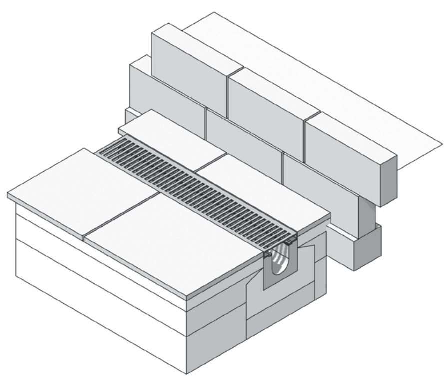


Figure 1.19 Perimeter surface slot drain in paving

The location or orientation of a water feature may require that the surrounding paving is best laid level with and to the same fall. A slot drain or brick-slot drain will act as an interceptor drain and prevent surface water from entering the pond. The drain itself need only extend over the length of the water feature that is immediately below the fall in the paved surface; however, it can be prudent to continue the slot drain to the entire perimeter of the feature for aesthetic and practical purposes. The drain can be connected to the overflow or directed separately to the preferred outlet.

Water features that are constructed out of the ground should have an interceptor drain along any wall or upstand that impedes the general flow of surface water across a paved area. A slot or brick-slot drain is simple and discreet.





1. Pond wall
2. Slot drain cover/brick slot
3. Bedding layer for paving
4. Slot drain
5. Sub base (e.g. DTp1)
6. Concrete bedding support for slot drain.

Figure 1.20 Perimeter surface slot drain against raised pond

CHAPTER 2

Water bowls and containers

A water feature in a bowl or small container is perhaps the simplest and cheapest way to experience water and water-gardening in a confined space.

Complexity will depend on what effect is desired, but at its simplest a still, water filled vessel will support plants or act as a reflecting surface, given some regular maintenance and the correct treatments.

A water bowl is essentially a pond on a micro-scale. They can be subtle and understated or the centre of attention. Water can be made to enter or leave a container in the same manner as found in larger features, although the effect may have to be somewhat restrained for the feature to work without too much water loss for instance.

An advantage of container water gardens is that the structure is already available and may be water tight and so the problem and expense of creating lined and sealed edges and joints is usually already solved. Where a vessel is not in itself waterproof or there is uncertainty, there are several simple and inexpensive ways to ensure that the water remains where it is required.

The bowl or vessel can be anything. Old enamel or butler style sinks have been popular in the past, as have half barrels and troughs. There is an increasing range of bespoke bowls of all material types, some are available preassembled with pump, hoses and all connections supplied. Some suppliers will even “convert” bowls or urns to allow them to operate as a water feature. However, there may be little latitude in the type of effect that is offered and whilst it can be an attractive option it is often best to be clear in the effect that is required (e.g. fountain/spill or rippled surface) and have the vessel made ready for electrics or hose connections, sourcing these as separate items to the required specification.

There are numerous permutations to creating effects in containers. The site may impose some restrictions – no ability to create a subsurface reservoir, for instance – that may prohibit certain types of effects. Depending on the scale

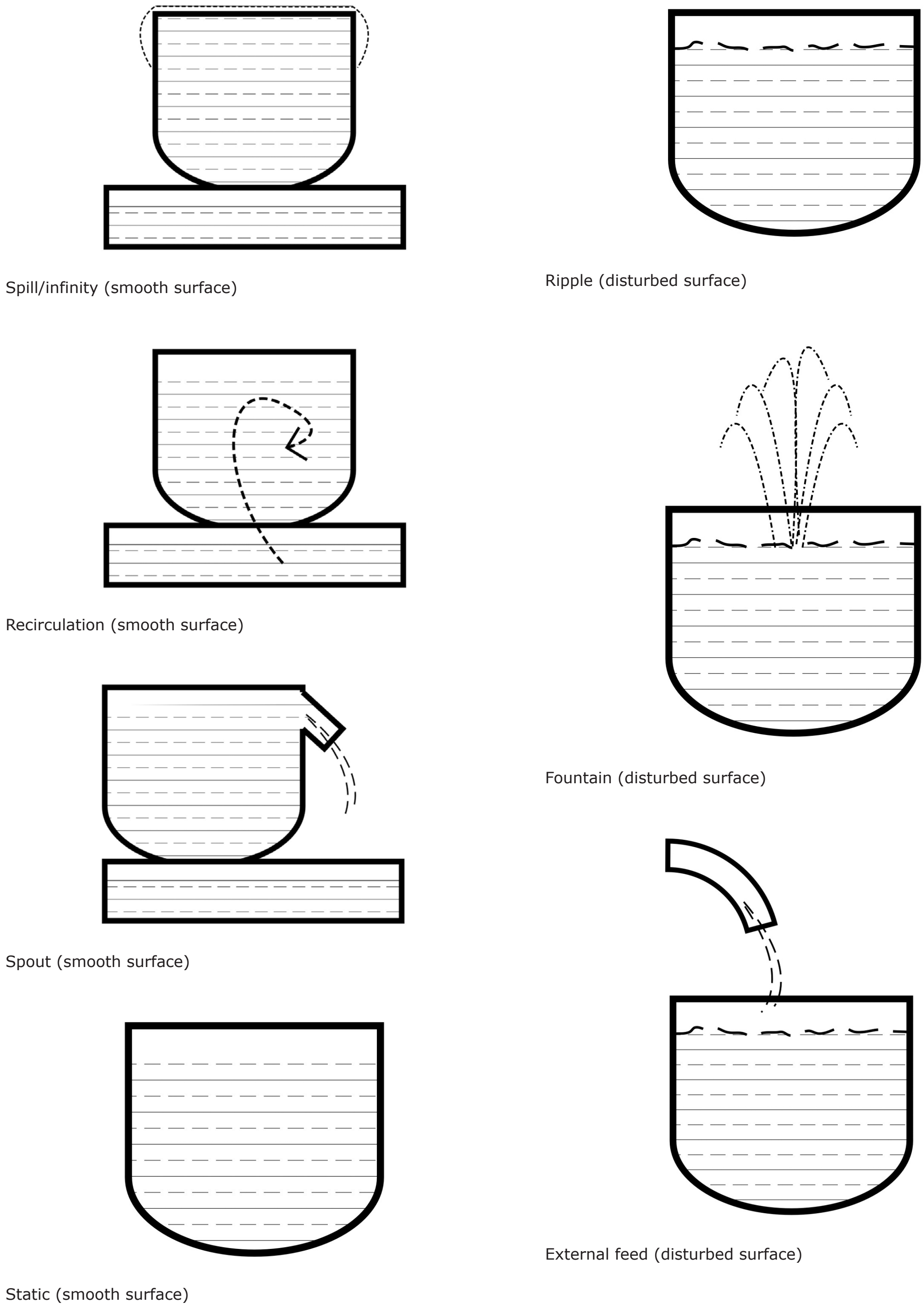


Figure 2.1 Types of water container features

required, there are usually work-arounds and frequently using standard stock components.

The primary consideration is to establish whether an external reservoir is required. While this is usually set in an excavated hole in the ground, often with no specific construction required, it can just as easily be built into the sub base of a patio or terrace or under a decked area. Prefabricated reservoirs come in a wide range of shapes and sizes. Where a particular size is apparently unavailable it can help to be lateral in sourcing. Rainwater harvesting tanks or water butts for instance come in a range of depths. If a bespoke chamber is necessary, then the construction should follow that for a formal pond (see the section on Edges). A container that is 1m diameter and 350mm deep can hold up to 550L of water (in practice this will be 350–400L) imposing a load of over 500kg on the supporting surface. If such a reservoir is used over a roof or suspended floor (e.g. deck) then it will be necessary to establish whether the roof or suspended floor can support such a load, or whether modifications are necessary.

Water bowls work best when sited away from full sun. The reduced volume of a smaller container will mean that the water body responds much more dynamically to the environment than larger water features. They are particularly prone to water loss through evaporation. This can be exasperated where the effect of a prevailing wind is present.

Importantly, any contained body of water can develop a temperature gradient (stratification). This is a phenomenon whereby water that is warmer (e.g. surface water in a bowl) separates into a layer above the cooler, shaded water. Water at different temperatures has different densities, creating the stratification. Without circulation the water layers have little interaction and do not mix. The warmer upper layer can create suitable conditions that encourage insects and bacteria, which are neither beneficial nor desirable (e.g. midges and mosquitos). The location and type of container will significantly influence the degree to which water stratification occurs. Steel containers, for example, will heat up quicker than a timber or double skinned polymer container.

A circulation system within the container will mix the water and help to establish an even temperature; however, in full sun a volume of water may still reach elevated temperatures that favour insects and bacteria whilst being detrimental to plant life.

For example, a water container 800mm in diameter and 300mm high (approximately 150L volume) can attain +30°C where a persistent air temperature of similar value is present.

Algae, in particular, blooms in warm water and left unchecked or untreated can choke the life from a small body of water and is particularly unattractive to look at.

It can be a difficult balance between creating a feature for the effect of moving water and incorporating plants. It is possible to have both but a chemical intervention may be required. Water in a self-contained, small system should be treated against bacterial and biological problems. There are many products available (see Appendix 8) and a wide range of effects. Some will kill anything and everything, which may be what is required, others will treat algae but claim to be fish and plant friendly. It is necessary to read both the small print and instructions. Whilst a fish friendly product may be useful, frequently additives will still kill invertebrates, amphibians and insects, which can upset the ecosystem if the container is intended as a wildlife feature. Many products are added in a diluted liquid form, some as tablets which slowly dissolve. The frequency of dosing can vary enormously and it is useful to calculate the expense of such additives over the spring and summer months. Algae only flourishes from spring to late summer and with the change in air temperature the need to dose small features stops for the cooler months. In larger pools and ponds algae can be partially treated against through the use of a UV clarifying bulb, often incorporated into the filter set. These can be bulky and combined pump and filters that use a UV system may be too large for a small container or bowl.

Locating a container water garden is less of a structural decision than a large water feature. Much like a large plant in a pot, the container should be sited where it will be visible and enjoyed, either in passing or perhaps as the focus of part of the garden. It is best in shade/partial shade. The size of the water feature may be determined by the container that is available. If the bowl is to be purchased then there is more scope and choice both in style and scale. Whilst the material and style will be a matter of personal taste, the size of the feature should be considered in the context of the space for which it is destined. It can be useful to mock up the preferred bowl, even as a simple representative cylinder from cardboard. What may seem large on paper can sometimes appear insignificant when it is sited.

Whilst the more complex features will have a pump and water recirculation, all bowls or containers will require regular inspection and cleaning. It is therefore essential to consider how the water will be drained and where the water will go, as well as how it can be refilled.

A water bowl should be drained down at least once a year to inspect the container sides, clean surfaces, replant and divide, service the pump if present. The simplest method is to scoop out as much water as possible and if the vessel is manageable, to tip out any remaining water. This assumes that the surround ground can absorb

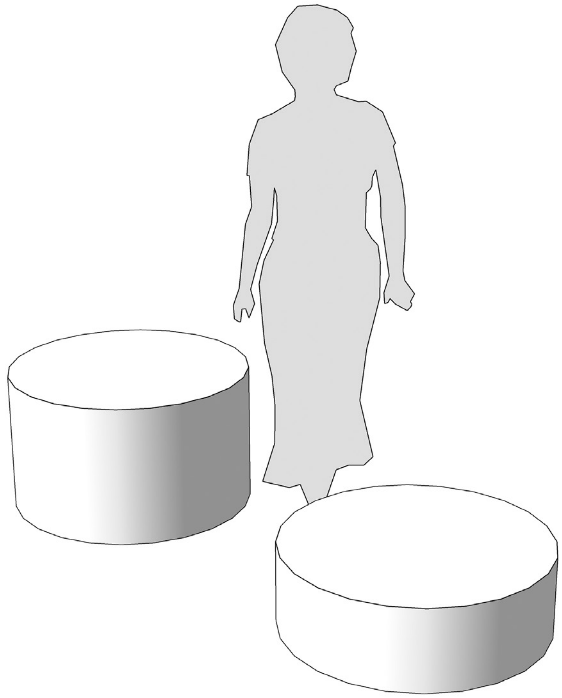


Figure 2.2 Water bowl mock-up model

a large flow. Roof gardens, or gardens over heavy clay don’t have this benefit and so it will be necessary to have a more elegant method of draining. **Tank connectors** are simple coupling devices that screw together either side of a hole in a water container. They come in many sizes and often have a coupling thread or barb by which external pipes, hoses or valves can be attached. If it is possible to discreetly locate and create a 1” or 2” hole as close to the bottom of the water feature as possible, then a tank connector with a screw cap closure can be used as a drainage outlet. An inline valve can be added with a flexible pipe attached to the valve during the drainage to direct the drained water to a suitable bed or gulley.

Some containers are by their nature or through their original manufactured purpose waterproof, though many are not.

LININGS FOR CONTAINERS

Non porous materials such as terracotta, metal, stone, may still require a waterproofing layer inside the container. Metals can rust and contaminate the water, the terracotta pot may prove to not be as watertight as hoped. Prefabricated liners are usually rigid and made from fibreglass. They are available for standard shaped containers such as half barrels.

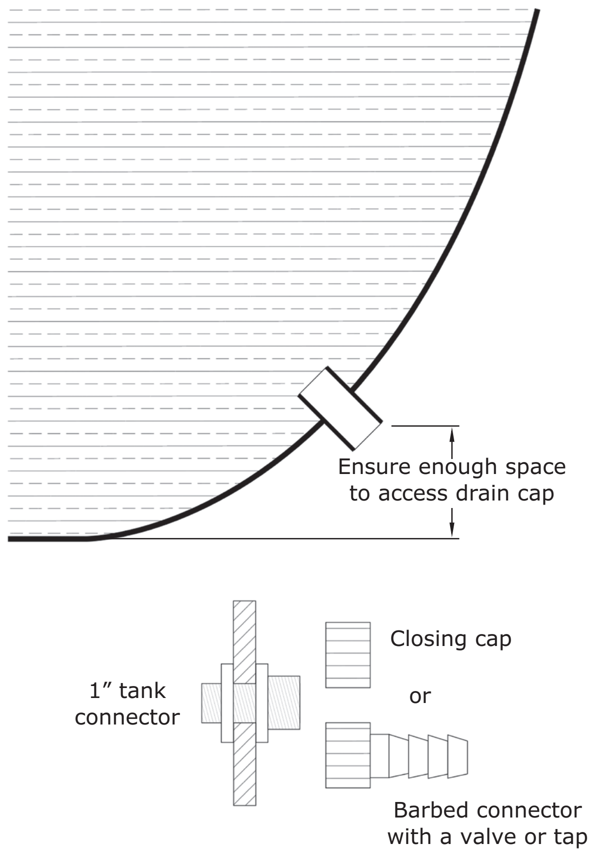


Figure 2.3 Tank connector drain outlet

If one is not available in the shape or size required then there are three options:

1. Use a “paint” on waterproofing agent. There are several types. The best will probably require several coats. Some waterproofing agents are unsuitable for use in water that is used to attract wildlife or support plants (e.g. “black-jack” style bituminous paints). These may have a high volatile organic compounds (VOC) content and are primarily designed for shielding inert materials before they are used in construction in-ground. A specific pond lining material should be used (see Appendix 8).
2. A flexible liner can be used inside the container. These are available in a range of materials; whilst some materials are better than others for large water features, in a small container the principle characteristic needed (apart from being waterproof) is that the material should be very flexible. It can take some practice to fit and smooth out creases; part filling the container can help hold the liner in place. What is critical is how the liner is held at the

top edge. It is important that the liner extends past the upper water level, which is likely to rise in heavy rain. Organic shaped containers will result in a creased liner. This will mostly be hidden except at the top lip, where a trim feature to hide tucks and creases will be needed.

3. Glass fibre is supplied as a "mat" which is applied in thin alternating layers with a paint on resin. Several courses are applied until it forms a continuous waterproof lining. The top course is where any pigment should be applied. It is very adaptable to surface undulations and bumps and sets to form a rigid and long-lasting skin.

The natural colour of the container may be suitable as the finished surface, but if waterproofing is required, black works best. It can convert the water surface into a mirror, reflecting the sky or surrounding planting to great effect; surrounding and overhanging planting will also be highlighted with a black lined bowl.

Unless the container is set below ground level it is unlikely that fish will survive, due to the elevated summer temperatures and winter freezing. If fish are to be added then they will need to be inspected for diseases and injuries, as well as ensuring the water is sufficiently oxygenated, either through plants or an external oxygenating pump.

ELECTRICS AND PUMP SIZES

The type of effect required in or into the water feature will direct the decisions towards a suitable pump. A simple recirculation pump will be of a lower specification than a pump used to create a spill effect. With small water features the difference between the flow rates required for different effects can be very small and so the range of pumps to choose from is considerably less than when the feature is scaled up and flow becomes a much more significant factor.

WHAT TYPE AND SIZE OF PUMP IS REQUIRED

Effects such as fountains and spilling/brimming water features can require

Table 2.1 Size and type of pump required

Effect	Pump flow rate	Pump price (£)	Power consumption
Recirculation	300L/h	<£50	5W
Small fountain	750L/h	<£50	9W
Spill effect	2–3000L/h	<£100	32W
Spout (gentle)	600L/h	<£50	11W
Spout (dynamic)	800L/h	<£100	11W

Flow rate is given in L/hr; to convert to US g/hr multiply by 0.264172

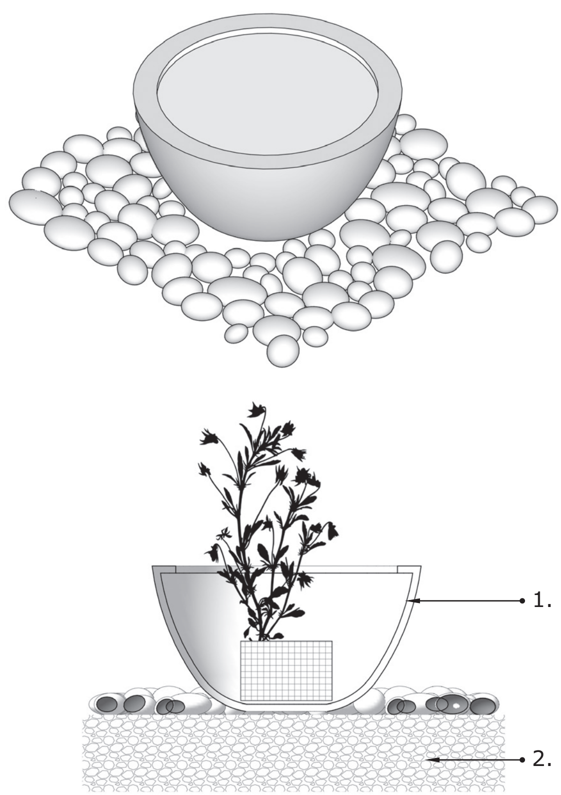
(See Appendix 2 for average costs for running pumps) subtle adjustments. Simply changing pumps will not give the level of control required to fine tune the flow. It is not recommended to use an inlet or outlet valve to restrict the flow of water. Pumps are designed to work at a set rate and restricting their flow can cause them to fail prematurely. A good quality compact pump will have an integral flow control and this should be used to refine the water flowing through the system.

An easy way to make an initial guess as to the required flow is to use a domestic water hose. First the flow from the hose should be established. Time how long it takes to fill a bucket or container of known volume. A typical flow rate for an external tap in the UK is approximately 10L/min (600L/hr, 160USg/hr). This can vary depending on where a tap is located relative to the main residence and the local mains supply pressure.

To establish the approximate flow rate for a brimming bowl, fill the bowl almost full. Place a hose connected to an external water supply and turn on. It will help if the hose is held down within the bowl by a heavy object that does not break the surface (e.g. a brick). Disturbing the surface with an arm or hand will create currents and the effect will not be as expected. When the water spills from the bowl, and assuming the bowl is set as level as is practical, there should be a continuous ribbon or film of water around the rim. If there is not then it is likely that there is not enough water flowing to create the cascade. Some breaks in the film can be due to breaks or rough areas on the rim and these should be cleaned up as much as possible. Whilst it is a simple experiment, it does establish whether a pump of 600L/h is adequate or whether a larger flow rating is required that can be fine tuned. You can always adjust a pump's flow rate down but never increase its flow capacity.

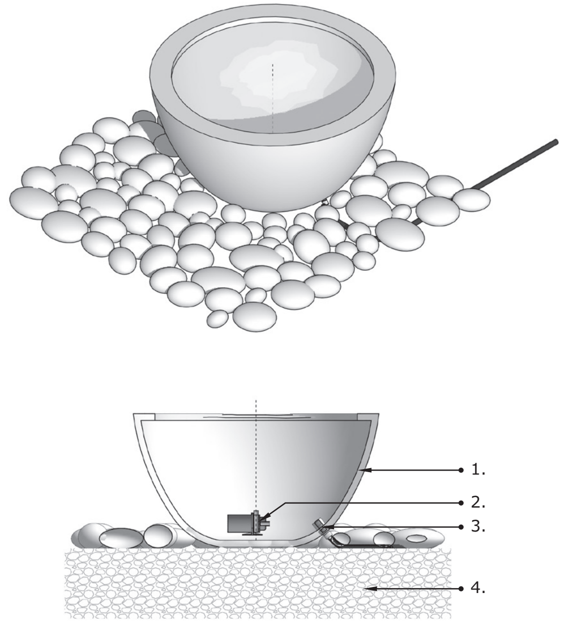
Where pumps are required there needs to be an electrical connection. This can be taken over the rim of the container but in most cases this will not give a particularly attractive effect. Some containers or bowls have provision to make a simple connection through the base or sidewall already included. Where there is no hole present one must be made. A cable transition gland is a small connector (rated to IP68, waterproof) that permits electrical cables to be taken through the sides of water reservoirs. For small water pumps with a cable size 7.5–14mm a 20mm diameter hole will house the connector and seal around the cable. A standard M20 gland connector will accommodate up to about 5mm wall thicknesses.

Pumps are sold with an amount of cable attached. This is usually "potted", set in resin within the pump body to prevent any leakage or water reaching the electrical connection and left as a free end cable. Supplied cable lengths can vary from 2m to 10m. Electrical cables that are used in a garden should be installed in accordance with local regulations. Ideally the cable should be armoured or run through a secure casing and in open soil or beds set to a depth of no less than 500mm. Tape identifying the presence of an electrical cable below should be used directly over the conduit. Cables that run under hard landscaping do not need to be buried as deeply and so long as the landscaping is permanent (e.g. paving) cables can sit within the sub base (hardcore) layer. Cables are best laid within a conduit. This allows for the pump to be easily removed or replaced or additional cables to utilise the same run. Conduits are best placed in the early stages of a garden build and at least two draw cords should be added at this stage to allow cable lengths to be pulled through when required. Where the electrical connection is further than the cable length a joint will need to be made. This must be in a weather-proof cable connector (IP67 Weather-proof) if the connection lies outside the pond or with an IP68 rated waterproof junction box or cable connector where the cable union is located within the water body. Pumps for domestic applications will simply require a plug and to be attached to an outlet socket. Where the socket is located



1. Internal waterproof coating, if required.
2. Free-draining layer such as hardcore (DTp1) or gravel.

Figure 2.4 A simple, static water bowl or basin without internal circulation



1. Internal waterproof coating, if required
2. Low flow recirculation pump. 300L/hr with integral flow regulation
3. Electrical cable glands (e.g. suitable for cable 7.5m–14mm, transition hole to be drilled 20mm, IP68 rated, water feature wall thickness 5mm max)
4. Free-draining layer such as hardcore (DTp1) or gravel.

Figure 2.5 A simple water bowl with internal recirculation

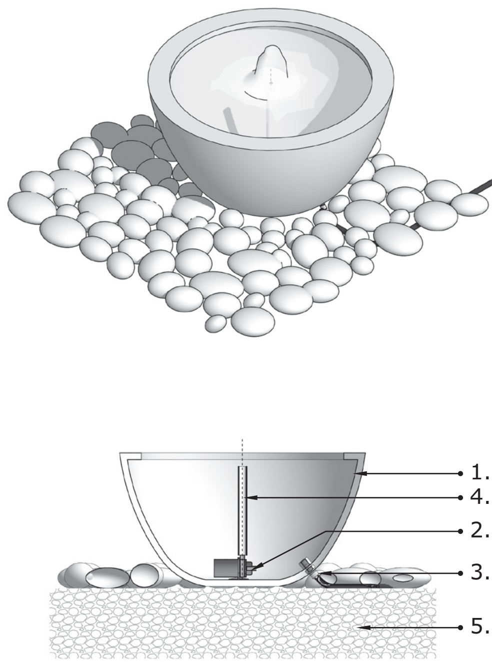
outside at building it should be IP67 rated. The price difference between a single and a double outlet is minimal and a double allows for additional devices such as pumps and lights.

This is the cheapest and easiest way to bring water into an outside space, no matter how small the area.

The water level spills over in heavy rain and onto the surrounding ground. It can be helpful to set the bowl over a layer of hardcore or free-draining material so that the ground remains stable. Pebbles or small rocks will disguise the ground but can quickly discolour.

Planting can be added. These are best retained in basket or pond pots as they will need to be replaced or divided. The pot tops can be covered in a decorative aggregate or with stones but to prevent algae blooms the water should be treated with a suitable ecological additive (see Appendix 8).

The difference between creating a simple, gentle rippled surface and a more pronounced bulge on the surface is simply the location of the water outlet relative to the surface. Closer to the surface, the more pronounced the rise in the bulge created. A low flow pump (less than 300L/h) will create little surface disruption but maintain water circulation. The addition of a suitable treatment will effectively sterilise the water and prevent



1. Internal waterproof coating, if required
2. Low flow recirculation pump. 300L/hr with integral flow regulation
3. Electrical cable glands (e.g. suitable for cable 7.5m–14mm, transition hole to be drilled 20mm, IP68 rated, water feature wall thickness 5mm max)
4. Rigid pipe connected to the pump outlet (size varies on model)
5. Free-draining layer such as hardcore (DTp1) or gravel.

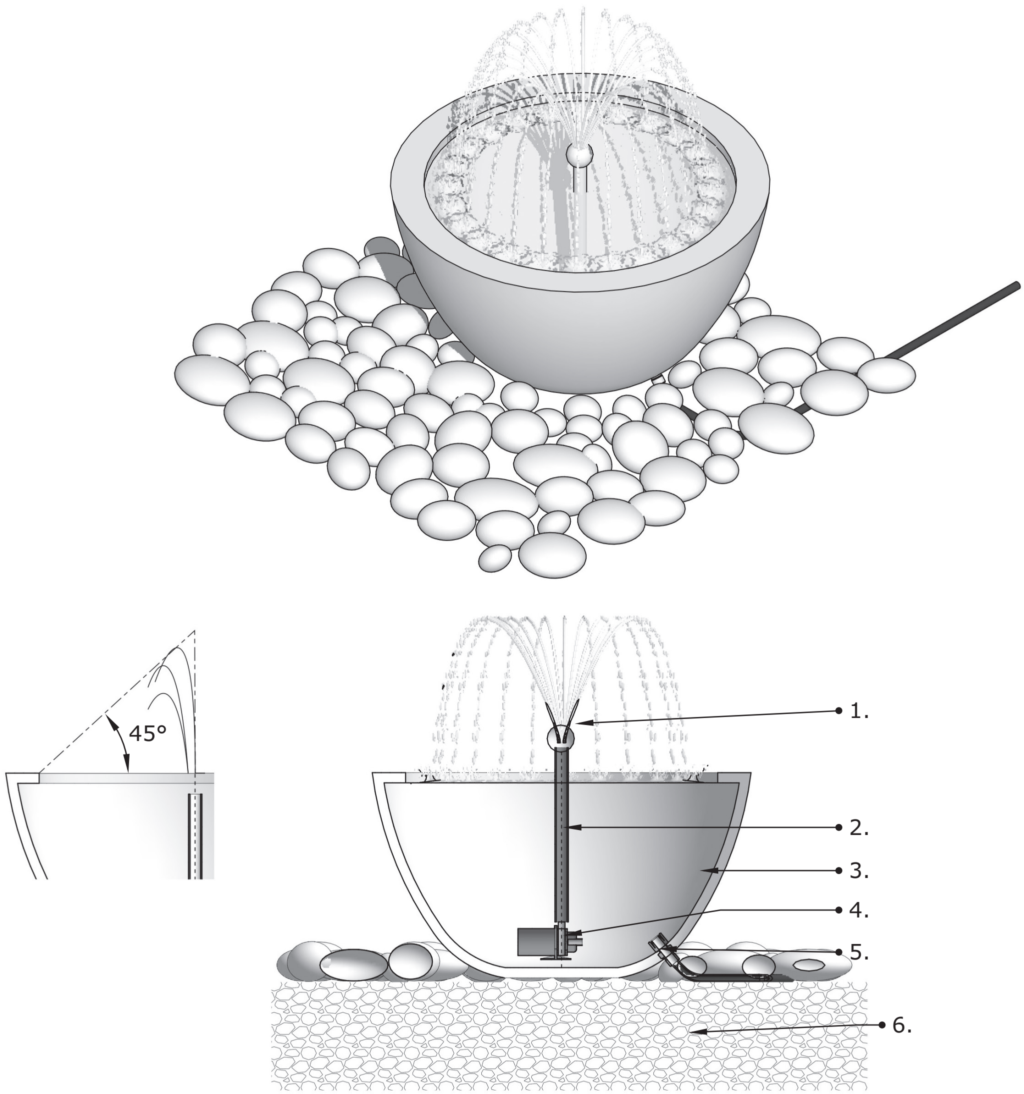
Figure 2.6 Simple water feature with internal circulation and a dynamic surface

a biofilm building up on the internal surface. If plants are to be added, then the water treatment used should be ecologically safe.

Introducing an internal circulation will stabilise the temperature of the water body. A low flow pump (less than 300L/hr) is small and discreet. It may be disguised by adding a layer of large pebbles or stones but if the water surface is disrupted it is unlikely that the pump will be visible. By adding a tube to the pump (some types are telescopic), the water can be dissipated closer to the surface. It will not create a fountain, but adjusting the water flow on the pump can refine a raised bump or bulge.

The electrical cable connection is made through a simple gland, which is selected to suit the diameter of the cable and the thickness of the container wall. The cable running back to the supply socket should be located within a conduit either under hard landscaping or buried to a sufficient depth in planting beds with a marker tape laid over the conduit surface.

A fountain is created through the extension of the outlet, above the water surface and the addition of a unique nozzle. Fountain pumps are specifically

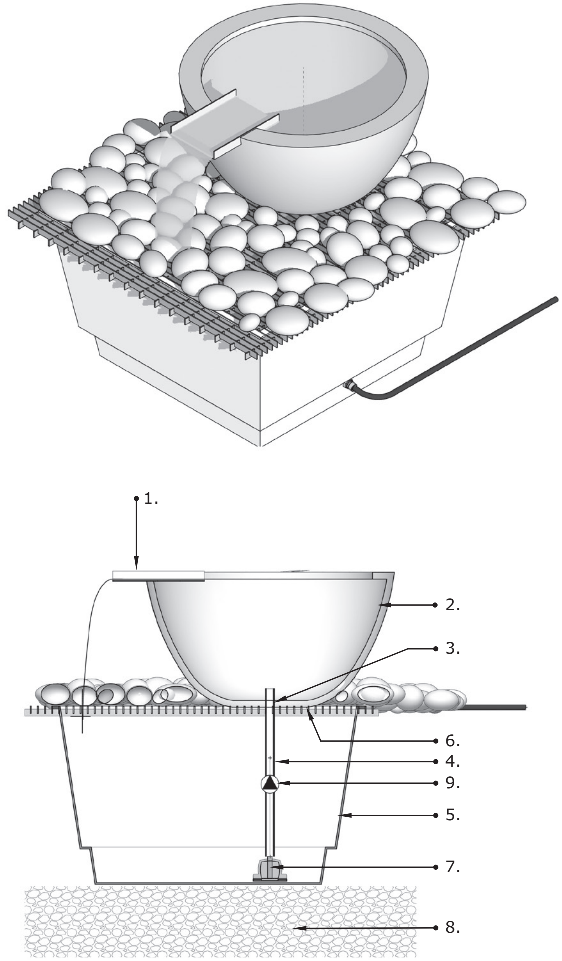


1. Fountain head nozzle (selected for the required effect/pattern)
2. Extension pipe from pump
3. Internal waterproof coating, if required
4. Fountain pump (e.g. 750L/hr)
5. Electrical cable glands (e.g. suitable for cable 7.5mm–14mm, transition hole to be drilled 20mm, IP68 rated, water feature wall thickness 5mm max)
6. Free-draining layer such as hardcore (DTp1) or gravel.

Figure 2.7 Water bowl fountain

designed to raise water at a suitable flow rate. They are usually supplied with a range of pipe connectors and fountain heads (nozzles). Simply attaching one of the included nozzles can create different effects. The pump flow rate will need to be adjusted to ensure that the effect is reasonable and to the right size. In wind, water can be carried beyond the perimeter of the container, resulting in rapid water loss. A simple rule of thumb is to keep the fountain height at or below the height of a 45° line drawn from the edge of the bowl.

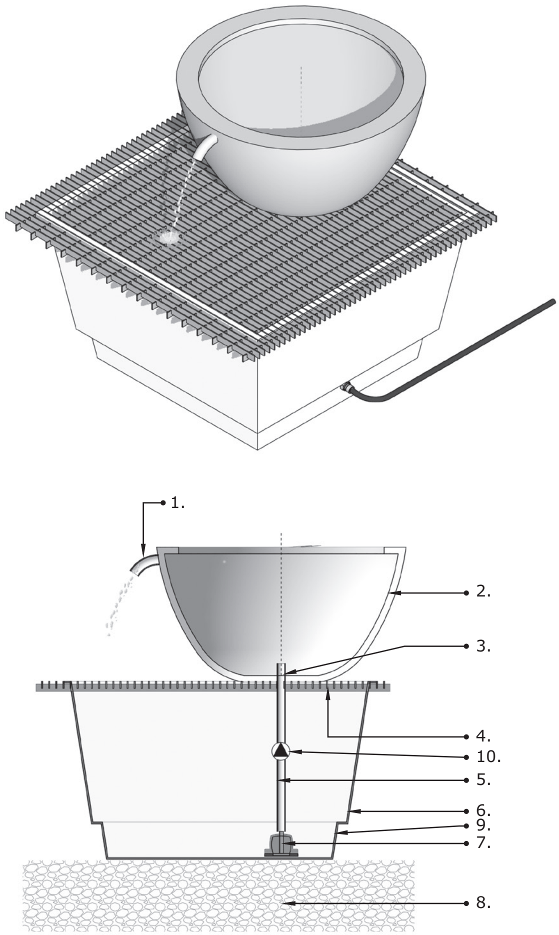
Unlike larger water features where the circulating pump has to run for 24 hours a day, small feature pumps can be switched off overnight or in inclement weather, if required. The water should be sterilised through the addition of a suitable treatment (see Appendix 8) rather than relying on a mechanical or biological filter system.



1. Water bowl outlet/chute. Some water bowls come with these included. They can be fabricated from bent metal – if steel then it should be galvanised or treated with a suitable waterproof coating
2. Internal waterproof coating, if required
3. Tank connector to attach the pump outlet pipe
4. Outlet pipe from the pump (e.g. 13”mm/1/2”) advised by pump specification
5. Water reservoir. This may be prefabricated (e.g. Ubbink 71x40cm with metal grate)
6. Metal grate. This should be grate or tread mesh, fully galvanized. Metal *mesh* is a thin sheet material and unsuitable
7. Water pump (1000L/hr)
8. Free-draining layer such as hardcore (DTp1) or gravel
9. Non-return valve.

Figure 2.8 Water cascade

Water that leaves a bowl or container needs to be replenished. The easiest solution is to capture the water in an external reservoir and return it back to the bowl. Where the water fall is wide, care should be taken in the placement of pebbles and stones that the water will strike. The resulting splash can direct water away from the reservoir, resulting in water loss. The pump flow to create



1. Spout, to a larger diameter than the inlet from the pump
2. Waterproof coating, if required
3. Tank connector
4. Metal grate
5. Outlet pipe from pump (e.g. 13”mm/1/2”) advised by pump specification
6. Water reservoir
7. Water pump, 600L/hr
8. Free-draining layer such as hardcore (DTp1) or gravel
9. Electrical cable glands (e.g. suitable for cable 7.5mm–14mm, transition hole to be drilled 20mm, IP68 rated, water feature wall thickness 5mm max)
10. Non-return valve.

Figure 2.9 Water bowl spout

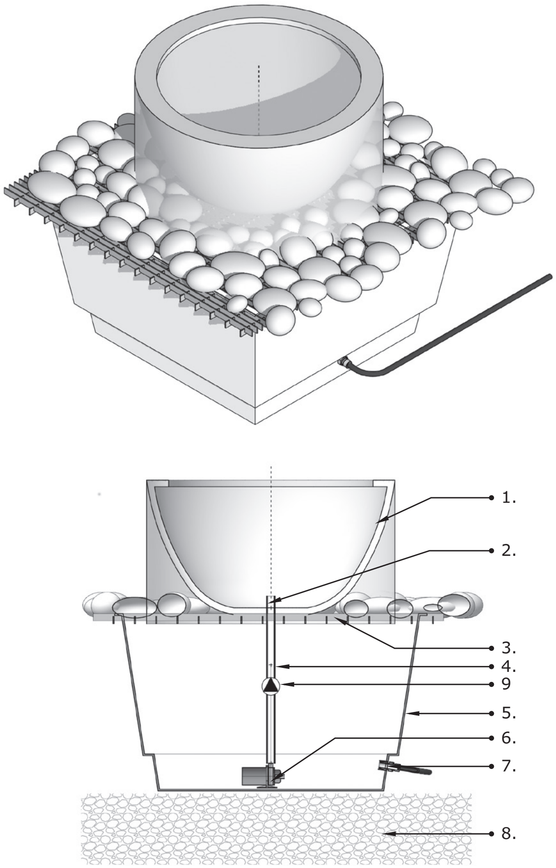
a dynamic cascade will be higher than that used for a simple recirculation. The strength of the cascade will be determined by the pump flow. A cascade less than 100mm wide will require about 1000L/hr flow rate. The pump should have a flow regulator to fine tune the effect. The pump is best located in the receiving reservoir, connected into the container with a discreet pipe or hose in its base. A simple non valve return (NRV) is added to the pump outlet. This prevents back flow, when the pump is switched off the water will be unable to fall back into the reservoir. A tank connector is required to seal the hole in the bowl and connect to the pump outlet.

There are several types and styles of pond reservoirs. One should be chosen that will support the load of the water feature (full) along with other features such as rocks or pebbles. Alternatively a simple chamber can be constructed in the ground from block work over a concrete base. This should be waterproof. It is essentially a small pond and a range of construction details are shown in this book.

Water spouts work in a similar way to a chute or water blade but require a much lower flow rate. The water is much more concentrated and so can be directed into receptacles, secondary bowls or simply appearing to disappear into the ground. The flow rate out must equal the flow rate in. As a guide, an average domestic external tap will have a flow rate of 10L/min (600L/hr). The pump will push the water into the main bowl under pressure with the water inlet pipe full. As water will flow out only under the effect of gravity, the outlet spout will only be partially full, so it is likely that the bowl will overflow if the inlet and outlet are the same diameter. To prevent this, the outlet should be a larger diameter (e.g. inlet pipe from pump is 25mm/1” diameter, spout outlet 30–50mm diameter).

To create a brimming or spilling effect over a water feature there has to be a considerable volume of water flowing over the edge or rim. The bowl needs to be set dead level – any deviation will bias the water to one side or another. The rim of the bowl needs to be smooth and clear of burrs and debris, as even minor imperfections can create breaks in the water curtain. As with other effects, the flow of water in small features can be controlled to some extent by adjusting the flow rate on the pump. It is essential that a pump is selected that has this facility. Restricting the input or output flows with a separate valve can damage the pump. There is a simple formula for calculating spill rates for larger and faster bodies of water such as water blades and infinity effect pools. On a small scale these calculations do not translate well and result in excessive water flows.

A water bowl with for example a radius of 350mm, will have a rim circumference of just over 2m (see Appendix 1: useful formulae). A flow rate of 1000L per



1. Waterproof coating, if required
2. Tank connector
3. Metal grate
4. Outlet pipe from pump (e.g.13”mm/1/2”) advised by pump specification
5. Water reservoir
6. Water pump, 3000L/hr (determined by the length of the bowl rim)
7. Free-draining layer such as hardcore (DTp1) or gravel
8. Electrical cable glands (e.g. suitable for cable 7.5mm–14mm, transition hole to be drilled 20mm, IP68 rated, water feature wall thickness 5mm max)
9. Non-return valve.

Figure 2.10 Water bowl brimming

metre of rim should be sufficient; giving a 2000L/hr flow rate pump. To allow for rough surface and defects, a higher flow rate may be required, so it would be prudent to use a flow rate of 1500L/hr for every 1 metre of rim. As with other water effects that drop onto surfaces or materials creating splash back, there should be some adjustments and careful positioning to ensure that water loss is minimised. Spill and cascading water features in particular should have their water levels checked regularly, and topped up as required.

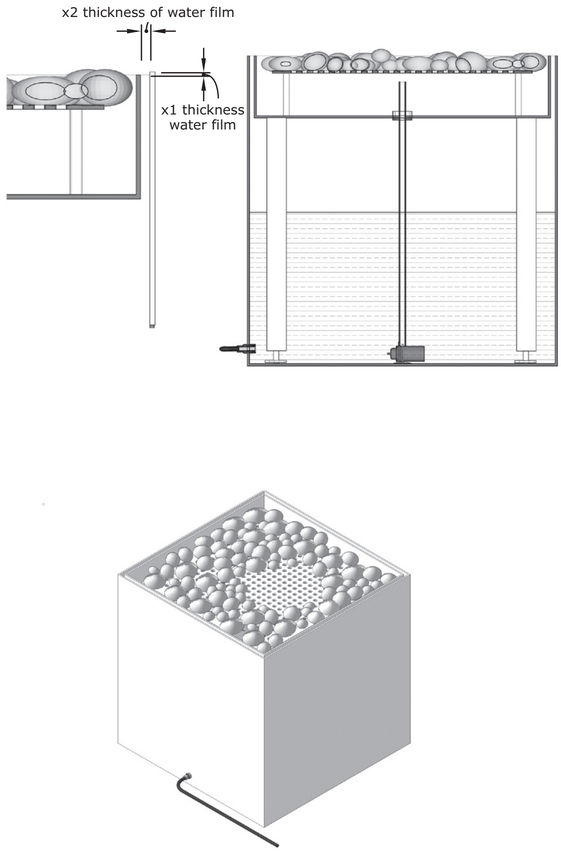


Figure 2.11 Water bowl brimming infinity edge

An infinity edge feature can take many forms. Some spill, cascading water over the rim, others keep the water within the vessel. A self-contained brimming feature is something that requires consideration, accurate fabrication and some experimentation.

To create a simple system where an elevated tank is fed from below the reservoir, it is set on a cradle with adjustable feet which allow it to be independently set level. The depth of the reservoir can vary, the effect required will determine whether a deeper tray is needed, for say the inclusion of pebbles, or a shallower tray where the diffuser plate can lie within 15mm of the surface.

The water input should be centrally located and cut close to the base. This creates a volume of water over the inlet which will help calm the inlet flow. The diffuser plate can be perforated or solid. A solid plate should have sufficient gap around the sides to allow the water to fill without creating eddies or currents.

The diffuser plate should be removable to allow access to the water inlet.

The critical detail is the position of the internal reservoir relative to the main container, with its relative height and the gap between the two. Too close and the surface tension of water may create a bridge between the two and water may spill out of the feature rather than down the gap. The flow of water will determine this relationship. The film of water over the rim should be about 5mm thick. A pump with a flow regulator is essential in controlling the volume of water entering the reservoir and therefore the thickness off the film over the rim.

This edge can create the effect of a film of water level with the external rim. With a low flow the water movement is barely perceivable. The detailing does require careful and accurate placement and finishing. The internal surfaces of the feature benefit from being painted/ powder coated black. All components should be level with a high degree of accuracy. Adjustable feet on the main water tank and separately on the internal tray will help with the final adjusting.

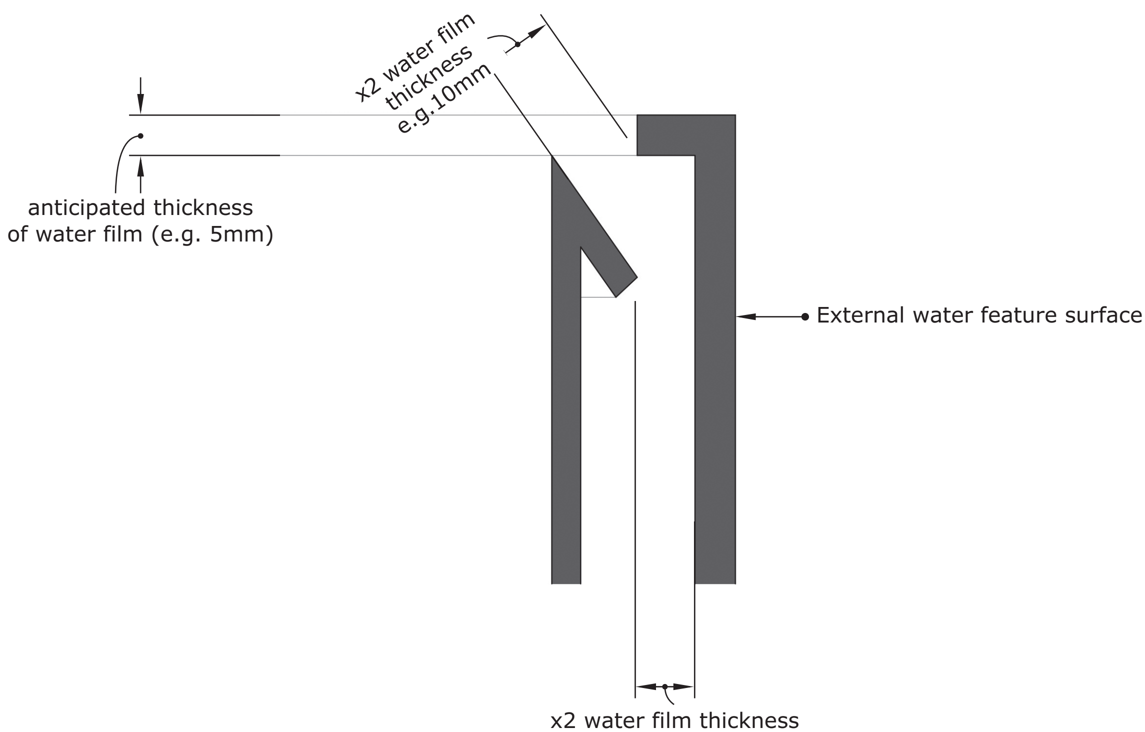
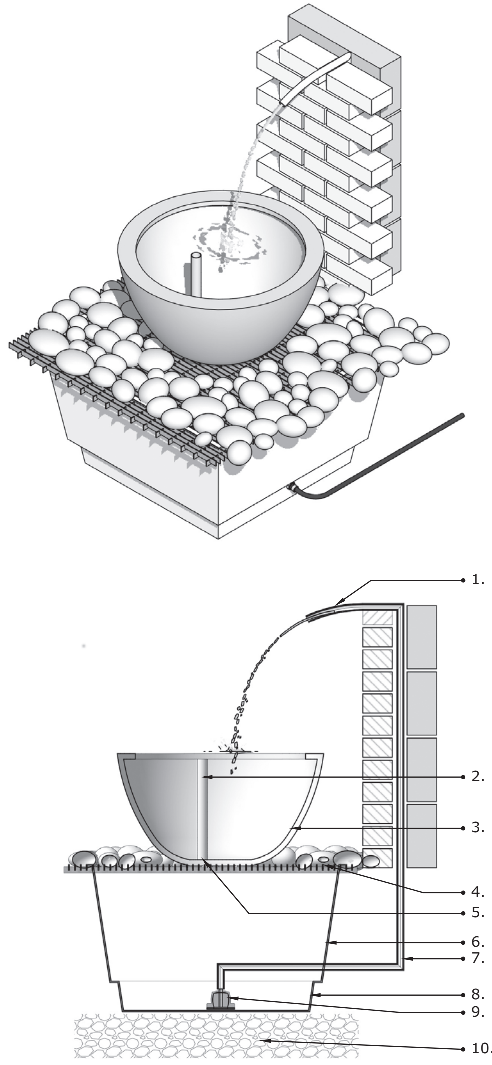


Figure 2.12 Water bowl brimming infinity alternative edge



These dimensions are given for guidance only. The actual detail will be informed by several external factors including water flow, wind conditions and accuracy and refinement of the construction. It is always useful to create and test prototypes before committing to final production.

1. Spout
2. Overflow pipe (one size up from the inflow pipe diameter)
3. Waterproof coating, if required
4. Metal grate
5. Tank connector
6. Water reservoir
7 Outlet pipe from pump (e.g. 13”mm/1/2”) advised by pump specification
8. Electrical cable glands (e.g. suitable for cable 7.5mm–14mm, transition hole to be drilled 20mm, IP68 rated, water feature wall thickness 5mm max)
9. Water pump, 600L/hr
10. Free-draining layer such as hardcore (DTp1) or gravel.

Figure 2.13 Water bowl external feed

A water bowl that is fed from an external source can be quite dramatic. It may be connected or placed next to other bowls or containers to create a cascade or row of repeating features. Unlike other features, the water is taken out of the reservoir to a remote point where it flows back into the bowl. The water bowl might be allowed to spill over and the water collected into the recessed reservoir. If the water is required to remain in the bowl then a simple overflow is needed. This is a simple pipe with a thread connection, screwed onto a tank connector in the base of the bowl. The pipe is cut at the required water level so that any excess flows over and is taken directly to the lower reservoir. To prevent the water overflowing the bowl rim, the outlet should be at least one size up from the inlet pipe (e.g. if the inlet pipe is 25mm/1", the next size of pipe up is 32mm/1.25" – see Appendix 3 for standard pipe sizes). An advantage of such a pipe is that it can simply be unscrewed and the water bowl drained down. Care must be taken in establishing the water level of the reservoir so that if the bowl is drained it does not cause the reservoir to overflow. The height of the outlet (where the water is pumped up to) is important. If the height from the *surface* (not the pump) of the water in the reservoir to the outlet point is less than 1m then the pump operation is considered normal and the standard specifications apply. If the height (called the head) is greater than 1m, the pump has to work harder to overcome gravity and frictional losses incurred in the pipes. The flow rate required will have to be increased to compensate. This will usually require that the next pump up in the range is specified, however each manufacturer has their own specification and flow rate calculations and these should be consulted to determine what is the most suitable pump (see Appendix 4: Pumps and filtration). In some instances the diameter of the pipe may have to be increased as well. The water delivery pipe should be discreetly located. In some cases (e.g. where a water bowl is close to an outbuilding) the pipework can be taken inside a building to emerge as a simple spout or outlet. Alternatively, the design may celebrate the delivery pipe and it can be a distinct element of the feature. A purpose-made structure, such as a wall, can be built to accommodate the delivery pipe within the wall cavity or below the final surface cladding. The sound of water can be a principle reason for creating a feature. It should be assessed at all times of the day to determine whether the feature should run continuously or not.

CHAPTER 3

Walls and edges

The edge of a pond is one of its defining characteristics. A hard straight masonry edge is what characterises a formal pool, whereas an organic, smooth lawn edge is typical of a more naturalistic setting. The material and style of the edge needs to be in both character and context with the overall garden style and its setting.

Regardless of the design style, there are some details that all edges should incorporate. Edges alongside water need to be secure and of sufficient size that they do not move or dislodge; small stones or pavers create a serious risk. Paving that is used to create an edge to a pond that is set to ground level should be large (+600mm) and at least 75% of the underside surface should be set on a mortar or adhesive bed. This ensures that the paving will not move or become loose. If an area is paved with small format materials (pavers for example), consider using a large sized material to frame the pond or line the pond in such a way that the area under the paving is maximised; e.g. a flexible liner is unlikely to work with small unit paving as it is usually pulled tight over the perimeter block work. There would be less than half of the paving material secured by a bed of mortar.

Regardless of whether a pond has crisp angular edges or softer planted verges, wildlife will always be attracted to water. Provision should be made to accommodate it. Birds, cats, dogs, hedgehogs etc. will all want access to the water. The height of the edge of the water can be critical in allowing or preventing access.

The edge of a pond should rise slightly at the waterside. This discourages surface water from flowing into the pond, which might suffer from pollution or become unbalanced in its composition.

Edges can blend into the surrounding landscaping, either as an extension of the paving, so that the water appears as a pool below ground level or perhaps as if a hollow has been worn away through erosion.

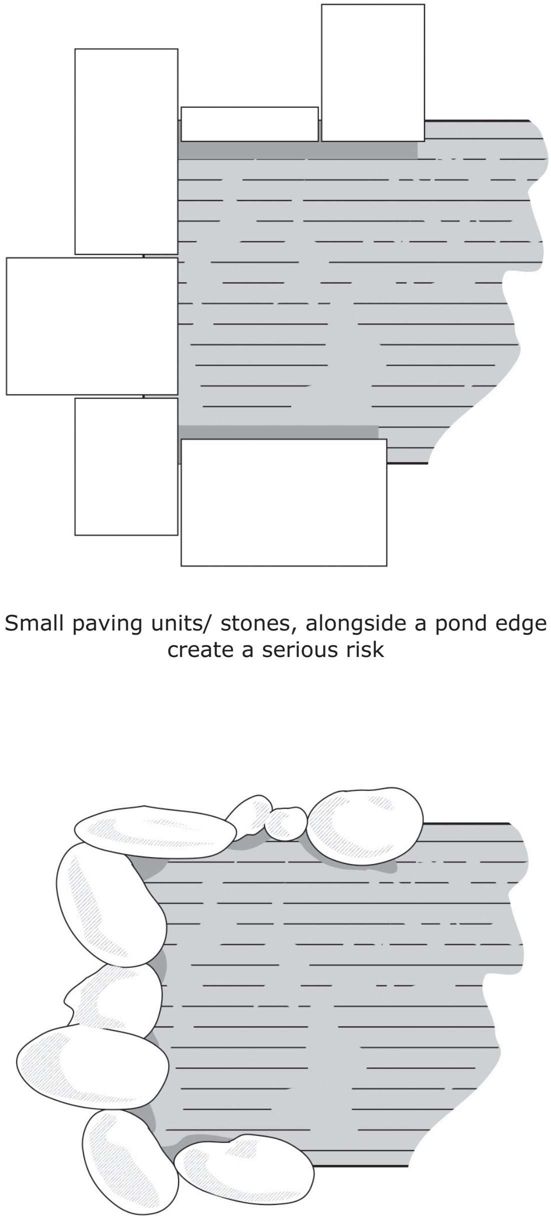
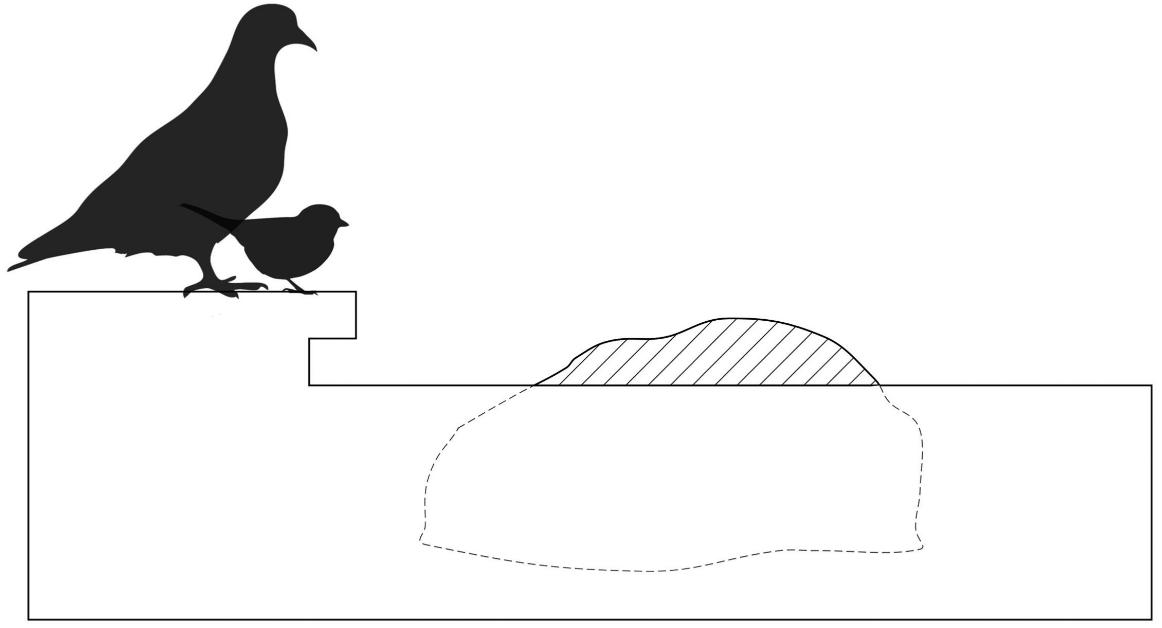


Figure 3.1 Small paving stones risk

SOLID EDGES

Formal features will use regular, geometric paving units to edge a pond or pool. These should be constructed over a solid foundation and set on a full bed of mortar. The thickness of the paving units can change the aesthetic of a pool. Thick edges add a sense of gravity and solidity to an edge, Some modern paving materials can be as thin as 20mm and when viewed edge-on can appear less than substantial.



Edges over 25mm from the water surface can prohibit access for small birds.
Use low edges where possible, even in one local area, or consider introducing rocks or objects that break the surface. If close to the edge these can allow wildlife, such a frogs to enter and leave a pond.

Figure 3.2 Edge height

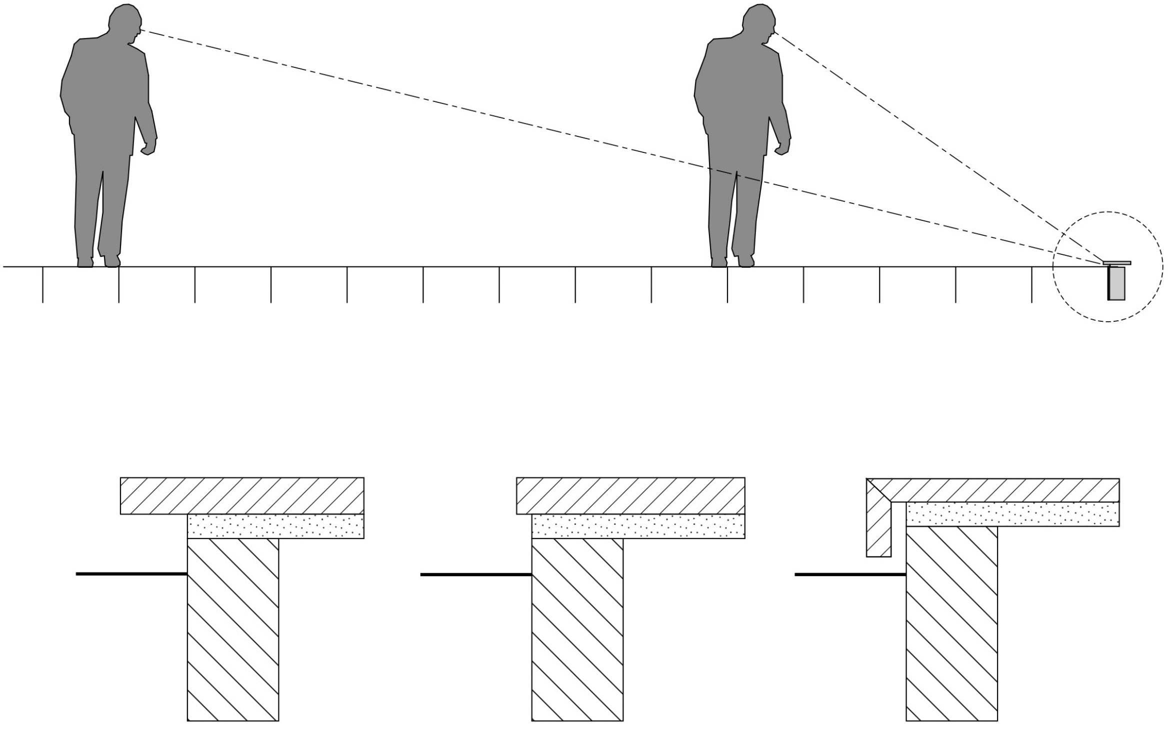
Despite only being a perceived rather than actual weakness, thicker edges do look better. Some stones/paving materials can be supplied with "pool surrounds" pre-cut or specially mitred sections that have a 30–40mm (approx.) down-stand added to one edge of the tile or slab. This creates a sense of thickness to the edge as well as hiding the joint between a liner and the paving above.

Irregular paving materials might be used around a natural pool. These again should be set over a solid foundation.

The mortar line under paving at the lip of a pond can be unsightly. Uncoloured mortar can be prominent against a black liner and the lack of adhesion to the pond waterproofing material can result in spalls and cracks. The mortar line can be disguised by using a larger overhang (+50mm) or by colouring or painting the mortar surface. Alternatively a simple metal edge (12–15mm) can be used. An angled strip of steel, aluminium or a belcast bead (used for external render) all work to give a clean edge.

LAWN EDGING

Lawn edges can be created in several ways. They can be used to create both formal or informal shapes. It is important that maintenance is considered when designing which construction detail to employ. If the grass will be mown then a "mow-strip", a depth of material such as



Even from a distance the mortar/adhesive line between the paving and the pond wall can be visible. An increased overhang (50mm–75mm) will eliminate this, or a specialist coping edge can be used, such as a mitred porcelain tile (step edge).

Figure 3.3 Visibility of mortar

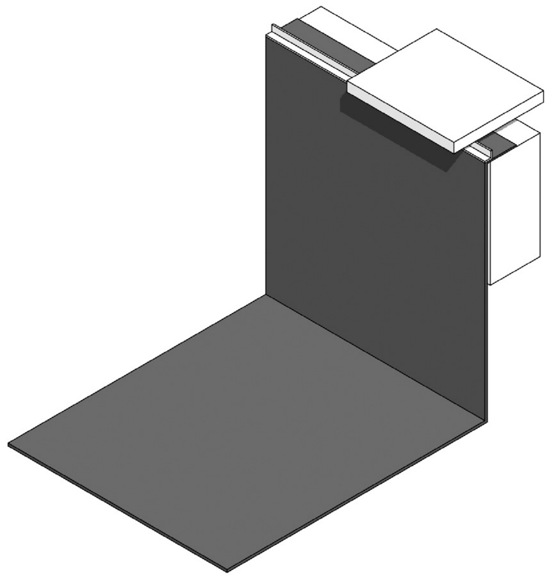
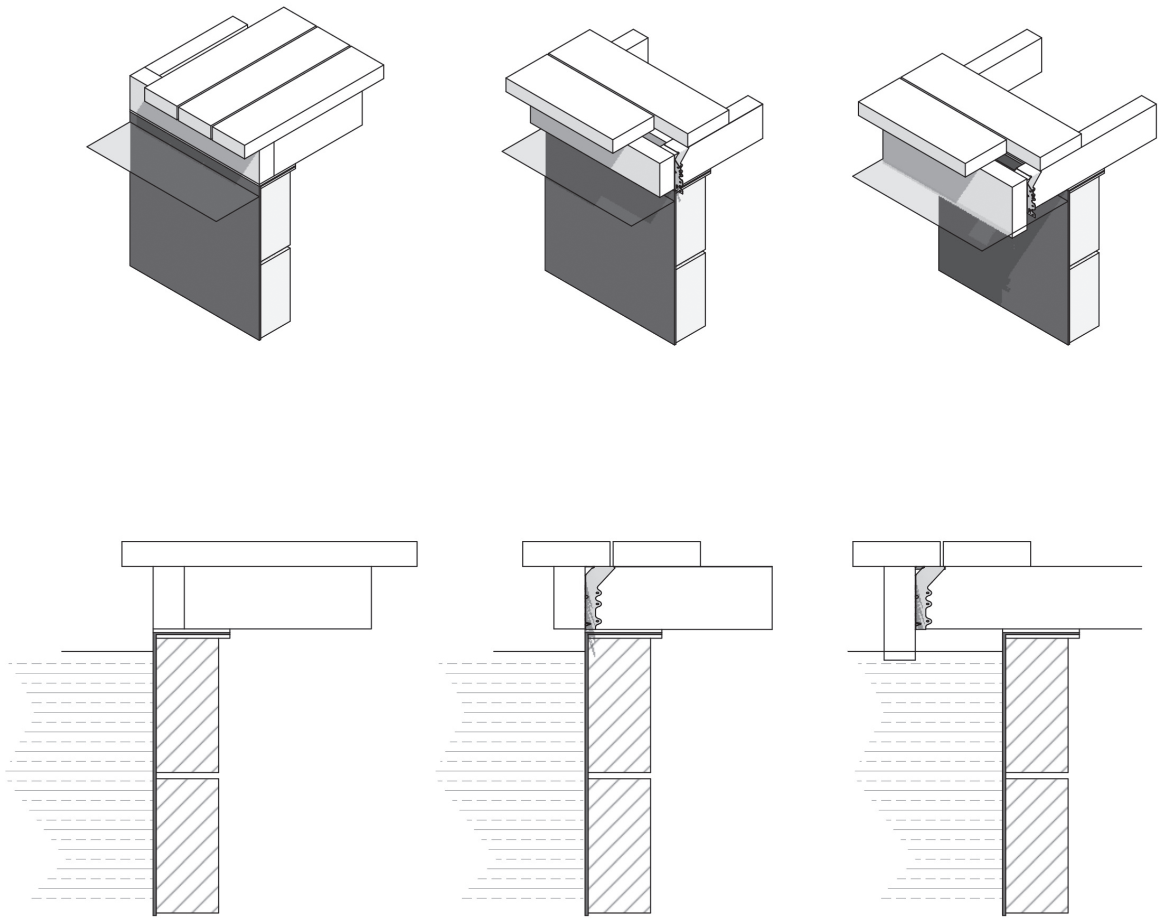


Figure 3.4 Metal edge at mortar

brick or setts alongside the water edge will keep a clean and angular edge. A rough edge can be cut by hand and might not need to have a rigid or formal detail. Some long grass at the water's edge can be a haven for insects, such as damsel flies and wildlife wanting to be elevated but close to the water's surface. It is important that grass cuttings are prevented from falling into water as the high nitrogen content can create an imbalance in the pond chemistry.

TIMBER EDGING

Timber is at its most vulnerable when in contact with water. In particular at



Timber joists set on the pond edge with 50mm overhang of deck boards.

The main joists are set over the pond edge and a trim board is added, secured with a joist hanger or corner connector. The deck boards run away from the pond edge.

The main joists can be extended over the pond by up to 300mm if they are sufficiently well attached to the main deck substructure. The trim detail that hides the joist ends can be set at or just above water level.

Figure 3.5 Timber edges to a pond

the junction between wet and dry – the "tide-line". Not all timbers are suitable for use as edging around water features. Softwood should be treated so that it is suitable for use in such conditions. There is a graded system for the use of timber and suppliers will treat timber in such a way that it is appropriate to the conditions it is intended for. Timber is simplistically categorised by its use (Use Class or UC). The higher the number the more challenging the conditions.

It is important to specify the right use class, rather than a specific type of treatment. The manufacturer will have treated the wood accordingly, to comply with the UC:

Use Class 1: Dry, internal structural timber floor joists and truss rafters. The main risk is from insect damage and timber treatment will manage this risk effectively for the service life of the timber

Use Class 2: Internal timber with slight risk of wetting, such as tile battens (external walls)

Use Class 3a: External timber above ground with occasional contact from wetting/rain intended for coatings (stains, oils, paints), window frames

Use Class 3b: External timber above ground that will not receive additional coating/protection, such as fencing panels/railings

Use Class 4: External timber in direct contact with the ground, or set in the ground, decking and fence posts

Use Class 5: External timbers that are in continuous contact with marine environment, e.g. jetty piling.

Ref: **BS EN 335-1**

Pond edges should, where there is a certificate/UC system in place, be specified as UC4. The application of a coating on site may offer some protection to wood but it will not be as effective as industrial applied products. Timbers that are certified but subsequently cut or drilled on site should have a suitable treatment applied to the cut. The timber supplier should be consulted on the specific type of methods and products used to achieve UC4 – not all are suitable for use in ponds as the chemicals may leech into the pond and pose a risk to wildlife. Most timber merchants will stock UC4 timbers in standard construction sections as a matter of course. There may even be a choice of treatments available (e.g. for fence posts "green", "brown" or incised). Hardwoods are not covered by the UC system. Most would be approximately equivalent to or perform in excess of UC4, e.g. oak. Timbers can be sourced that are further upstream from testing or treatment, directly from a sawmill for example. It is worthwhile discussing the application and intended use with a timber supplier so that they can recommend a timber that is suitable.

An advantage of sourcing directly from a mill is that invariably the timber available is very local and will have been sourced and managed with consideration to the local environment. A mill will also cut wood to your requirements – thicker and longer sections can be very useful. Cedar, larch and Douglas fir are widespread species. They all make excellent construction grade timbers. Larch is a traditional cladding material for the hulls of boats.

STONE EDGING

Rocks or paving should be chosen to suit the function, style and context of the site. A formal, geometric design might utilise any type of stone. A naturalistic feature has less scope and may appear somewhat incongruous; for example, using slate when the indigenous rock is sandstone can jarr. If little or none of the surroundings are visible then there is scope for the introduction of new materials.

Porous stone such as sandstone can develop algae quickly when wet. If materials surrounding a water feature are likely to get wet, consider how it will be cleaned or whether wet areas might pose a hazard, the risk of slipping for example. Stone can be finished in several ways – riven, sawn, shot blasted, flamed or hammered, to name some of the options.

"As cast" is a surface found on manmade paving materials, such as **porcelain**. The paving units are cast or **sintered** and the mould used defines the surface of the paver. Textures can be smooth, rippled or embossed.

The type of texture applied to paving found around water should be considered and specified with consideration. A water feature that is built above ground will not be as much a risk as a pool that lies flush or below ground level. The material suppliers will give the best source of advice. Slip resistance is the best measure for determining whether a product is suited for use around water. Designers have a duty of care to ensure that the selected paving/stone surface is fit for purpose and does not pose a safety risk. There are several measures of slip resistance – they can be misleading and are sometimes incorrectly described.

Surfaces are frequently given "R" ratings. This is a system that rates the resistance to slipping as R9, R10, R11, R12 or R13, the latter being the best. Results below R9 are classed as failures in the test procedure and are not recorded. Anything below R12 may not be suitable.

A type of test used to determine slip resistance uses a pendulum (called the pendulum test value, SRV); the results are sometimes quoted and used to describe slip resistance. The test has a pass mark of 36 (which equates to a value of R9/10). This result may be acceptable for internal, dry flooring but is not acceptable for external and wet surfaces, where a value of 45 or higher should be specified. The standard covering slip resistance for paved surfaces (DIN 51097: 1992) also has a separate category for wet paved areas. This applies in particular to areas where wet, bare feet are the norm.

The standard uses a simple ABC method of rating the suitability of surfaces.

A "C" rated surface is the most suitable for use where bare feet and wet surfaces are common or likely.

Most stone surfaces can be modified to suit different applications. Hard stone, such as granite or slate can be flamed, a treatment whereby the surface is exposed briefly to intense flaming. This causes minute ruptures and blisters, which give a dense pock- marked effect and considerably enhanced resistance to slip. For example, Welsh slate with a fine rubbed finish has a slip resistance of 55 which is enhanced to 60 when it has been flamed (ref. Welsh Slate Ltd).

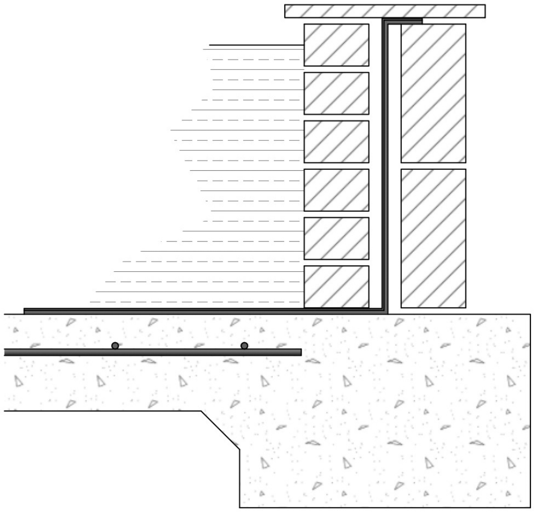
An important consideration in the selection of stone, whether as paving or gravels around water features, is their colour, both dry and wet. Some surfaces do not change when wet – porcelain, for example; whilst others can exhibit a significant shift, becoming much darker. A blue-grey granite has a mid-grey tone dry but darkens when wet to a deep grey or charcoal. Stone usually exhibits its subtleties and characteristics to more obvious effect when wet; shades, seams and ribbons that are dulled and bleached when dry become evident and much more pronounced when wetted. Stone should be assessed when both dry and wet for its suitability in its intended location. This is particularly important where only part of a water feature gets wet. The splash, for example, of a water blade will wet the immediate area leaving the rest of the stone dry. Stone that experiences a marked colour or tonal shift might not be the most suitable in such locations, unless the wet-effect is part of the design.

The strength of concrete used for pond bases will vary slightly depending on the surface area of the water. The larger the area the stronger the concrete mix should be. Some aspects of garden and landscape construction are not reliant on a completely consistent and known strength of concrete; however, the base of a water feature must be built with a suitable strength mix and laid level. Concrete is specified by its strength class on a scale of 1–100 (100 being the strongest and designated by a C-prefix) – a C25 strength class is

Table 3.1 Slip resistance comparative systems

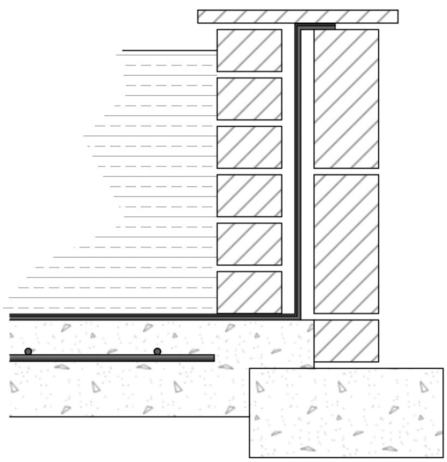
ABC rating value	PTV (pendulum test value)/SRV (slip resistance value)	CoF (coefficient of friction)
A	21–31	0.21–0.31
B	32–42	0.32–0.42
C	45+	>0.45

Ref: DIN 51907: 1992 (ref. www.hse.gov.uk/slips)



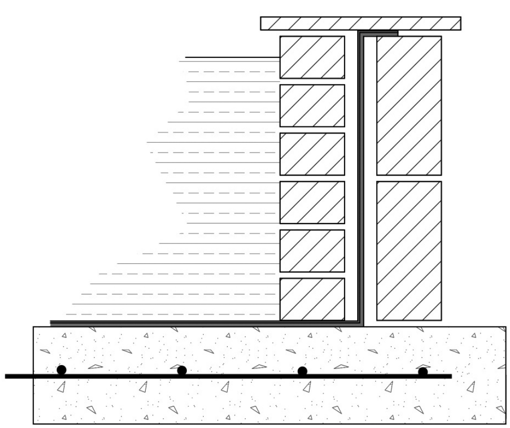
Combined base and footing (raft)

A cast concrete base that is thicker at its perimeter than through the main body. This suits deeper ponds with larger retaining walls or in ground conditions that are uncertain.
This benefits from being a unified structure that is quicker and more economical to construct as all concrete work is undertaken in a single pour. This is constructed from delivered concrete rather than mixed on site as the strength needs to be consistent and the level of the cast base is critical.



Separate footing and base

The strip foundation for the perimeter wall is cast and at least the first course of brick/block work laid. This can be used as the level guide for the subsequently poured concrete base of the pond.



Flat foundation and base

The base and foundation for ponds can be cast to a consistent, combined thickness for small ponds. The concrete must be reinforced and well compacted after laying.

Figure 3.6 Pond concrete base options sufficient for most small features(up to 15m^2 surface area). For larger areas or where ground conditions are uncertain, the input of a structural engineer might be necessary. It is often more economical to use delivered concrete rather than trying to mix on site. The minimum depth of concrete for a pond base is 150mm and this will require reinforcement on all but the smallest features. Reinforcing must be set so that it is no closer than 50mm from any external face. The location of the waterproofing layer should be decided in advance. It can be placed above or below the concrete base.

WATERPROOFING

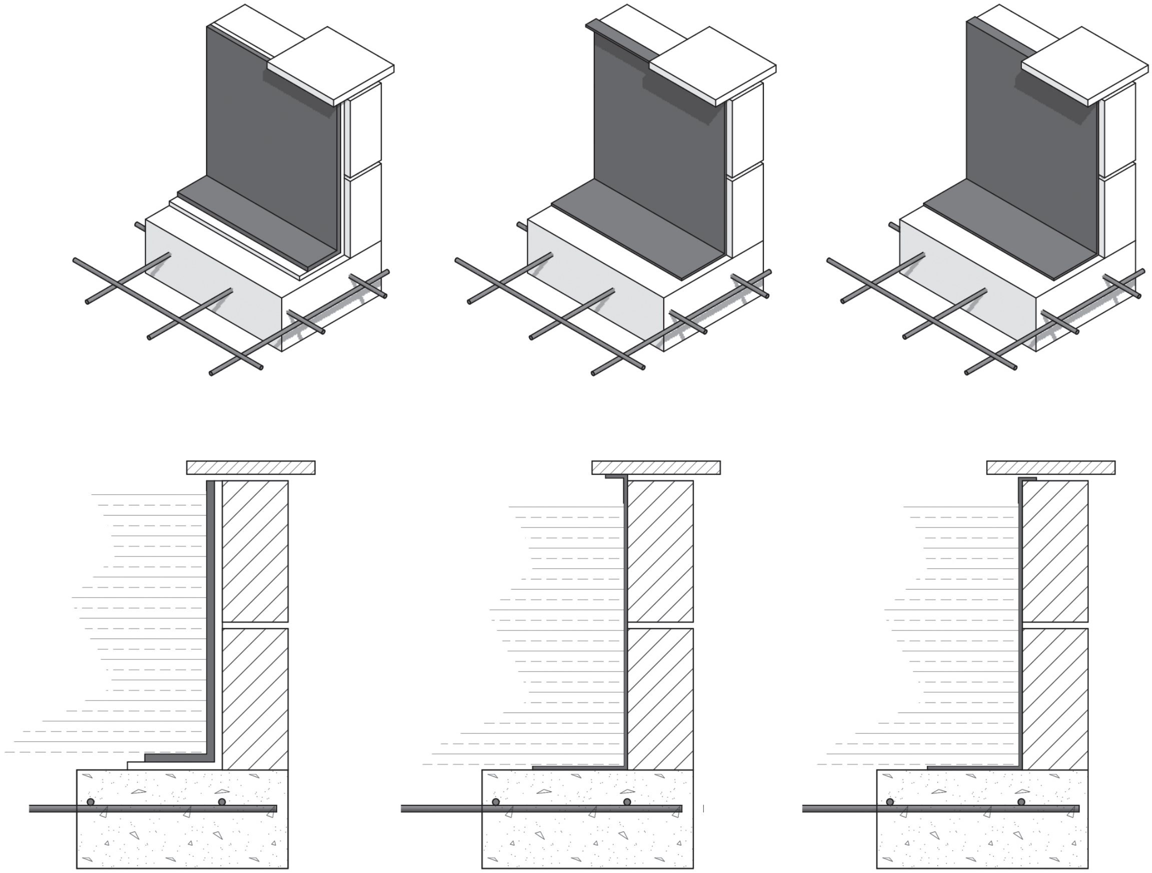
A successful water feature is the result of good planning. Not only does it need to be well built, plumbed with correct filters and pumps and electrical connections, but correctly designed for the plants, fish and people who use it.

There are many ways to ensure that water remains where it was intended.

1. Liners, there are several types of sheet materials that are used to line a pond:

    a. PVC is flexible and cheap but may leech chemicals making it unsuitable for aquatic life, it has little stretch and this may cause installation problems on anything other than small features, it is not readily welded, and can become brittle with time.
    b. Polypropylene is generally better than PVC sheet but still has little stretch and can easily develop pin punctures through poor handling.
    c. Woven polyurethane is light and very flexible. Some products degrade in UV (sunlight) and so it should be used with care.
    d. EPDM (ethylene propylene diene monomer) rubber has great stretch and flexibility, can be welded and is non-toxic.
    e. Butyl is non-toxic and has the necessary flexibility and stretch. Unaffected by age or whether it is easily joined to make larger sheets and punctures can be repaired much like a tyre inner tube. It is, however, the most expensive of the lining materials.
    f. TPO (Thermoplastic polyolefin) is a single ply membrane originally created for roofing applications. It welds readily and is non-toxic.

All liners will require a protective underlay, to prevent sharp objects puncturing it. Use a proprietary landscape fabric; do not use carpet or old fabrics to protect the liner. If built directly onto the ground the soil under a liner should be ventilated with perforated land drain pipes, this will prevent bulges of captive gas from forming and “heaving” the liner up or even out of the water.



Render, usually cement based and laid in two coats. The top coat should be sealed with an appropriate pond paint.

GRP (Glass reinforced plastic/ fibreglass) is laid to the internal face of the pond.

Flexible pond liner Liner can be on the internal or external face of the pond. The membrane is laid over a thick non woven geotextile 220gsm.

Figure 3.7 Common waterproofing methods

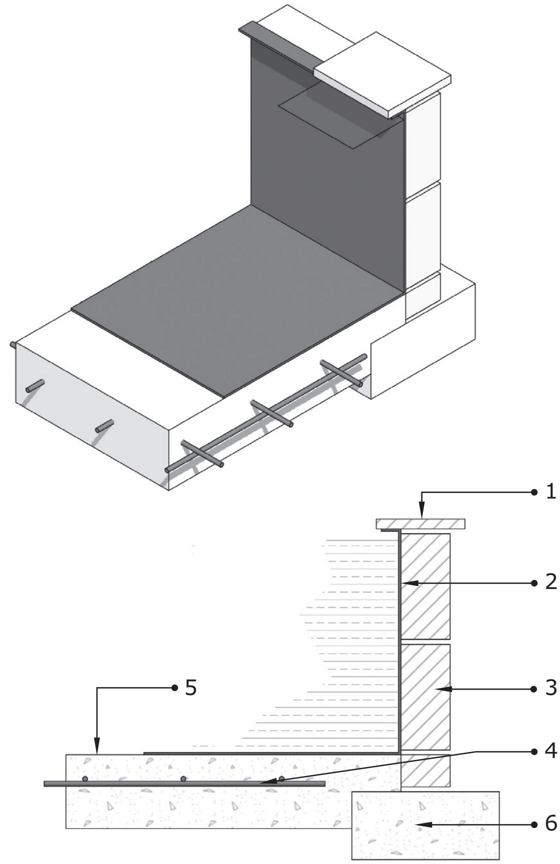
2. Liquid liners:
    a. Impermax, is a 2-coat polyurethane (for 10yr guarantee) or 3 (for 25yr) liquid applied with soft brushes, rollers or even sprayed. It can be applied directly to rough concrete, brick and tiles without an initial render and will seal hairline cracks. It can also withstand weight of up to 21kg/cm^2 which is a consideration when boulders etc. are being placed in a pond. It is harmless to plants and fish and is completely seamless.

b. FTS Polyseal 25 is a product used for ponds and large water features, tanks, swimming pools and lakes. Sprayed on in a single application, this requires specialist application, at a rate of up to 700msq/day. Similar to Impermax, it can be applied over existing structures and raw masonry surfaces as well as existing butyl liners and soil when a special textile is used. Gunite or sprayed concrete is projected onto underlying formwork or a constructed surface. It can be sprayed over reinforcing or have small fibres added to the mix. It dries to a continuos and waterproof surface.

A liquid-applied liner is worth considering for vertical water features, where walls and often, irregular surfaces need to be water sealed.

c. Paints, such as A1 pond paint or Gold label pond paint can be applied over smooth surfaces such as render or concrete but are less successful over rough masonry, such as concrete blocks. They usually require several coats. They are an economic solution to waterproofing containers/bowls intended to hold water.

3. Concrete additive and untreated concrete when dry is hygroscopic; it will draw in a considerable amount of moisture and may become saturated and leak. Additives and coatings are typically applied to cast concrete to create a barrier or make the concrete itself waterproof. Several manufacturers (e.g. Sika) have concrete mixes, specialist cements or additives that will make concrete waterproof. All concrete ponds should be treated with a proprietary sealer (such as G4 pond sealer). This will seal the surface for added protection but also act as a **bond bridge** to any subsequent waterproofing coatings. Concrete can be subject to cracking and most in-ground structures will require reinforcement.
4. Fibreglass (GRP glass reinforced plastic) has a long history of waterproofing roofs. Pre-formed features for gardens are limited in size and shape but are relatively easy to install. For custom features, GRP can be applied as a matting, with the addition of resins, layers are built up to create a tank, this can be time consuming and experience is required to prevent air pockets, the end result though is an extremely durable and safe lining. It is also easy to colour. Rigid pre-formed liners are available in a range of styles and sizes.
5. Render is a traditional pond lining material. Applied in two coats (the first is called the “scratch” coat) over rough masonry. The ratio of sand and cement can vary between contractors. See Appendix 6 for a render composition). The final coat will require a waterproofing primer or paint application.



1. Coping set to the required overhang.
2. GRP waterproofing, sometimes applied over a rendered surface. The colour is applied to the final layer.
3. Supporting structure, e.g. 7.3kN dense concrete blocks.
4. Reinforcing as required.
5. Cast concrete base. This should be flat and smooth.
6. Foundations for side wall support.

Figure 3.8 Pond GRP lined

Where coatings, including paints and GRP, have been used it can be useful, after filling to leave a pond stand for up to 2 weeks. Some pigments or resins can take +10days to cure and may still release toxins into the water.

GRP (fibreglass) is a slightly labour intensive but highly adaptable method of waterproofing a pond. The underlying structure must be clean and free from spall, bumps and protrusions. Block work should be struck flush with mortar. As each layer of the fibreglass mat is built up it will pick up and reflect these surface marks and errors. It is common practice to render the inside face of a water feature to achieve the smooth finish required for laying fibreglass over. Fibreglass uses a resin to bond the laminates together, this also bonds extremely well to uPVC and can dramatically simplify the inlet detailing around pipework that comes into a pond.

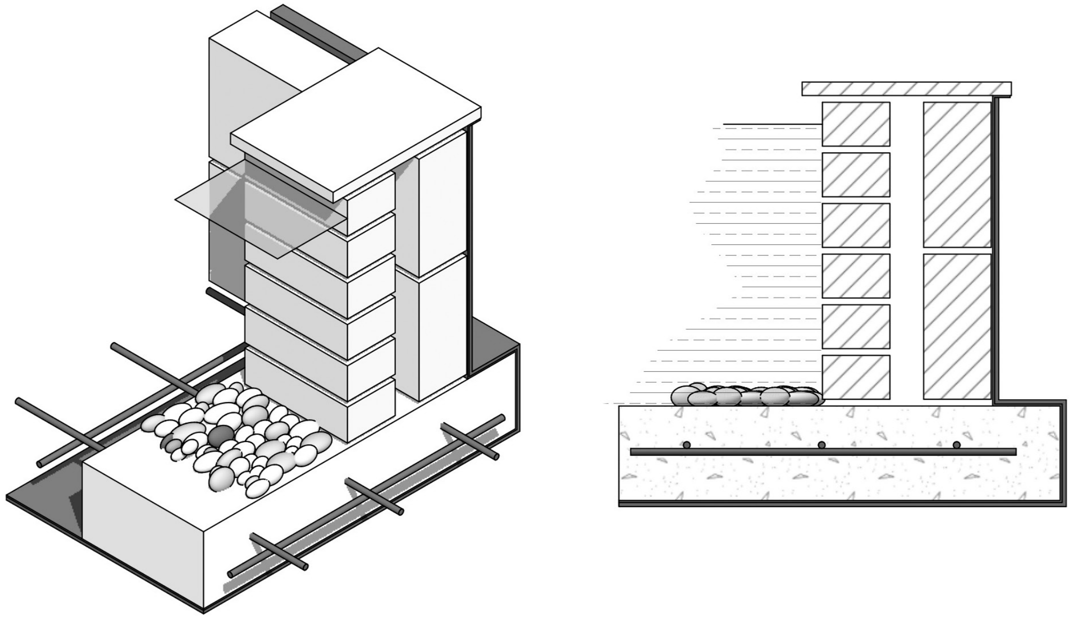
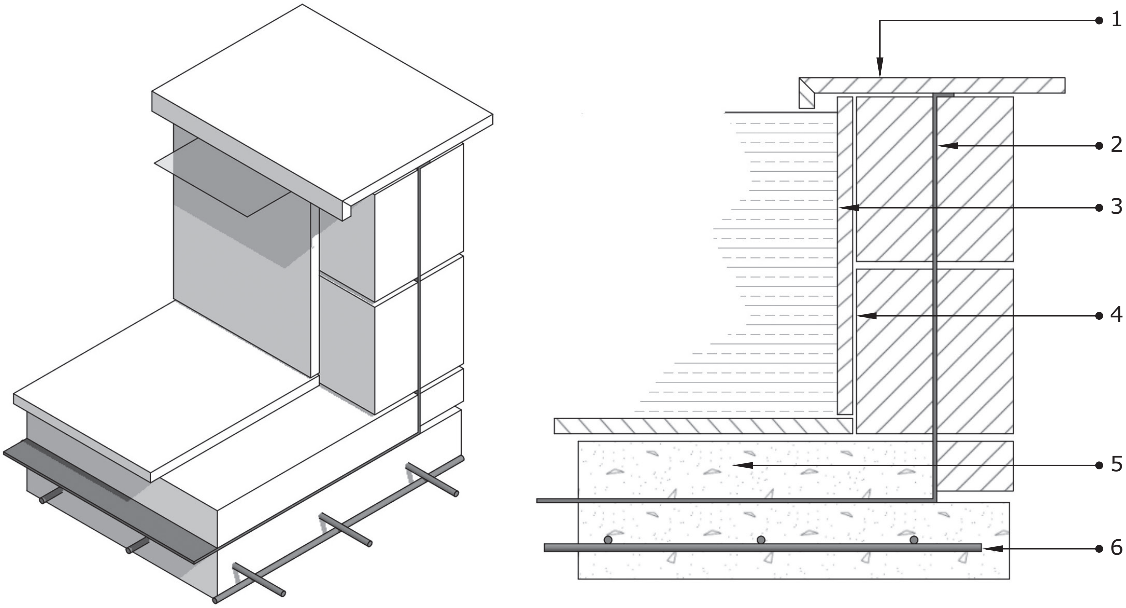


Figure 3.9 Flexible liner external to pond

A distinct advantage of GRP is that it can be brought to the underside of the pond copings and used to create a watertight seal. This eliminates the potential of seeing an unsightly mortar line and allows the water level to be set almost to the underside of the paving (–10mm to allow for rainwater surges).

The liner to a pond can be laid in one of three locations:

1. To form the internal wall face of a pond. This creates a black continuous surface. It is possible to add or construct with mortar over this membrane but usually a layer of geotextile and an additional layer/pad (from a scrap piece) of the membrane is placed between the boulder/foundation pad etc. and the primary waterproof membrane.
2. Laid over the base but below a secondary screed and between the cavity of the structural wall and the internal pond facing wall. This method allows for a range of decorative materials to be used whilst supporting the liner within the pond structure.
3. The liner is laid over a consolidated sub grade and sub base over which the concrete base is cast. A wall is built off the cast concrete base. This method gives the most scope for using materials within the pond but is the least suitable if fish are to be introduced. The concrete forming the base will leech into the water and can be toxic to some aquatic life, including fish.



1. Porcelain mitred coping.
2. Waterproof membrane (e.g. EPDM 1mm).
3. Facing tiles or stone.
4. Bridge bond to rear set on bed of waterproof external tile adhesive.
5. Screed sub base for tiles or stone. This benefits from having reinforcing fibres added to give the mix added integrity and resistance to cracking (e.g. 20mm polypropylene fibres).
6. Base raft RC25.

Figure 3.10 Pond wall porcelain

The internal face of a pond can be covered with almost any material, if the wall and base structure is sufficiently robust. In some cases the material used on surrounding paving can be used on both the sides and the base of a pond, if it is suitable for use in water. Porcelain tiles are a relatively recent addition to the paving palette and benefit from very low water absorbency. Similarly, granite, basalt slates or other natural stones with similar characteristics can be used, although the colour of porcelain does not deepen to the same extent as natural stone when wet.

Porcelain tiles benefit from being laid on a flat solid sub base This is laid as a secondary surface over the primary reinforced concrete raft. The waterproofing membrane should be set over the principle raft and below the sub base screed. An initial perimeter course of bricks or block work can help set the level for this sub base. The tiles (or natural stone) should use a bridge bond and suitable external, waterproof tile adhesive. The tiles should then be pointed with a waterproof grout. All connections through the liner should be made and sealed (e.g. flanges and electrical tank connectors) prior to laying the sub base screed. Porcelain tiles are typically 20mm thick. Where it is used as the adjoining paving material, overhanging the pond edge, it can look uncomfortably thin. Tile stockists and suppliers are able to create mitred joints that give the impression of a thicker (usually about 40mm) edge; this is also used on step treads.

A timber edge can be used to create the pond edge. Retained by 50x50mm stakes at 500mm centres. The liner is brought up and secured to the timber with clout nails on the top or ground-facing side of the retaining edge. A simple shelf in front of the timber edge can be used to support a brick edge. This should be set on a full mortar bed. Where a more substantial edge is required a foundation strip is necessary to support the increased mass of the edging materials. The liner should be brought as high as possible without becoming visible.

Planting zones within water features can take many forms. The most typical is the marginal shelf, created at the edge of a pond. These can be set at differing heights, some just above water, others below to allow for a variety of plants. The width and depth of these shelves should take into account the intended plants and the space required to support or contain their roots.

1. The liner can be taken below the decorative edging to a pond. This should be done about one course below water level and the liner cut so that it is hidden within the level of the surround gravel/soil/paving.

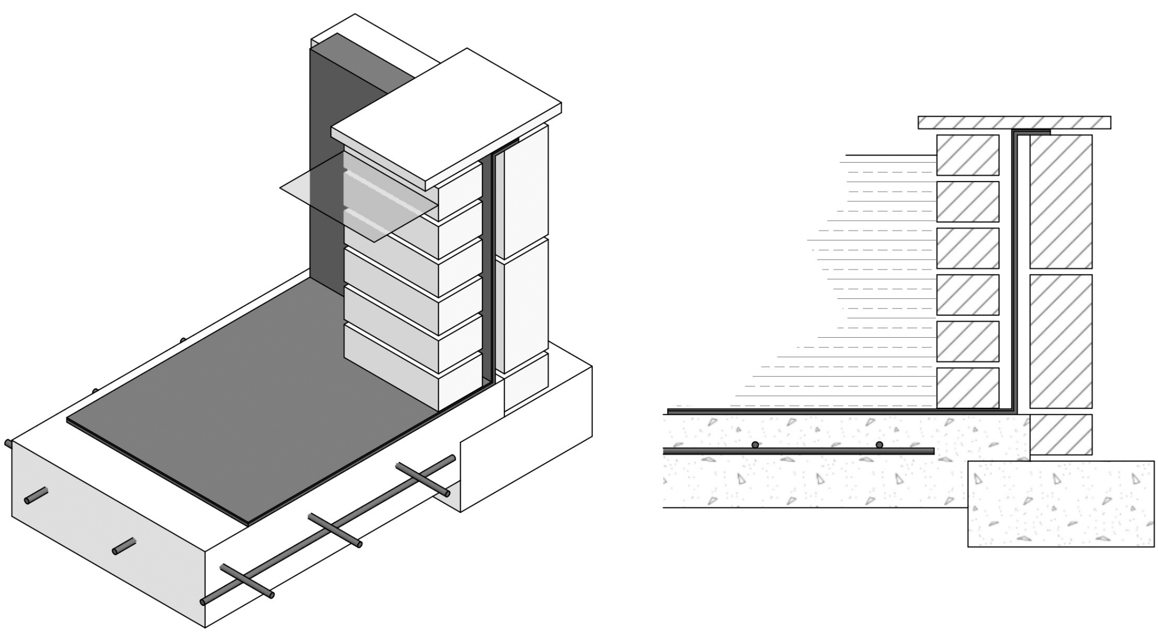
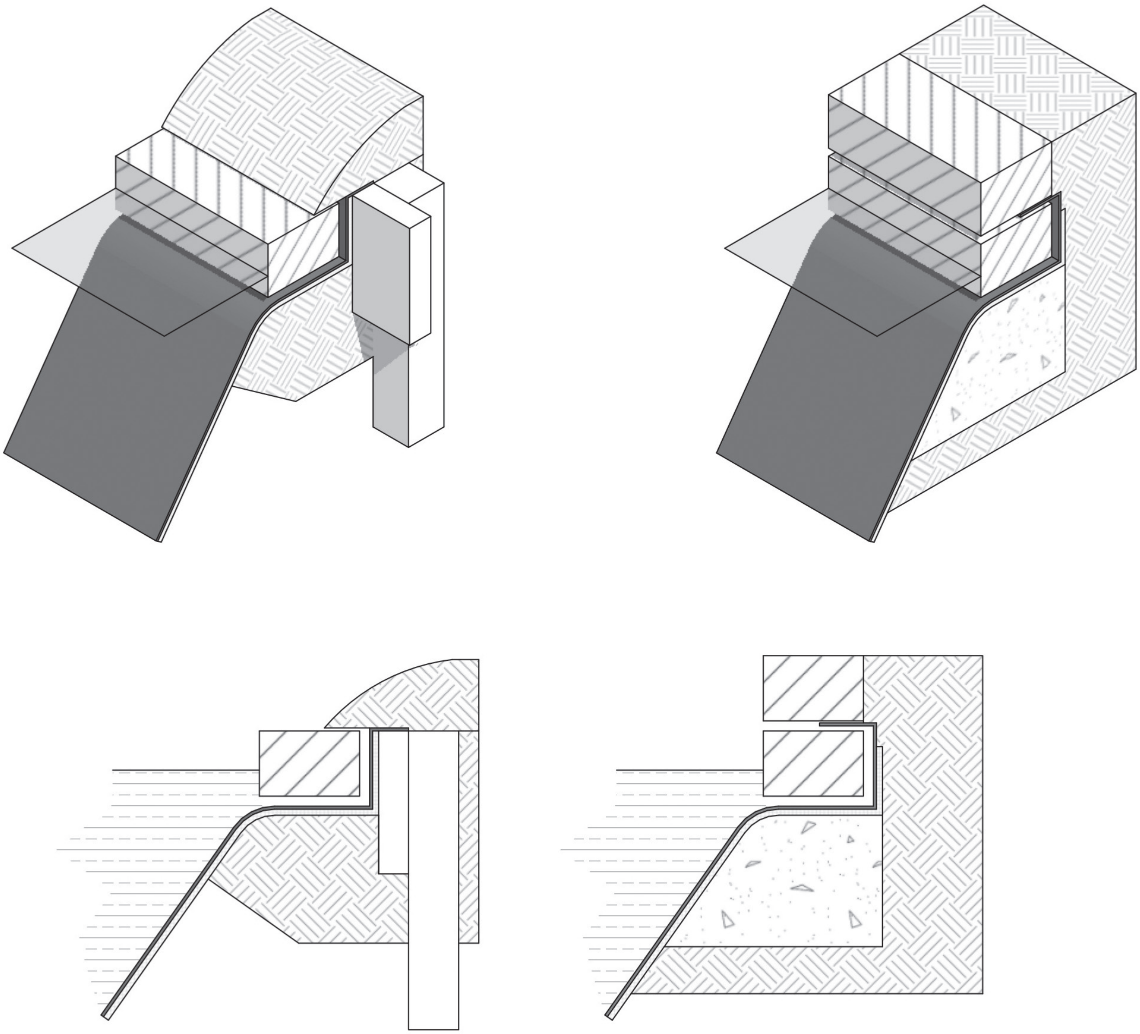


Figure 3.11 Liner in wall cavity



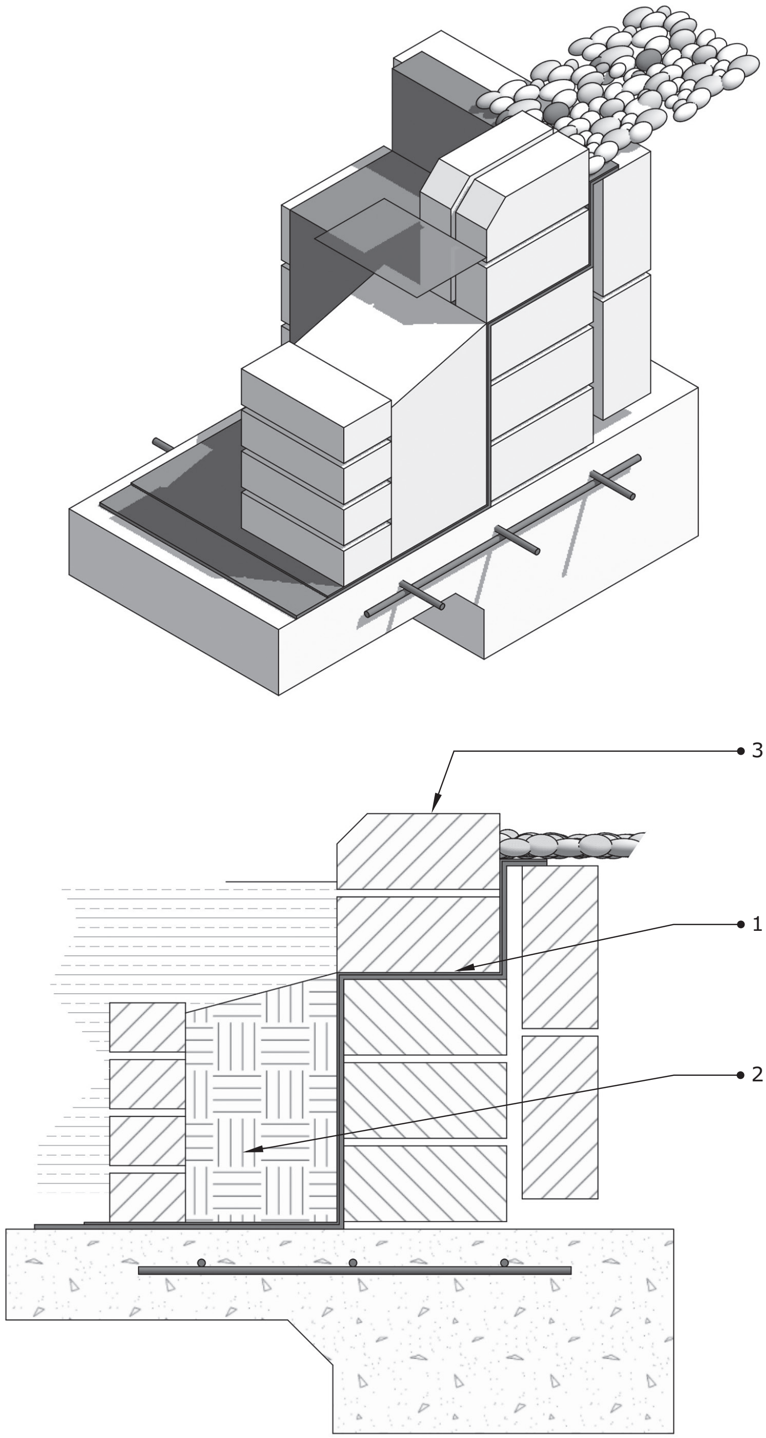
Simple timber and brick edge

Brick edge over a foundation strip

Figure 3.12 Simple pond brick edges

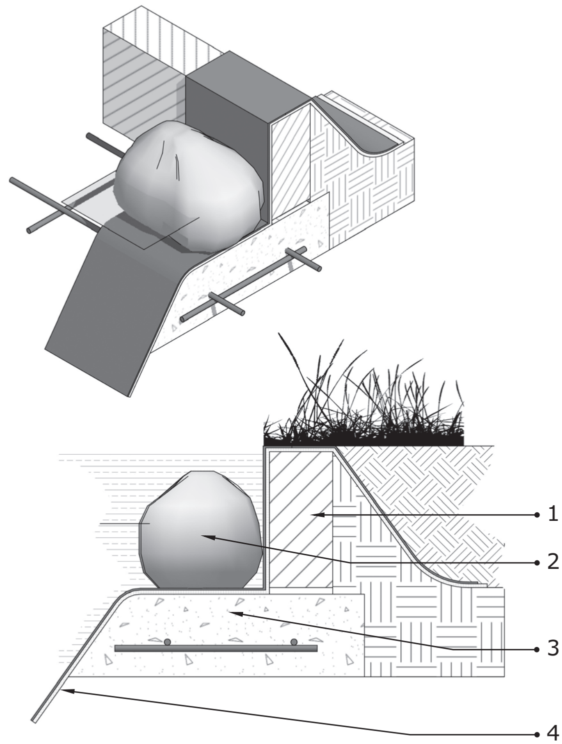
2. The size, width and depth the planting shelves will be determined by the type and number of plants to be used. Shelves should be set at a variety of heights.
3. Decorative edging materials should be at least two courses to ensure that they are sufficiently joined to give both mass and strength to the edge.

The overflow from a pond can be used to support planting in adjoining areas. A bog or storm water garden can be fed by the overflow from a pond, and possibly other water sources. The flexible pond liner is extended past the rim of the pond and used to line an adjoining area. There are several details that can be used to create the division between the pond



1. Flexible pond liner over geotextile
2. Soil for plats, ideally a heavy loam or clay
3. Decorative facing material.

Figure 3.13 Internal plant shelf



1. Supporting sub structure for the pond edge and liner. Lowered locally at the entrance to the storm water garden.
2. Edging to the pond can be naturalistic or more geometric (e.g. brickwork).
3. Reinforced concrete RC25 shelf to support the pond wall and facing materials.
4. Flexible waterproof membrane, e.g. EPDM 1mm over geotextile 220gsm.

Figure 3.14 Bog garden edge 1

and the **bog garden** but simplistically it requires that the entrance to the overflow area is slightly lower than the rest of the pond rim. The bog garden itself should have an overflow and frequently the liner has holes added to allow a slow infiltration of the water through to the water table.

The supporting shelf for the pond edge can be extended back into the surrounding ground. An upstand within the ground ensures that the two water bodies function separately except when there is excessive water added to the pond through rainfall. If the storm water garden is not designed around the full perimeter of the pond, then the local separating wall should be higher (100mm) to ensure excess water is directed as intended. The extended shelf behind the pond edge can be used to retain soil, gravel or rocks for a naturalistic effect. A much deeper shelf or ledge would effectively create a beach.

An internal planted area is a simple detail to include in a pond or for later addition. The depth and width of the soil

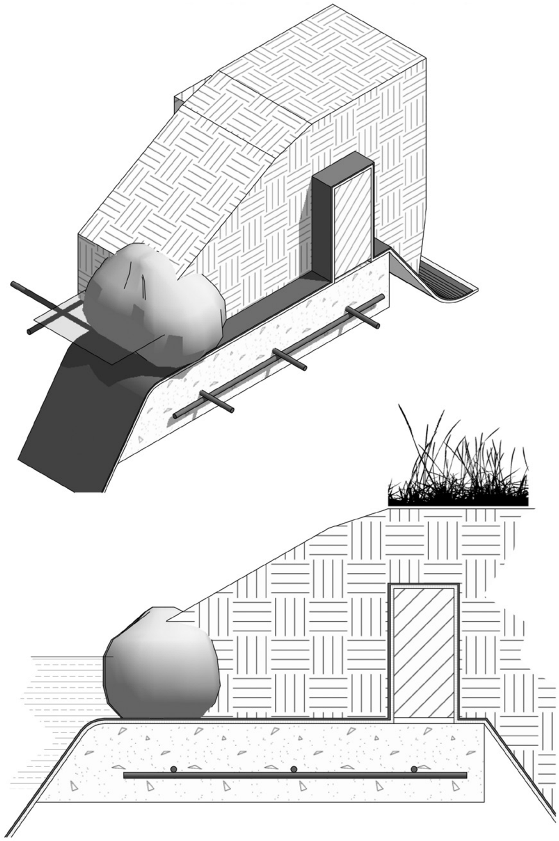


Figure 3.15 Bog garden edge 2 – naturalistic pond edge

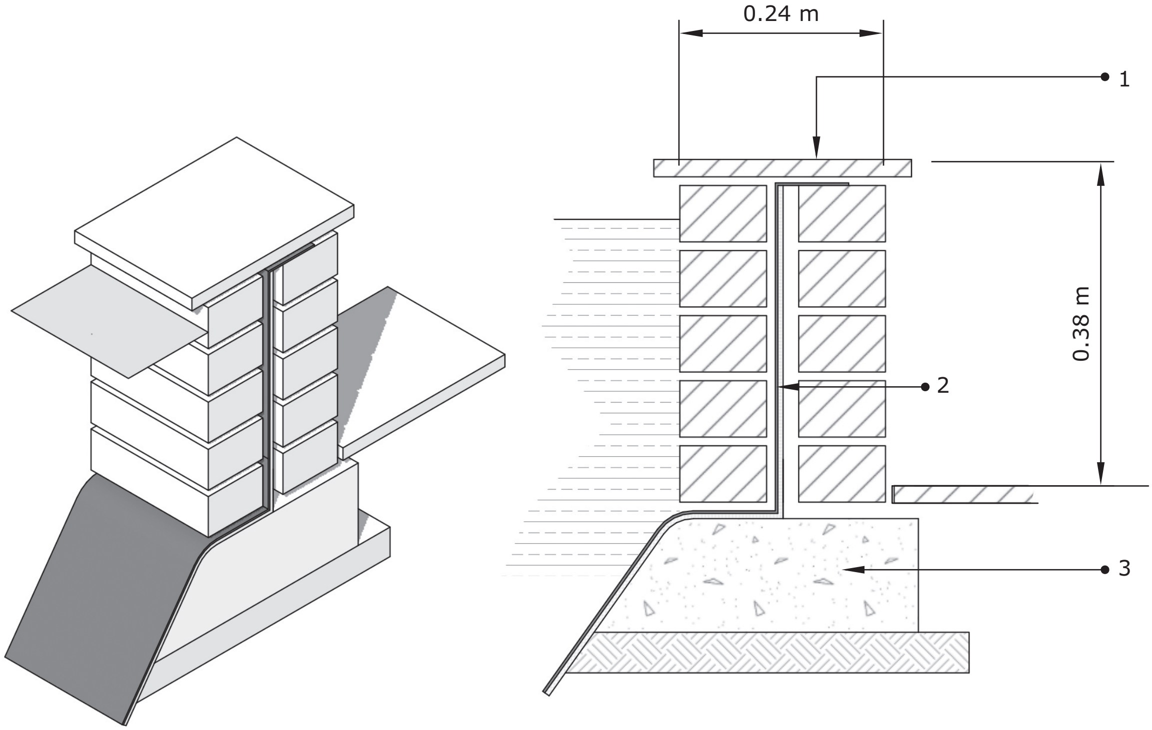
area should be informed by the type and quantity of plants required. A surface layer of gravel, suitable for aquatic applications, will help stabilise the soil and prevent erosion. (limestone gravels should not be used as they can slowly dissolve, introducing calcium carbonate to the water which in turn can create surface deposits over a liner – limescale).

Where ground conditions are suitable a pond can be created by simply excavating a basin into the ground at subsoil level. If drainage is required below or around the pond these should be excavated and installed at this stage. This soil should be consolidated and graded smooth. The basin should be lined with a robust geotextile (220gsm) and a flexible liner laid over the top.

A formal edge can be created by laying a strip foundation to support the internal face of the pond. Where a paved surface meets the pond edge a concrete or mortar bed over a consolidated sub base should be created and the liner retained to the top surface of this.

A concrete block wall is probably the cheapest and easiest way to create an above-ground retaining wall for a

A pond set above ground with a flexible liner over a graded subsoil base



Pond and water features that are built out of the ground require different construction techniques to those set below ground level. There can be a requirement to make both the internal and external face "fair". One of the determining factors is the height to which the raised pond wall is built above the finished floor level. A height of 375–500mm is suitable for sitting on. Whilst it can be convenient to erect a wall using modules of the facing materials (i.e. full bricks and blocks rather than arbitrary cuts) the actual paved or finished floor level can be set independent of the wall construction. The excavation required for a pond includes sub base and the actual pond floor. This frequently requires groundworks below the existing garden levels and all of the checks and investigations required for sunken ponds should still be undertaken.

1. Coping stone. This should extend 25mm min to either side of the wall.
2. Flexible waterproof membrane (e.g. EPDM) laid over a non-woven geotextile 220gsm.
3. Concrete RC25, foundation support for wall.

Figure 3.16 Raised pond brick wall

pond. Laid vertically, a twin skin wall will be required, using stainless steel cavity ties to brace both leaves of the wall. Alternatively, blocks laid on their side will create a substantial structure. This can work well where the wall is designed for sitting and is less than 5–7 courses. The internal face of the pond can be treated in several ways – render, flexible liner or GRP. In all cases the surface should be as smooth and even as possible to ensure that any blemishes are not highlighted by the application of the waterproofing layer.

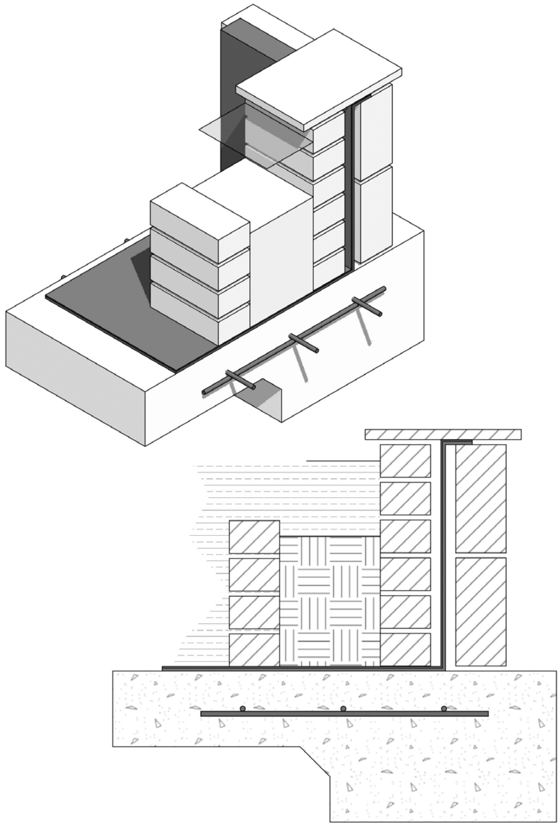
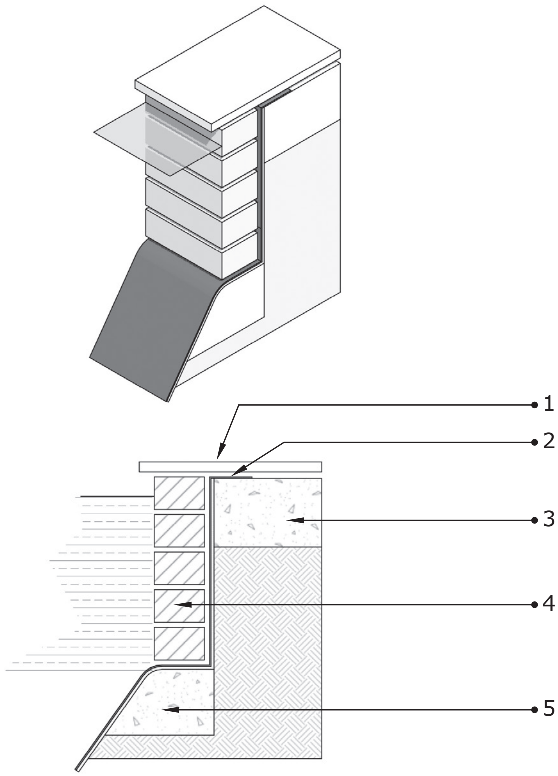


Figure 3.17 Raised pond with internal planter

A metal lined pool can seem over-engineered but it can in some circumstances be a simple and economical solution. They work best on small ponds where the metal chamber can be fabricated and delivered as a single unit. There are suppliers who carry a standard range of steel containers that can be used as a water feature. Unless the steel is +3mm it is likely to require bracing or support struts to prevent the sides bowing or buckling. Alternatively, a simple perimeter wall can be built to support the metal faces. Steel will rust and all faces, internal and external, will benefit from a proprietary coating/pond paint to stabilise them.

Earth bags can be laid to create a vertical face (see Figures 3.25–3.27, pp. 84–86). Where such walls are required or where wall heights exceed 1.0m it is prudent to employ supports and retaining devices, such as geo-grids. A geo-grid is an engineered sheet or mesh of high tensile material, usually polymer based. As construction work progresses they are laid between coursed bags and set back into the surrounding land. The area in proximity to the pond wall would be filled with a



1. Paving or coping as required over adhesive layer or full mortar bed (30–50mm).
2. Flexible liner (e.g. EPDM) over non-woven geotextile (220gsm).
3. Sub base support for paving (150mm DTp1).
4. Internal facing material, suitable for use in contact with water.
5. Concrete foundation strip C15–20.

Figure 3.18 Excavated basin with brick wall

clean sharp aggregate (e.g. 6–20mm) and this will captivate the geogrid, preventing it from moving. This method of construction relies on the earth bags being laid external to the liner. In this configuration the colour of the bags is immaterial. Where the liner is in contact with the internal face of a pond it will show the indents and surface changes between bags when filled with water.

Planting areas within an earth bag pond are easily created by building small soil retaining walls off the pond base. The mass of the bags ensures that they will not move and there is no additional finishing required. Earth bags come in several materials and the colours can vary. A dark grey or black material works best when the bags are set within the water body.

Timber wall constructions should be substantial and utilise large section (100x200mm) material. The use of timber as a retaining structure should be restricted to above-ground features.

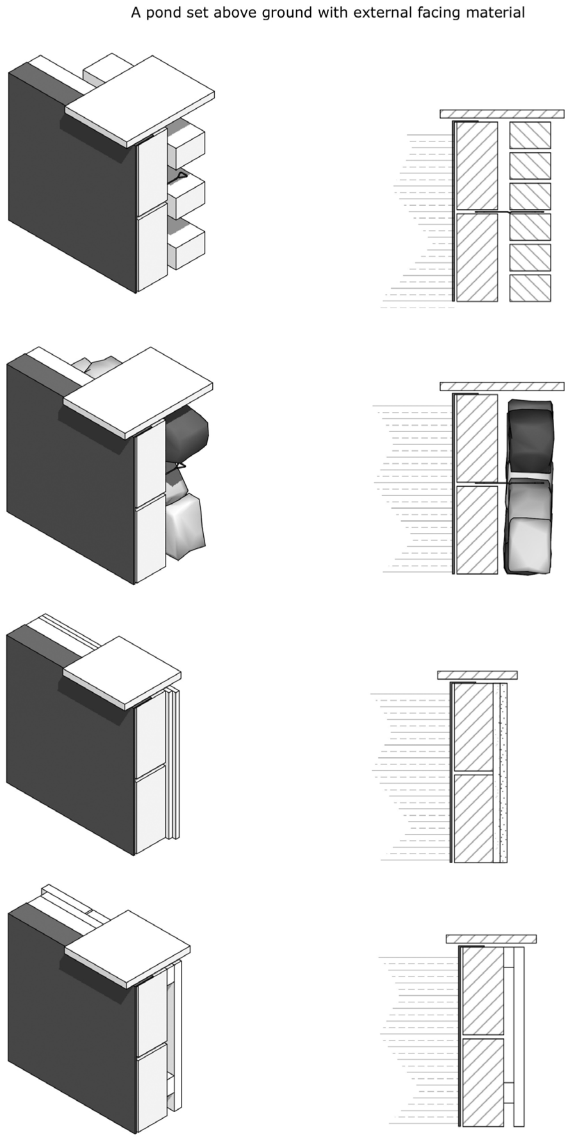


Figure 3.19 Raised pond external facing materials

Timber cladding (oak, larch, Douglas fir) can be used below water level and give a reasonable life in service.

The timber units are best laid flat and can be secured by a wide variety of fasteners (e.g. TimberLOK flange structural screws). The critical junction is at the interface with the foundation. Ideally, timber should be set on a concrete strip with steel rebar/inset stakes. The liner can be captivated between two timbers, a recess is required to accommodate the thickness of a liner and the geotextile. Alternatively, the

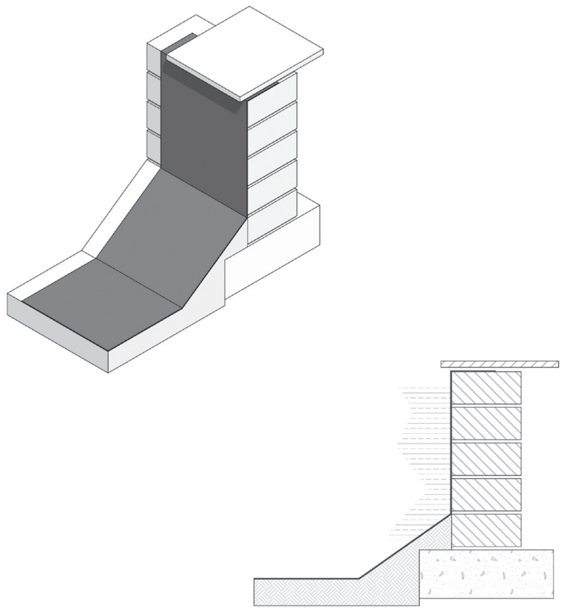


Figure 3.20 Raised pond with concrete block walls

waterproof membrane can be secured and hidden by a timber trim at the edge of the pool (see Figure 3.28, p. 86).

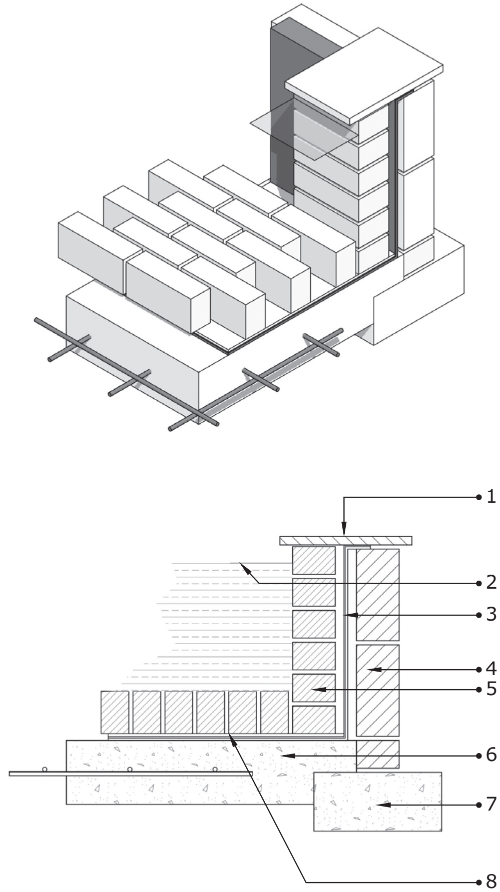
For safety or aesthetics not all ponds or water features need be open. A grating can be a permanent or temporary addition. The most robust grates are made from galvanised steel; often made in several sections they can span up to 2.0m without intermittent support. Gratings can be set at or below the water line and this may influence their material and colour. A grating set at the paving level will give a unified feel to the edge of a pond, whereas one set below water level will maintain some of the characteristics of the water surface and be less obvious. Even permanent gratings should be removable to allow for pond maintenance, planting etc.

INFINITY EDGE FEATURES

These are pool or pond designs where the pool edge is located below the water line. The water spills over and into a collection drain or reservoir and is recirculated back into the pool.

There are many variations in the design and style of these types of pools (see Figure 3.32, p. 90); the most common edge designs are:

- Vanishing
- Infinity
- Euro.



1. Coping, 25-50mm overhang
2. Water level
3. Flexible pond liner over geotextile
4. Dense concrete 7.3kN blockwork (faced)
5. Internal pond facing material, e.g. brick (select brick that is suitable for use in contact with water)
6. Cast concrete base RC25
7. Cast wall foundations C15+ 150mm deep
8. Waterproof mortar/ pointing.

Figure 3.21 Brick internal pond finish

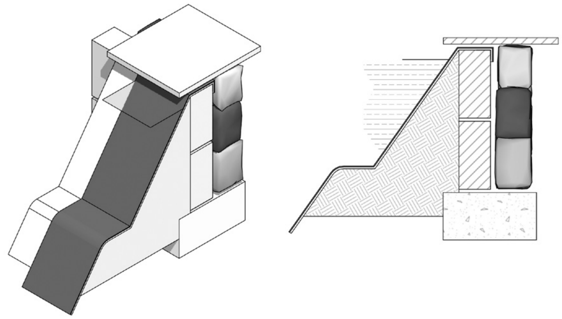
VANISHING EDGE

A pool whereby the majority of the perimeter edge is raised above water level with a small section that is locally reduced to allow water to spill over and be collected for recirculation. These pools are most effective where they are elevated and the reduced edge is directed towards a view. The vanishing edge can create an almost seamless boundary with a distant feature, water body or even the sky.

INFINITY EDGE

Pools where the edge containment is set entirely below water level. Infinity

A pond set above ground with sloped internal walls



The internal face of a pond does not need to be vertical A sloped surface works well for natural ponds. The soil under a liner should be sub-soil and not top soil. The final surface should be smooth and free from stones and large objects. A geotextile is set over the prepared surface and a flexible water proof liner laid to finish. Irrecgular shapes can be created through welding on site.

Figure 3.22 Raised pond with sloped internal walls

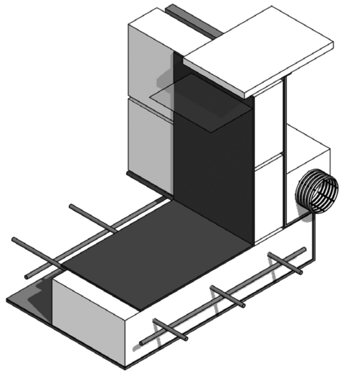
edge pools are usually set level with surrounding paved surfaces, with the water spilling down the narrow gap between the pool rim and the pavement edge. A modification to the infinity edge is called a knife edge. This adds a sharply sloped return to the outside face of the pool edge. This method minimizes the gap between the pool and paving whilst ensuring the water is directed effectively to the collection drain.

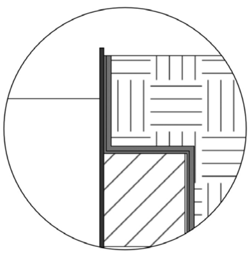
EURO EDGE

A euro edge is a retaining wall with a gradual slope towards the pool lip. This design is common in pools that are built for swimming in as the wider wall and slope help reduce the effect of sudden changes in water volume. A euro edge pool can be set level with or raised above the surrounding paving.

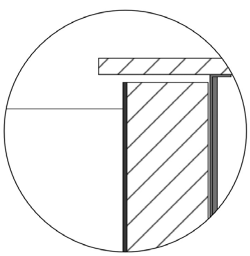
The volume and dimensions of the drain that captures spilling water is critical to a pool’s success. This is relatively easy to calculate but needs to consider:

a. Water volume in motion. The volume of water that is travelling over the edge as well as the volume retained in the drain and secondary reservoirs
b. Wind. Where edges are set below ground level the effect of wind is reduced; however, a strong wind can cause the water flow to bridge a gap between the pool and paving, resulting in water loss. Raised pool designs can have water blown from the descending face, again resulting in water loss
c. “Bather surge”, takes account of bathers creating water displacement (1KG = 1L water displaced); pools suitable for bathing are not covered in this volume.

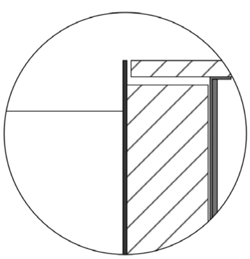




A.
Planting alongside the metal lined pond
For planting to flourish alongside a pond the soil level should be set below the metal edge to prevent organic material entering the water. The flexible liner is present as a precaution but is not critical. A sub structure is required to support the metal edged pond, unless it has external supports and braces. Where a constructed support such as block work is employed, it should finish about 250mm or x1 block unit below the soil to allow plants to grow as close as possible.



B.
The metal edge is set to the underside of the coping, essentially acting in the same way as a flexible liner.

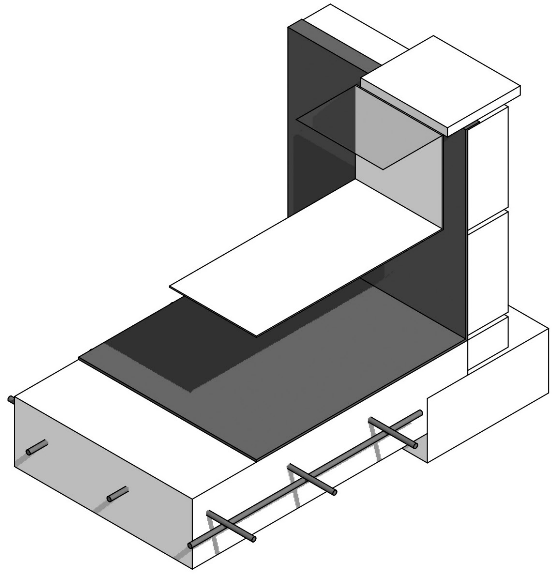


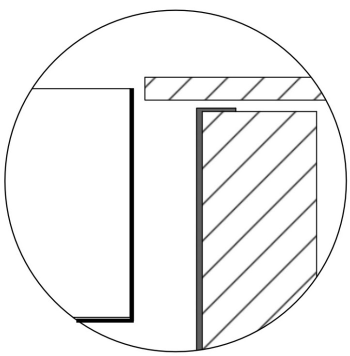
C.
A simple and effective detail in a metal lined pool is to set the liner edge to that of the paving material. The gap can be pointed and create a very sharp, crisp edge.

Figure 3.23 Metal lined pools

INLET

An infinity pool works best when the water surface has little or no noticeable movement, reflecting the sky and surroundings to their optimum (see Figure 3.33, p. 91). The circulated water inlet into the pool will create displacement and this is evident from surface ripples, the reflective quality of the water surface will be distorted even with minor water turbulence. The inlet is most effective when it is set in the bottom of the feature and baffled. There are several methods of achieving this.





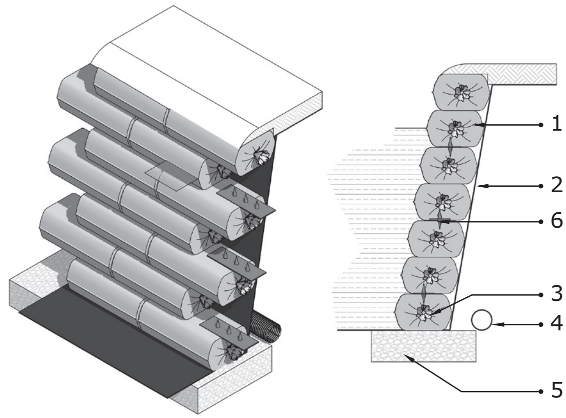
Infinity effect pools
It is possible to create an infinity or brimming pool set below ground level. Metal lined features will have a limit to their size, and work best on smaller designs; larger features are better suited to materials such as stone and tile over simple masonry construction.
Simplistically, a shallow inner reservoir is allowed to overflow with the water dropping between it and the larger external, lined pond. The water in the external reservoir or pond contains the pump, which cycles the water up into the smaller reservoir. The effect can be mesmerising.

Figure 3.24 Metal infinity edge

Larger infinity effect pools are best served with a centrally placed inlet; this may be split into two or more depending on how irregular the geometry or symmetry of the pool surface is. For the inlet to be discreet it should be recessed into the pool floor, creating a sump. This is also a convenient location for the installation of an outlet pipe for pool drain down.

The base sump may be left open but a simple grate or mesh cover will render it virtually invisible. The grate and the baffle arrangement should be loose/removable so that the sump can be serviced as required and the inlet flange inspected during the pool service.

Infinity pools work in a slightly different way to a contained water feature or pond. They are filled to the level of the

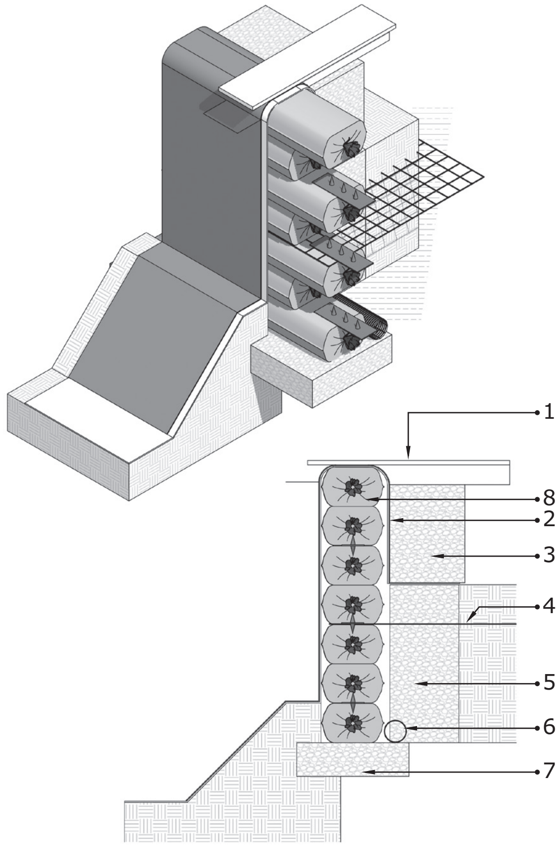


The use of sand bags or earth bag building systems is one of the oldest construction techniques. The bags and retaining components have been modernised but the principle techniques remain unchanged. The bags, usually about 800mm long x 300mm deep and 150mm high, can be filled with a variety of materials. When the bags are used within the water body over a flexible liner, they are best filled with a mixture of gravel and sand. Planting areas can be created as separate features alongside a wall. A simple sub base foundation is required and the bags are coursed with a staggered overlap. Larger walls will require rearward facing buttresses, achieved by turning bags 90º every 2–3m. Bags are secured to the courses above and below by a variety of devices but these are all essentially aggressively spiked plates that perforate the bags and prevent lateral movement (see chapter references for suppliers). Earth bag walls must have a drainage system installed to relieve water forces acting from outside the pond. Where the bag-aesthetic is not desired, the walls can be subsequently faced with a facing stone; this is frequently laid dry, but mortar might be used.

1. Earth bags, filled with a sand/gravel combination
2. Waterproof membrane (e.g. EPDM 1mm)
3. Lowest bag course set over a geotextile (220gsm)
4. 100mm diam perforated land drain set to the pond perimeter, in pea gravel bed wrapped in geotextile (+100gsm)
5. Sub base foundation 150mm
6. Connector plates.

Figure 3.25 Sand bag wall with external liner

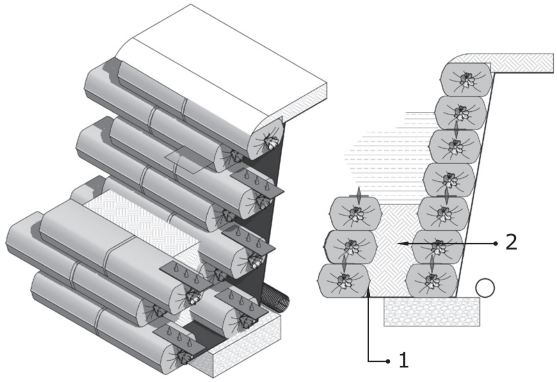
brimming edge and any additional water causes them to spill over. When switched off, the water level (provided a non-return valve is used) will remain at the level of the lip or edge. The additional water needed to raise the level to set the spill in motion must be drawn from a separate body of water. A secondary reservoir is usually necessary, designed as part of the feature structure, or the collection drain itself can be used as the reservoir if sufficiently wide and deep. The advantage of the secondary tank or reservoir design is that the circulation pump can be easily located and also any additional equipment such as filtration, electrics and automatic top-up. This reservoir chamber would be located below (for small features) or alongside the infinity pool with an access cover. A mains connected water top-up should have an electrical solenoid type activation switch rather than a simple floating ball valve (similar



1. Coping or decking as required
2. Flexible waterproof membrane. Brought over the rear of the earth bag wall and retained by sub base or soil min 300mm below finished level
3. Sub base (DTp1) or soil as required
4. Geogrid (see chapter references for suppliers)
5. Free-draining pea shingle/gravel
6. 100mm perforated land drain, connected to approved outlet, wrapped in geotextile (+100gsm)
7. Consolidated sub base 150mm DTp1.

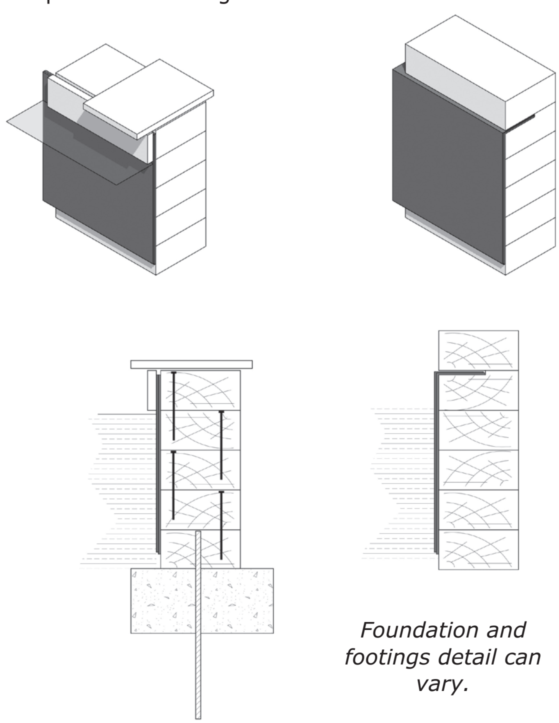
Figure 3.26 Sand bag wall with an internal liner

to a ball cock used in toilet cisterns). The reservoir will have two levels, a high level for when there is no water in transit and a lower level for when water is moving within the system. A floating ball valve responds immediately to the drop in water level when the system is switched on. This introduces water that is in excess of what the system needs and this will be removed by the overflow the next time the system is switched off. The electrical solenoids can be set to a high and low level and allow the system to operate between those parameters without drawing in additional water. Only when water is lost through wind or evaporation and the level drops below the predetermined level will water be



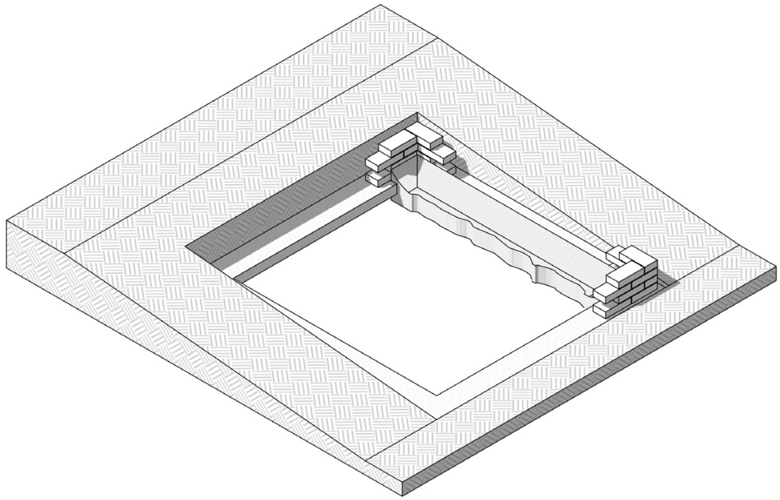
1. The lowest course of bags should be set over a geotextile to project the liner from abrasion (+220gsm)
2. The planting beds can be filled with soil or gravel as required.

Figure 3.27 Sand bag wall with an internal planter



1. Coping stone. This should extend 25mm min to either side of the wall
2. Flexible waterproof membrane (e.g. EPDM) laid over a non-woven geotextile 220gsm
3. Concrete C25, foundation support for wall.

Figure 3.28 Raised pond with timber walls

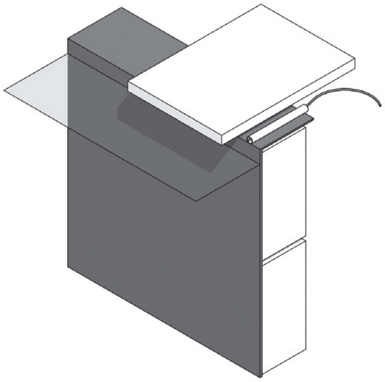


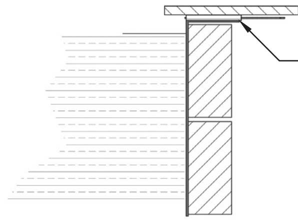
The intended site for a pond may not always be level. A water feature can be cut into a slope although the construction method should be selected with care and reference to how the pool will finally look. Unlike on level ground where a pool will be either above or below ground, features cut into a slope will have some of their structure below and some above ground. A reinforced concrete ring beam is required for the foundation of the retaining wall. The internal surface can be constructed over a solid base or simply lined over graded and compacted subsoil. The perimeter retaining wall should be block work either laid with a twin tied wall or using blocks laid flat. A slab level ground drain is necessary to ensure there is not obstruction to in-ground water.

Figure 3.29 Pond in a slope

drawn to top up. Where the water is to be filtered it can be prudent to use two pumps. One is a fixed flow that cycles the water through a filter unit, the second moves the water from the reservoir into the main water feature. A pump with a variable flow regulator will allow the water level over the rim to be fine-tuned.

The most appropriate metal to use for water features is steel. There are many types and all are available in various thicknesses. Mild or bright steel is suitable for fabricating water features but must be treated to prevent corrosion. The most basic treatment is red oxide. This should be applied as a spray to a clean and blemish free surface and is best undertaken by the fabricator. The oxide paint acts as a primer and can be overpainted by brushed, sprayed or powder coated paints. This coating will eventually deteriorate. A better protective coating for steel is galvanising (BZP bright zinc plating). Whilst this will appear bright silver initially it dulls within a year or so to a lead-like dull grey. It will maintain an integral coating for +50 years. It can be readily painted over or powder coated.





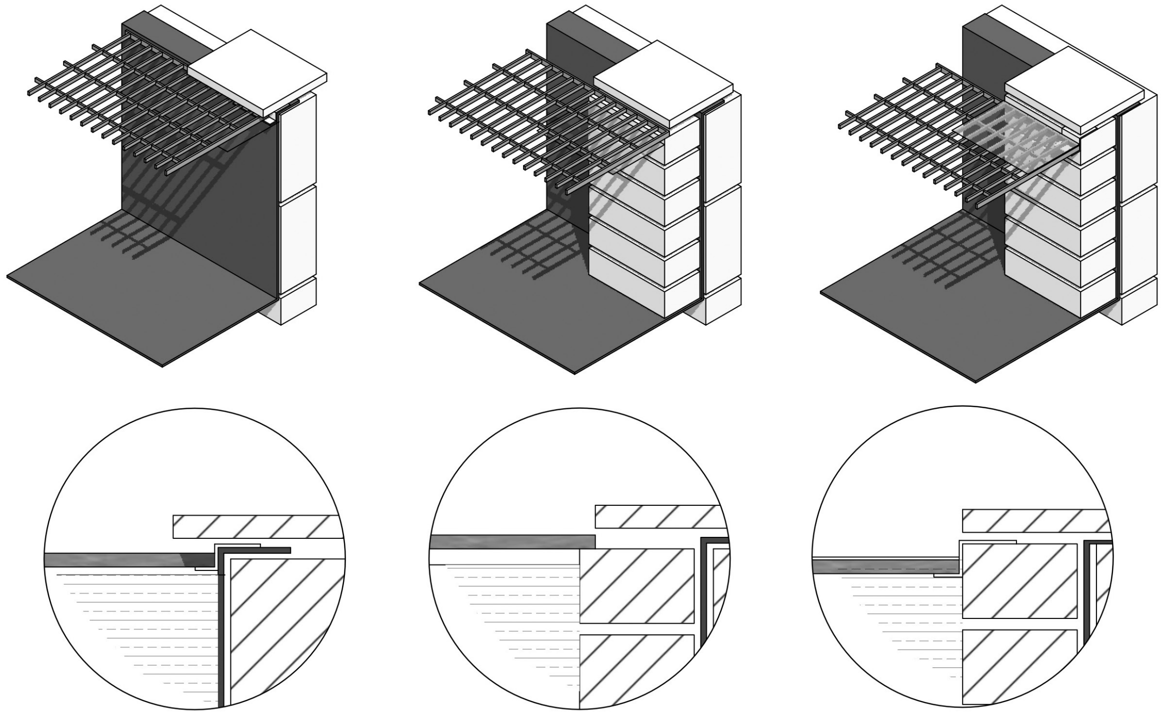
A pond may be created for one purpose but future demands or wishes may require modification or additions – the introduction of fish for instance. Even where provision has been made for fish etc., unseasonal weather may require intervention to rebalance a pond or ensure that the habitat is maintained. The inclusion of a flexible pipe under paving that adjoins a pond will allow the introduction of future functionality, should the need or desire arise. This may include a lighting system for the pond, or an aeration device to oxygenate the water during hot summers or where there are now fish and insufficient planting to provide for their demands. A simple 10–13mm pipe is an economical detail to add, even if it is never subsequently used. Set from the pond edge and ending at the edge of the garden or beyond the paved area, it should have a draw cord set within it before it is laid.

Figure 3.30 Airline provision

Weathering steel (Corten brand et al.) is a steel alloy containing small amounts of copper and other elements. It will develop an oxidised surface (rust) that stabilises to a deep bronze-purple with time. The oxidisation process relies on the steel being exposed to a cycle of wet and dry environmental changes. Where a surface is continually wet, immersed in water or at the water line the oxidisation process may not stabilise and can continue indefinitely. This may lead to the leeching of steel oxides into or around a water feature, to the detriment of surrounding surfaces and some aquatic life.

Internally a water feature can be sealed with a variety of thin, often painted materials, powder coating, pond sealers and paints and GRP to name a few. GRP laminations can result in a thick surface and the lip of a steel container will look better and be much more rigid if there is a small return, either as a flat lip or angled detail (knife edge). The GRP can be laid to this edge and will appear much more considered.

The thickness of steel needed for a water feature will depend on the size and volume of water contained. A simple square container 500x500x500mm could be fabricated from 1.5mm thick, whereas a larger trough style container may require 3mm steel. Internally it is possible to add angle (25x25mm section) supports



Continuous metal bracket.
This can be set above or below the water line. If the grating is to be temporary the bracket shoulder should extend beyond the edge of the coping overhang to allow removal.

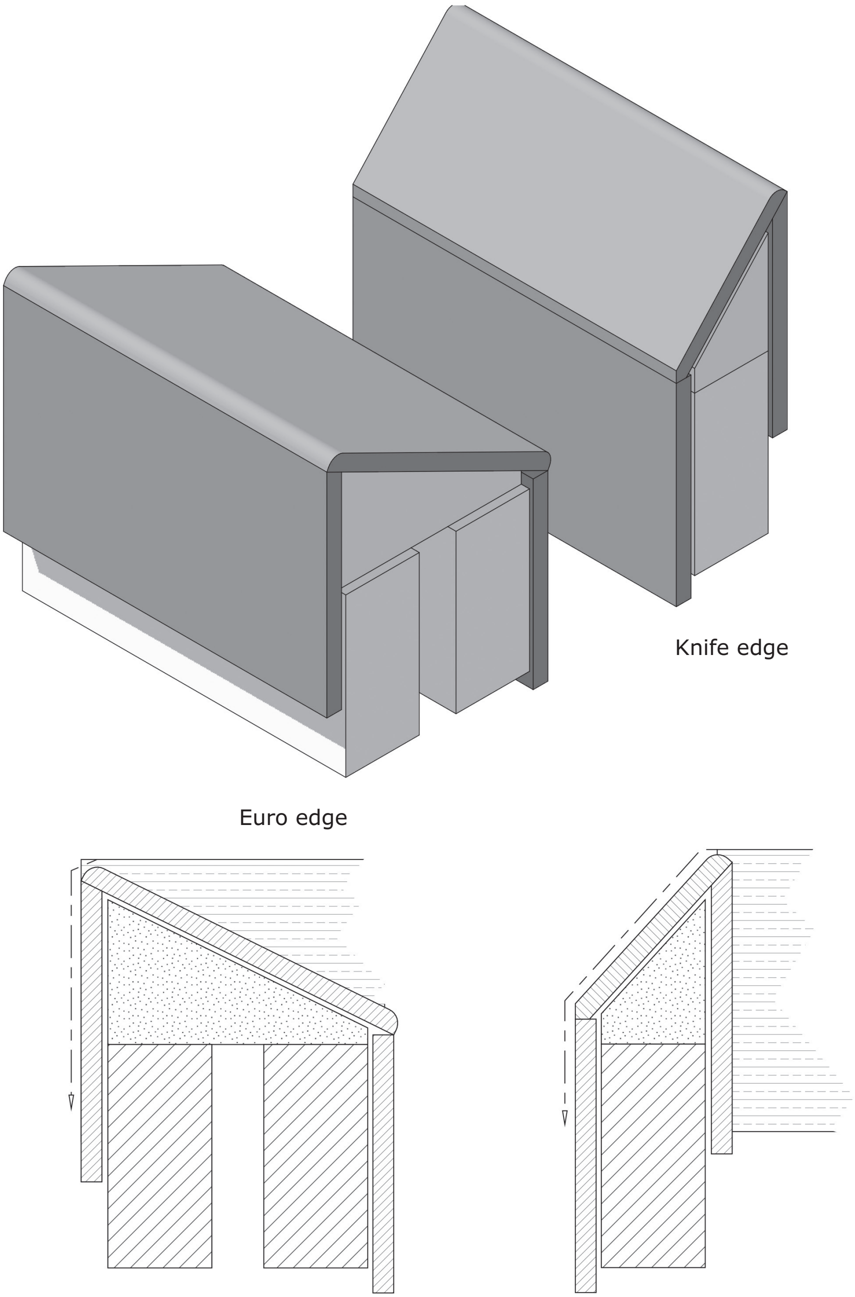
Recessed coping.
The coping stones are set back to allow the grating to rest on the top of the internal wall. Where an internal liner or GRP waterproofing surface is used the grating should rest on a continuous strip of material to prevent damage.

Intermittent brackets.
These are brackets that are set at intervals around the pool edge. The spacing will depend on the type of pool cover or grating used. Sockets can be included during the laying of the paving surround so that the brackets can be added or removed.

Figure 3.31 Pond grating support

which will prevent larger flat surfaces from bowing out. A good fabricator will be able to offer advice on what is both practical and most economical.

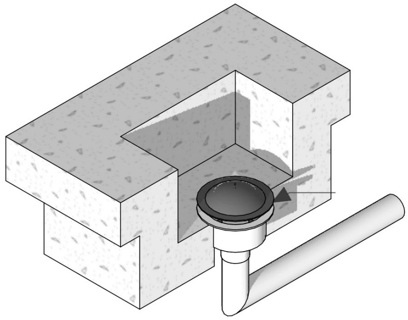
Small (less than 1.0m/side) drain runs will probably only require a single drain outlet (110mm diameter). Where there are longer perimeter drainage channels there should be adequate drainage outlets into the reservoir; e.g. a 1.5m x1.5m pool might have two drain outlets, in opposite corners, a 3mx4m pool night have one in each corner. The size and frequency of the outlets should take into account sudden storm water events that would otherwise overwhelm a drain. A simple detail at each outlet is to create a return pipe to the top of the drainage channel (see Figure 3.42, p. 100). Should the drain become overwhelmed or blocked.

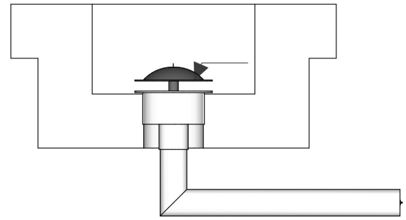


A Euro edge is wide, typically a double skin block or equivalent cast concrete wall. The top is formed to the required angle with concrete or mortar and the external edge is bevelled or rounded.

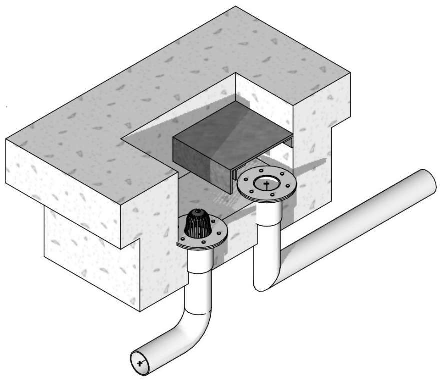
A knife edge is the opposite of a Euro edge; the slope faces away from the water and has a much steeper slope. Therefore the wall has to be thinner and is usually the equivalent of one concrete block.

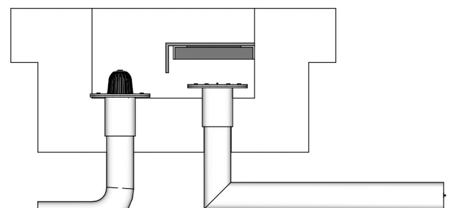
Figure 3.32 Knife edge vs euro edge



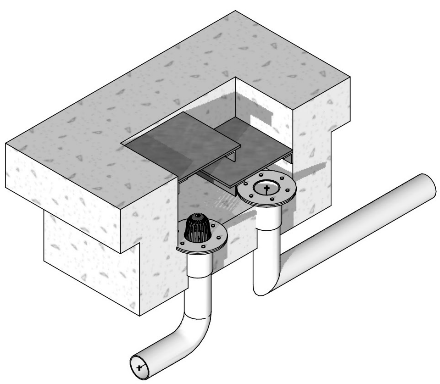


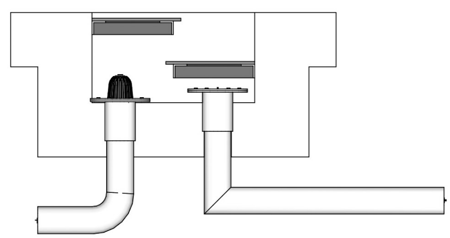
Bottom drain chamber used as an inlet diffuser (e.g. Oase DN100).



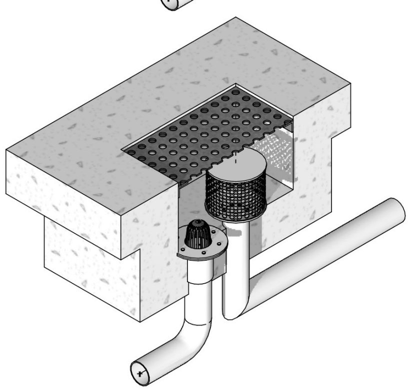


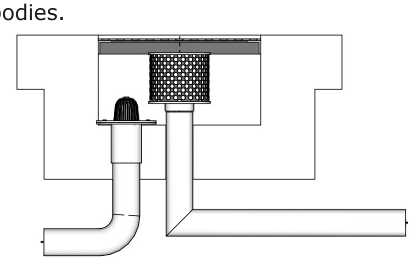
Simple baffle plate set over a support bracket.





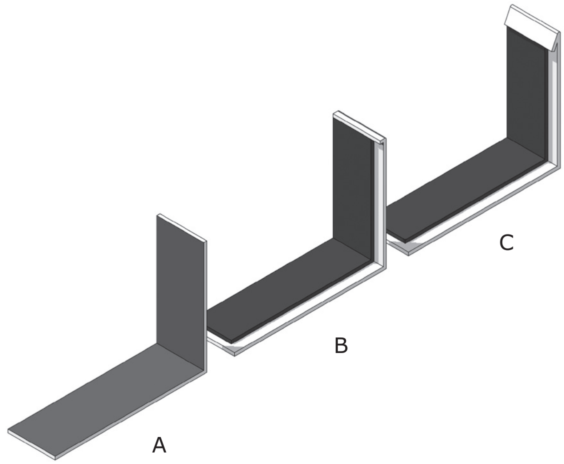
Double baffle plate set over a support bracket. This will calm the inflow to a greater extent than a single plate but the difference is reduced for larger water bodies.





A metal strainer, simple screws into the threaded inlet. These are usually supplier galvanised and may require painting if not concealed under a sump cover.

Figure 3.33 Infinity pool inlets



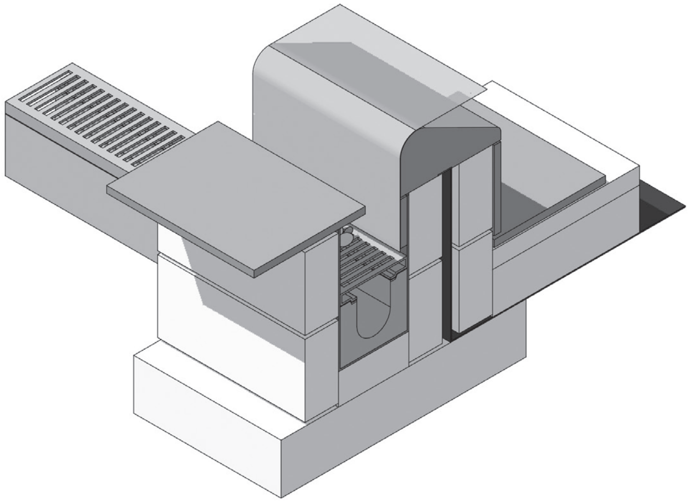
a. painted surface over clean metal surface
b. simple folded edge with GRP liner
c. folded knife edge with GRP liner.

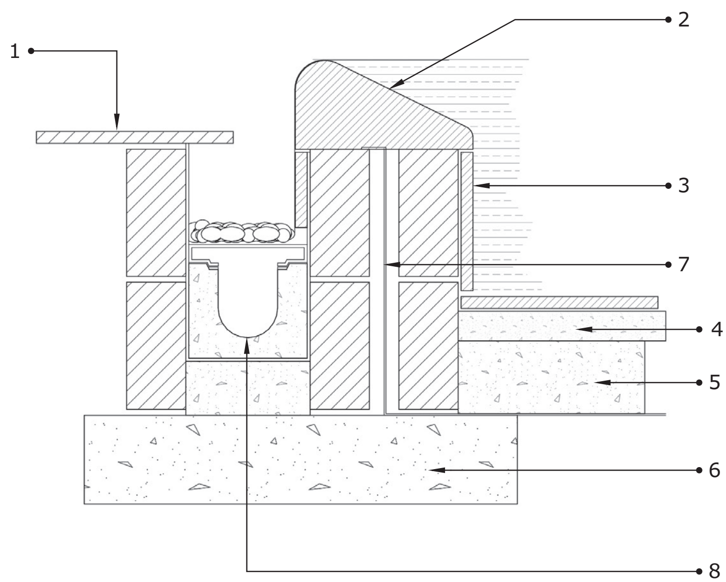
Figure 3.34 Metal tank waterproofing

An infinity pool can be created to almost any size; however, there are some basic principles that apply to all designs:

a. Decide whether the water will remain within the container or spill over
b. The inlet is best placed in the bottom of the feature; this should be baffled to minimise water disturbance
c. The pump controlling the inlet flow should have a flow regulator
d. Large pools may require filtering, small pools can be kept clean through the addition of water treatments
e. Where filtration is required an external reservoir will allow easy access to all equipment and provide a location for mains top-up
f. Include a valve/tap to drain down the feature.
g. The internal surface of the feature works best coloured black.

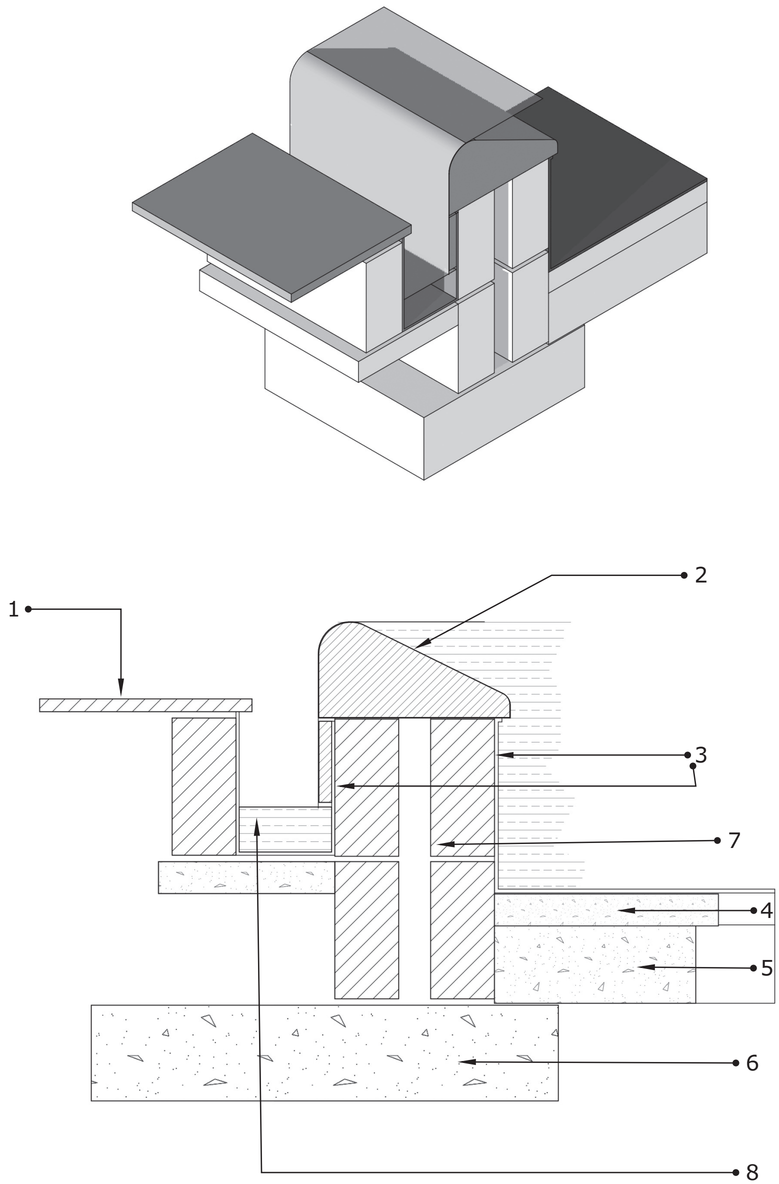
Where a pool spills but the water is returned internally, the edge detail and gap between the inner and outer containers is critical (see Figure 3.43, p. 100 and Figure 3.46, p. 102). The base of the water feature can be used as a reservoir (alternatively an external and separate reservoir can also be used). The inner container should be removable and the supporting frame should have adjustable feet to allow it to be set level. The inlet is located in the base of the inner chamber and a baffle plate suspended over it. There are several different edge details. The actual dimensions will depend on the size of the water feature and the volume of water flowing over the edge. It is worth experimenting before committing to a final design.





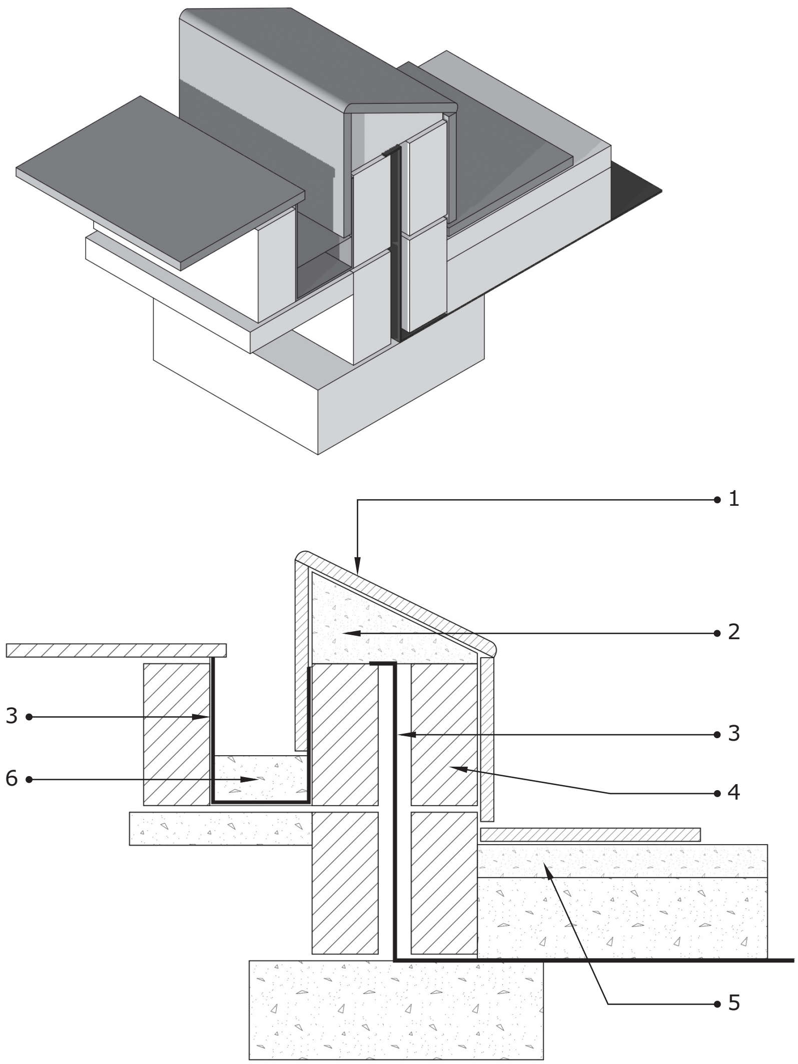
1. Surrounding paving as required.
2. Edge stone, this can be created by setting tiles over a mortar bed at the required angle or from custom cut stone such as granite. The rolled edge helps the water leave the pool smoothly.
3. Internal finish as required. The material adhesive and jointing should be waterproof.
4. Screed bed if required (e.g. porcelain/tiled finish).
5. Pool base RCC25-35.
6. Edge foundation C25. Depending on the level of the catchment drain relative to the internal finished level of the pool, the pool base can be extended to include the wall and drain. Frequently they are not at the same level and are best cast independently
7. Waterproof membrane (e.g. TPO). The membrane can be internal to the pool or set within the cavity of the supporting wall, if there is one. This is necessary to ensure that the pool water does not gradually create or find a leak.
8. Slot drain. If the design of the pool allows for a standard slot drain to be used, it can be a simple and economical detail. The drain cavity is available in a range of depths and the correct depth should be used based on the volume of water in transit calculation.

Figure 3.35 Euro edge with slot drain



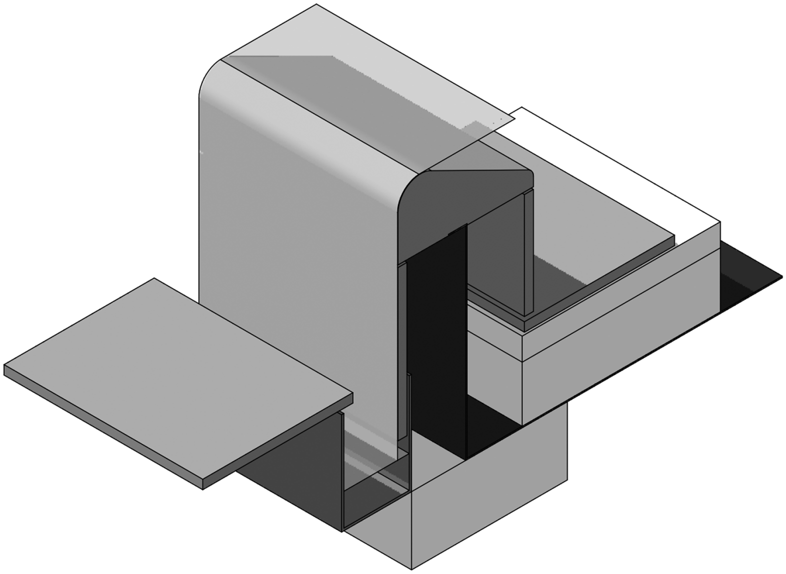
1. Surrounding paving as required.
2. Formed or custom cut coping stone.
3. Internal GRP over a screed base and rendered side wall. Bonded to the underside of the coping stone.
4. Smooth screed over cast base.
5. Cast concrete base RC25–35.
6. Perimeter concrete C15 foundation strip.
7. Blockwork or cast concrete (waterproof) wall.
8. Perimeter gutter and drain to reservoir.

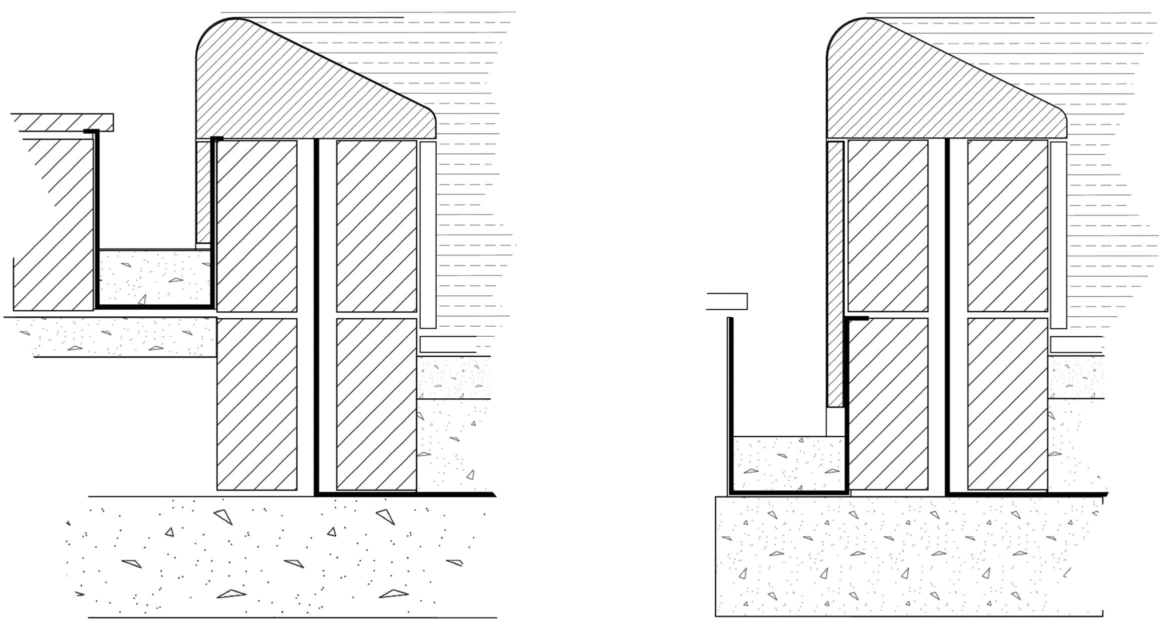
Figure 3.36 Euro edge with GRP liner



1. Porcelain tile over formed concrete lip. Tile has bridge bond to rear and is set in a waterproof external tile adhesive. A waterproof grout to the required colour is used between all tiles.
2. Formed concrete support set with a level edge and flat sloped face.
3. Flexible waterproof membrane set under the cast base and into the wall cavity Where a welded liner is used it can be taken over the external cavity wall and used to form the primary barrier in the discharge drain.
4. Concrete block or cast concrete wall.
5. Level screed over cast base.
6. Discharge drain. This can be lined with a flexible waterproof membrane, GRP or a proprietary pond sealer and paint.

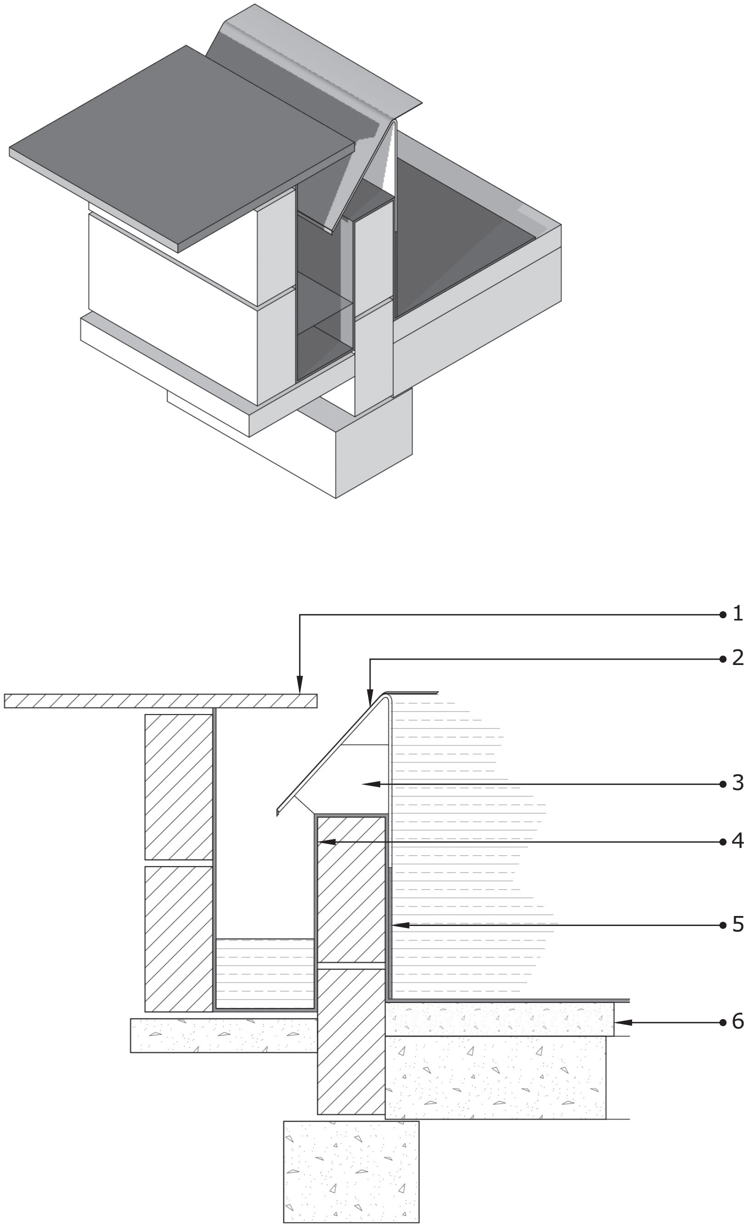
Figure 3.37 Euro edge with porcelain tiles





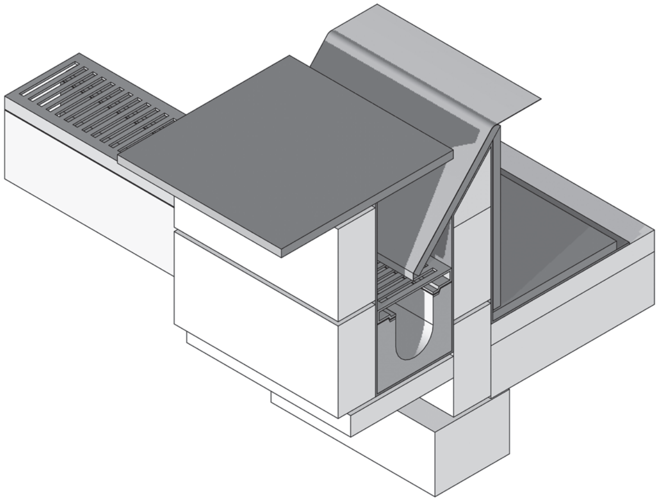
The height of the pool edge can be raised to any reasonable height. The surface over which the water descends can be smooth or inset with small details, such as metal ribs to give the water greater presence.

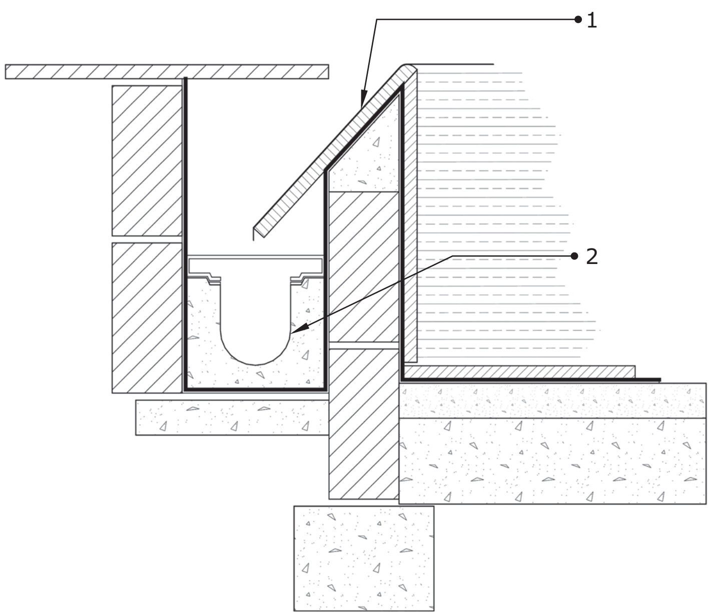
Figure 3.38 Euro edge relative height above paved level



1. Adjoining paving as required.
2. Folded metal edge.
3. Internal metal support rib to stiffen the knife edge.
4. Waterproof lining (GRP, flexible liner etc.).
5. The internal step between the metal edge and the liner can be left or an additional strip of membrane can be used to bring the two surfaces flush.
6. Screed over cast base to create a level surface.

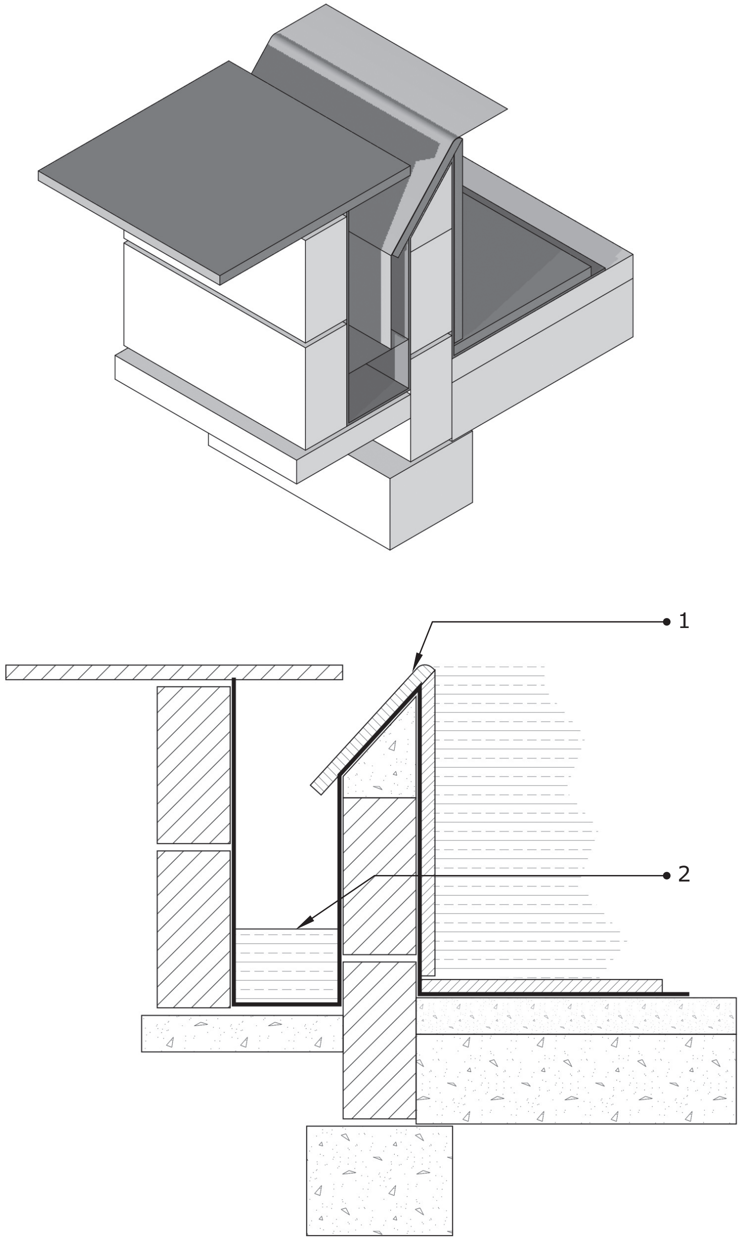
Figure 3.39 Infinity edge with metal rim





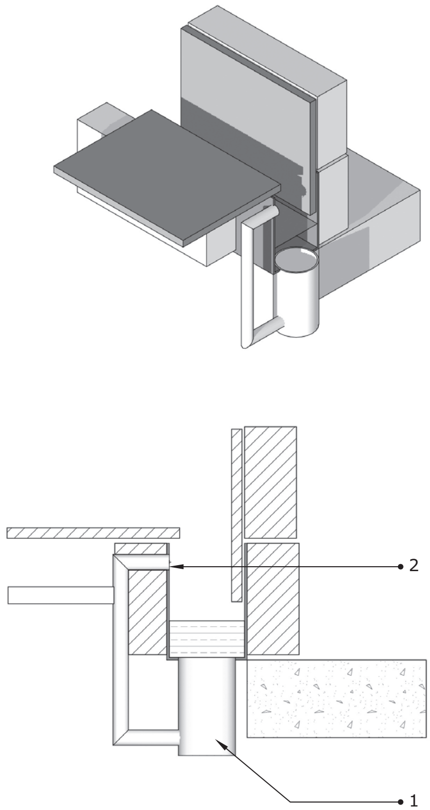
1. Porcelain paving, bonded to the internal wall surface at the mitre and attached over liner with adhesive.
2. Standard slot drain set within a waterproofed channel. The depth of the drainage channel element is selected to suit the calculated water volume in transit.

Figure 3.40 Infinity edge with porcelain tiles and slot drain



1. Stone or tile cladding as required, bonded over liner and at mitre with internal facing stone.
2. Deep constructed water channel; waterproof with a proprietary pond sealer and paint.

Figure 3.41 Infinity edge with custom drainage channel



1. Overflow for drain
2. Drain outlet to secondary reservoir.

Figure 3.42 Infinity or euro edge drainage detail

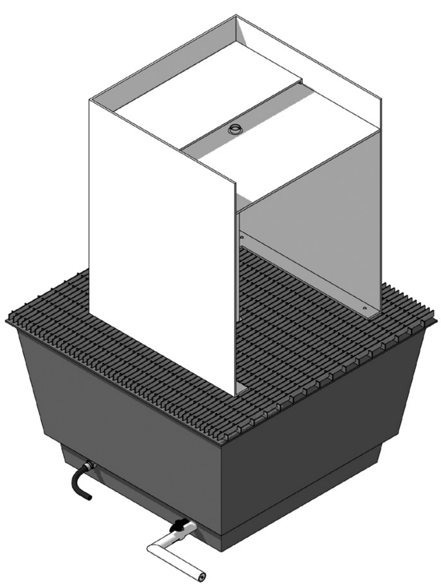
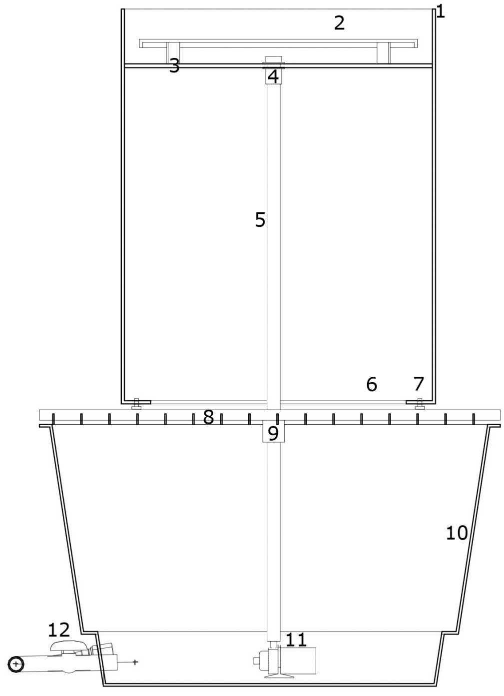


Figure 3.43 Brimming waterfeature



1. Bowl or container. Fabricated steel boxes create a rigid and slim structure. This should be waterproofed.
2. Baffle plate. This can be a continuous plate with a 10–15mm gap at the side to allow water to fill the spill chamber.
3. Support feet for the baffle plate.
4. Inlet pipe tank connector.
5. Inlet pipe with non-return valve.
6. As the upper chamber is sealed from the rest of the tank, the main structure does not require a base.
7. Adjustable feet to set the pool rim level.
8. Metal grate over reservoir.
9. Non-return valve.
10. Reservoir (e.g. Ubbink 79×48cm HDPE).
11. Submersible pump with flow regulator. Some reservoirs have a hatch allowing the pump to be accessed for servicing and adjustments.
12. Drain down valve tap.

Figure 3.44 Brimming waterfeature

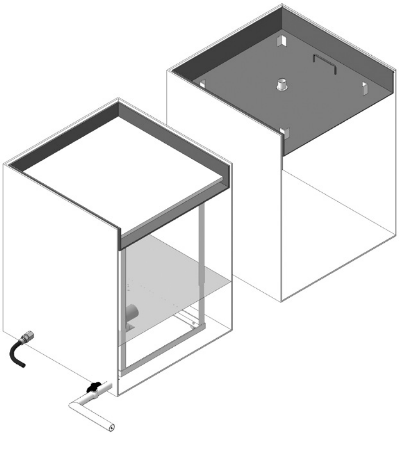
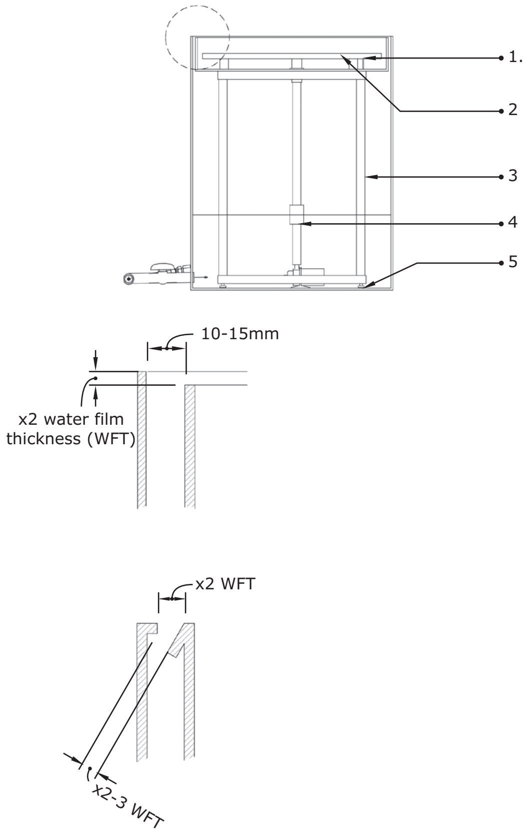


Figure 3.45 Brimming waterfeature intern spill



In a pool with parallel sides, the inner chamber should be set below the height of the external chamber wall by the anticipated thickness of the water flow over the rim, e.g. 5mm. The distance between the internal and external walls should be x2 the water thickness over the rim, e.g.10mm for a 5mm film. *This is given as a guide and starting point only, the design should be refined in line with the pool size and water flow.*

The water level can be lifted to the same or slightly higher than the external wall if a knife edge detail is added to the lip of the internal chamber. Surface tension will keep the spilling water in contact with the sloped surface and the sharp lip will allow it to readily fall into the gap between the chamber walls. The horizontal gap should be about x2 thickness of the water over the rim (e.g. 10mm). *This is given as a guide and starting point only, the design should be refined in line with the pool size and water flow.*

Figure 3.46 Brimming waterfeature intern spill

Note: Metal brimming trough

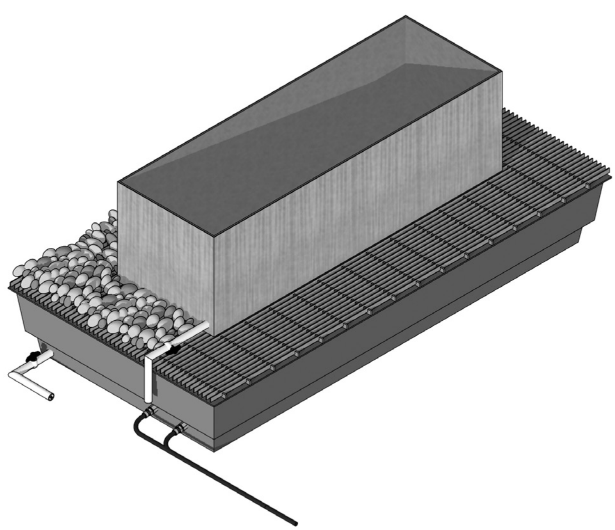
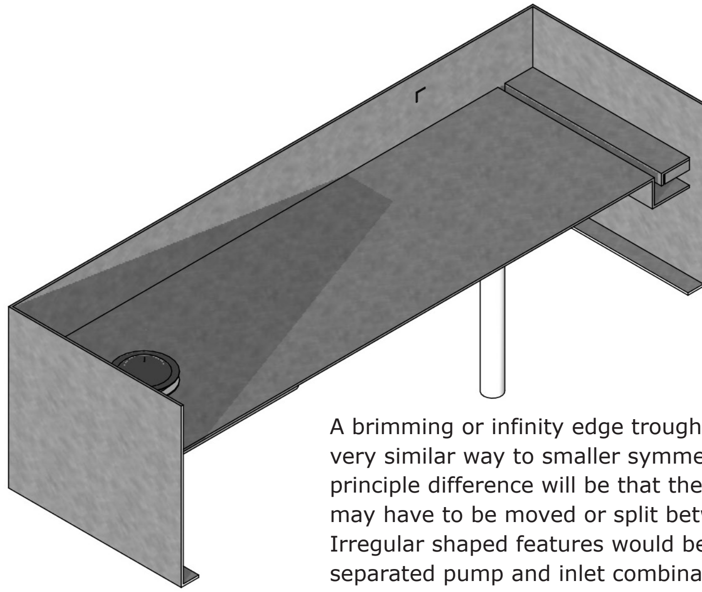
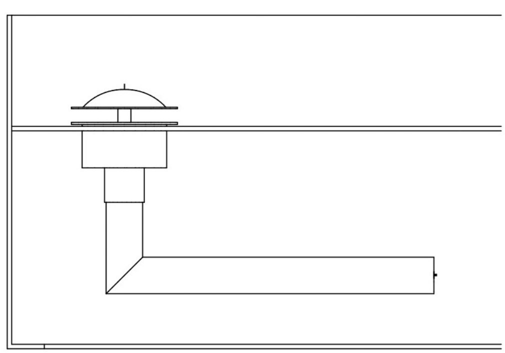


Figure 3.47 Brimming water trough

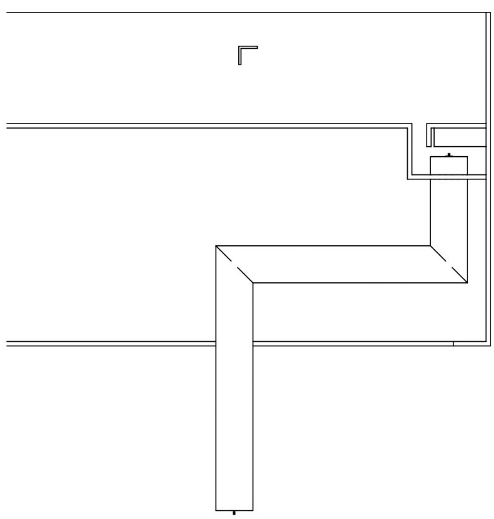
Note: Trough shown without inner chamber or baffling



A brimming or infinity edge trough is detailing in a very similar way to smaller symmetrical features. The principle difference will be that the water inlet position may have to be moved or split between two or more. Irregular shaped features would benefit from having separated pump and inlet combinations so that each can be regulated independently and an even film or edge effect achieved.
There are alternatives to a separate baffle plate.



A domed bottom drain (e.g. Oase DN100) can be used as a means of diffusing inlet water. These are supplied in black and are simple to install.



A slotted inlet can be created at two ends, along the main axis or to the entire feature perimeter. The inlet simply connects to the lower surface and a separate and removable plate sits on a support bracket covering the inlet pipe.

Figure 3.48 Brimming water trough

CHAPTER 4

Structures and crossings

Crossing water, whether by bridge, stepping stones or a meandering path adds an entirely different level of experience and emotion to a garden. No matter how substantial a bridge might look there remains a sense of exposure as soon as the bank is left. There is usually no opportunity to change direction, and so the route is at once committed. The land changes to water and, frequently without guarding or rails, the risk becomes apparent, if only fleetingly. Some routes are elevated above water, bridges for example, and there remains some distance between feet and fluid. Other times, with stepping stones, for example, a pedestrian can be elevated only centimetres above the water and there is almost a sense of walking on top of the water.

Direct routes cross efficiently and typically in a single span. Zig-zag paths and deck ways may introduce a change of direction that will require an intermediate support foundation and this may impact on the design and construction of the feature.

No matter which style of crossing, the key elements to consider are:

- Safety: assess the risk of falling or tripping, spacing between materials being used, how the crossing is accessed from the bank
- Maintenance requirements: what and how frequently (wooden structures will require more than stone)
- Slip resistance: the material used may have to be modified or altered for use as a crossing (timber type/finish).

Boardwalks, bridges, platforms and stepping stones are simple structures that allow access over a body of water. They can be constructed from a wide range of materials and are often set so that they are as close to the surface of the water as possible. A successful structure should be safe, perform well and fit the context of its location. The simplest crossing can consist of a thick plank of wood, extending enough onto a bank that the ground supports it. Several laid together may be connected to ensure there is no side-ways movement.

The type of constructions used over and in water are somewhat dependent on when the structure is being added:

1. Those built when the water feature is constructed
2. Those built retrospectively.

The length of structures that can span open water will be limited by the type of materials. Even large section steel will be limited to approximately 15m, beyond which the structure will require the input of an engineer. The most common structures used are those that have frequent supports and are built up from the base of the water feature. The most simplistic would be natural rock/stepping stones. A contemporary version of these are rectangular brick or stone clad piers with a sawn stone paver set above the water level. As the coping/paving stone edge will be visible, a thicker module can improve the visual integrity of the design (e.g. 50mm). A thicker paving unit will also permit the stone to have a greater overhang, reducing the visibility of the underlying support structure.

Pathways through gardens should be a minimum of 900mm wide and the same applies for stepping stones. The distance between units will vary on the stride length of those who use it (children vs adult male) – 250mm is a

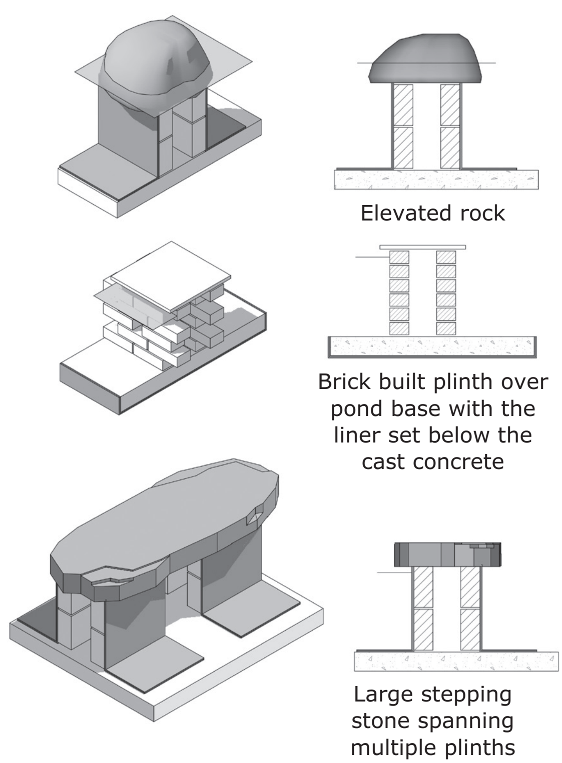
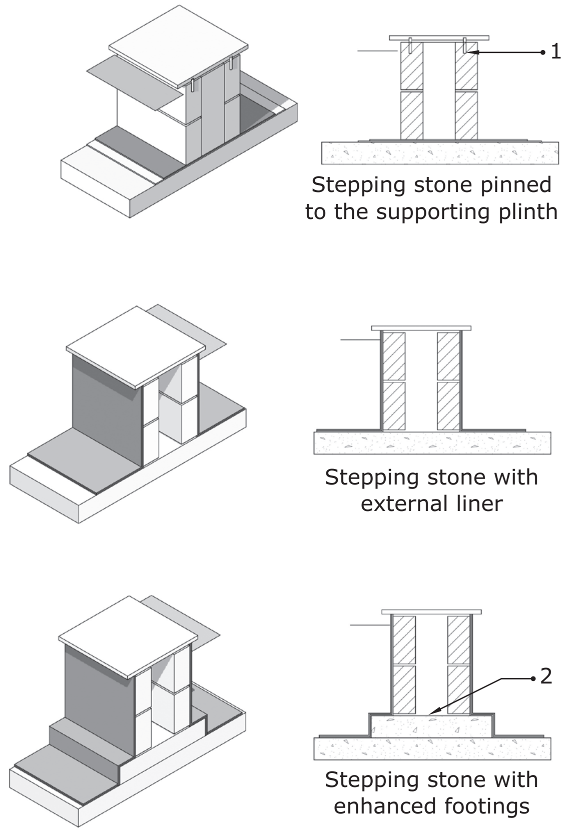


Figure 4.1 Stepping stones 1

reasonable gap to consider when starting a design. Paving used for stepping stones should be non-slip. Dense stone (slate, basalt, granite) can have a mechanically enhanced or even flamed surface texture applied. As well as the security of footfall on the stone, it is essential that the stone paving itself is securely attached to the supporting pier. As a minimum they should be laid on a full bed of mortar. So close to water, mortar can degrade; it is worth considering a propriety adhesive, such as an exterior grade thin-bed tile adhesive or polymer based "mastic" adhesive. The supplier of the stone will be able to advise which type would best suit. It can also be useful to "pin" the paving stone to the support pier. Small steel or polymer dowels are set in the pier and match a shallow hole (to about half the thickness of the paving). These are best secured with a polymer/epoxy resin. They prevent the stone sliding from the impact of footfall that may cause a more traditional mortar joint to shear.

Stepping stones often require plinths to support them. Natural pools and streams may be shallow enough or have enough existing rocks and materials for larger stones to be securely placed or set in mortar within the existing form of the pool or stream. Like a planted island, the plinth of a stepping stone should, where possible be considered when the pond is being designed. A plinth can be formed from a square of concrete blocks raised to the required level. This is best where the paved surface is 50–75mm above the water level or the underside of the paving is 10–15mm above the waterline. A single block wall will be sufficient if it forms a closed shape (e.g. a square). The centre can be filled with concrete and the paving set on a full mortar bed. It is essential that the stepping stone has a bond bridge applied to the rear when it is set on the bedding layer to achieve the strongest bond possible. Paving stones should not have an excessive overhang as this can encourage pressure to be applied to the stone edges and cause the adhesive bond to fail. A more robust solution for securing stepping stones is to add four dowels, drilled to half the depth of the stone and then set with epoxy resin into the perimeter blockwork of the supporting plinth. These also prevent sideways forces acting on the stone, keeping it securely in place. Where fish are to be introduced, the shadow of a plinth can be an important part of their habitat, concealed from predators or out of the sun. Plinths built from decorative material (e.g. brick) might have gaps to allow water to flood the internal chamber and create refuge for fish and amphibians. Large stones can be supported on a single plinth or span several; this allows for water flow through and under them.

Plinths built over or as part of a lined pool will require an external lined surface. This is decorative to disguise the colour of the masonry (e.g. concrete blocks).



1. Dowels set in the plinth retain the paving
2. Cast concrete pads built up off the pond base.

Figure 4.2 Stepping stones

A pond sealer can be used; however, if the plinths are visible in sunlight coming from behind the viewer, every detail of the surface will still be evident, even if painted black. Render would be a means to smooth and disguise the rough surface of block work.

Pools that have their liner/ waterproofing membrane below a concrete base allow plinths to be erected directly off the pond base.

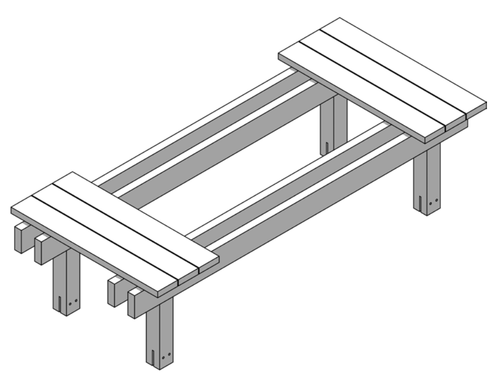
The type of structure that can be built off the bottom of a water feature will be determined by both how the water is retained and whether the structure is constructed at the same time as the water feature or is a later addition. A natural, clay-lined feature may support driven timber stakes. Unlike surface posts where two-thirds of a post is typically above its foundation, posts driven into waterlogged ground should be set to a minimum of 50% of their length. Driving a stake into the base of a pond can compromise its integrity.

Where a new, lined pond is being built the post holes can be dug prior to the liner being laid. The pockets can then be filled with a double layer of waterproofing membrane with a geotextile, onto which is poured concrete.

Posts can be set in a concrete foundation on top of the base of both existing natural and man-made water features. Where a liner is present, an additional section of waterproof membrane with a layer of geotextile should be used to reduce the pressure imposed by the foundation. The wider the foundation the less pressure it imposes on the base. Where the bottom is supported by a pre-cast concrete raft, the support foundation for a post can be as small as x3 the width of the post used (i.e. the width of the post on each side). The post can be set in the concrete base; however, if future maintenance is to be considered, it might be worth mechanically attaching a galvanised steel bracket to the end of the post which can be mechanically secured to the concrete pad.

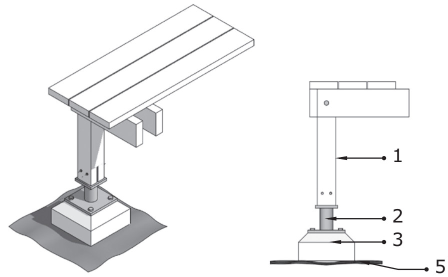
Timber posts have been used to create structures over and in water for thousands of years. There will be a range of indigenous timbers that perform well and are economical. In the UK, there are several timber species that perform well in water (structures in a marine environment will require additional specification): oak, Douglas fir, larch and sweet chestnut.

Connections should never be made into timber end grain; when wet, this has little or no structural integrity and any fasteners will become loose or fail quickly. Bolts, compression fixtures, work better than screws. Casting a timber post into a concrete **footing** will give limited life but is likely to degrade quickly. A better solution is to use a footplate that anchors through the side grain of the timber; this can be connected to a prefabricated foundation pad. An advantage to such

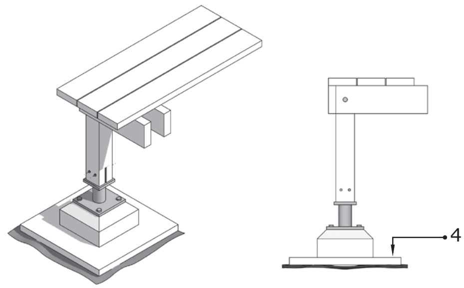


A timber boardwalk can be set very close to the water level. It offers access to water on either side and this can also impart a sense of exposure. Where a walkway might suffer from icing, wetting except from rain (e.g. boat wakes) or the users are unfamiliar with the route, a hand rail should be considered.
Walkways that are long or have frequent changes of direction would benefit from islands or refuges, where pedestrians can rest or pass.

Figure 4.3 Simple boardwalk



Timber post support over a lined pool



Timber post support over a lined pool with an additional support pad

1. 100x100mm UC5 timber or equivalent.
2. End plate or shoe (e.g. Simpson Strong Tie). These can be obtained with an adjustable collar to refine the level of the structure
3. Precast concrete foundation pad (e.g. Swift foundations).
4. Additional concrete pad/paving unit to support the foundation pad if required (e.g. over a soil-based pool). This could also be a geo grid (30mm thickness) which would reduce concrete content within the pool and be much more economical.
5. It is advisable to add an additional layer of geotextile and liner where a construction is placed over a lined pool. This protects the primary liner from abrasion and punctures.

Figure 4.4 Timber post supports

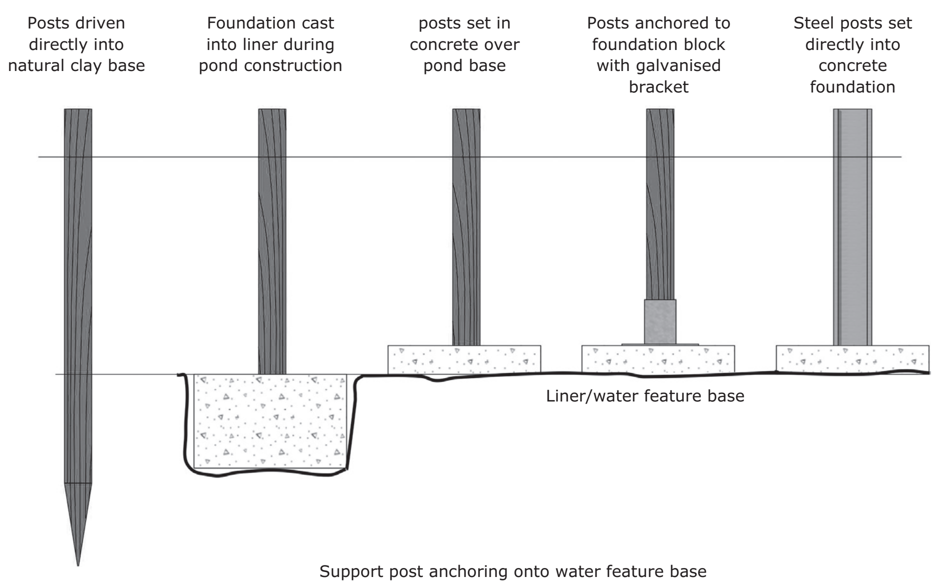
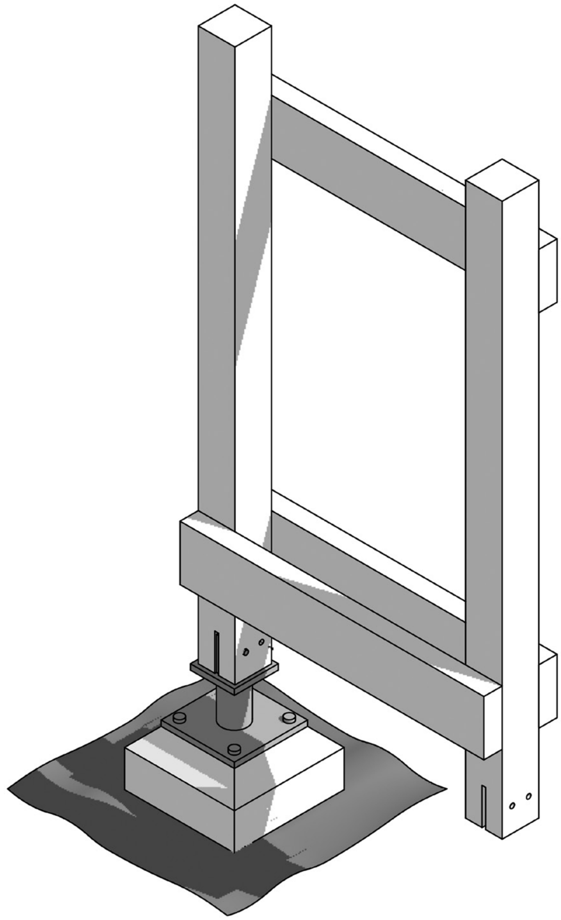


Figure 4.5 Timber support over liner

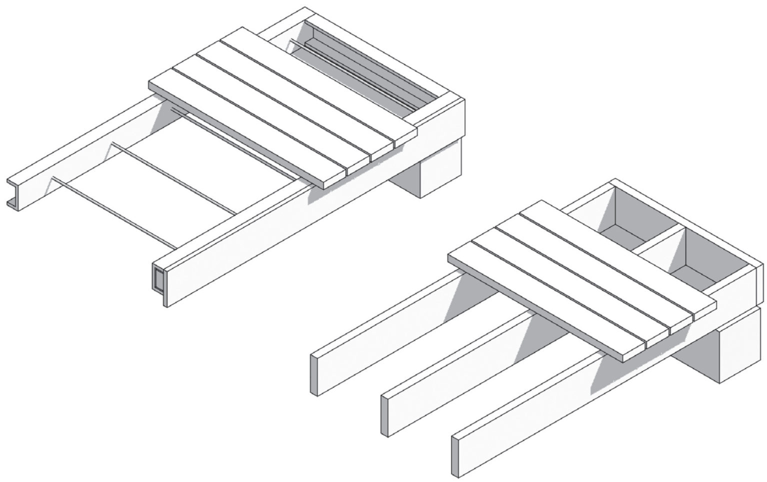


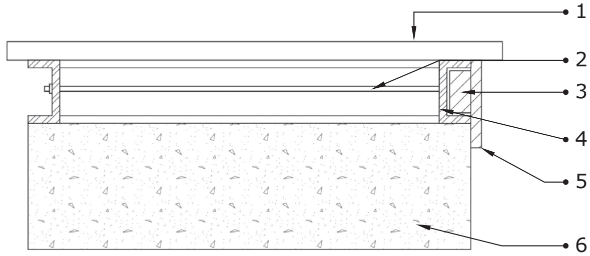
Where timbers have to extend +500mm from the base anchor to the boardwalk joists they should be braced close to the footing. This will prevent lateral movement in the walkway and ensure its stability. All fixings below water level should be galvanised or stainless steel and compression fasteners used (i.e. bolts) rather than screws or hammered in fixings.

Figure 4.6 Timber post brace

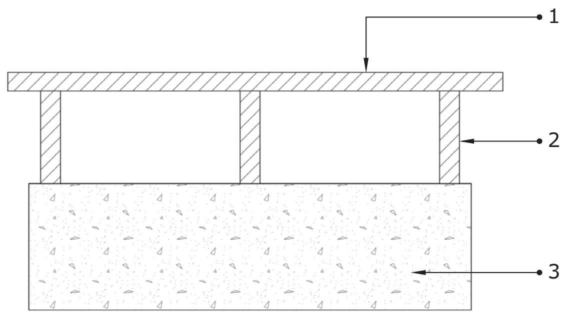
systems is that they can be repositioned as the construction progresses and are not permanent. If a timer needs to be inspected or replaced, the integrity of the pool or pond will not be compromised.

Where the width of a water body is less than 16m, a single steel span can be used. This has the advantage of not compromising the feature's integrity and does not introduce concrete into the water. The width of the span will determine the type of steel beams (USB – universal steel beam/I-beam) required. Usually two are set about 1m apart and braced to maintain a parallel form. This also helps reduce the deflection or "bounce" that long span structures can experience. Timber sections are attached to the beam sides and tops to which the final cladding





Steel beam over clad with timber



Timber span walkway

Timber span

1. Timber decking boards min 40mm with 25mm side overhang.
2. Joists; size of joists is given in the timber span tables.
3. 300x300mm section concrete abutment. Level will be determined by the position of the steel beam over the water level.

Steel beam

1. Decking min 40mm, side overhang min 25mm.
2. M12 stud (threaded rod) galvanised and secured with washers and nuts. Set at 500–750 centres. These prevent the metal supports drifting.
3. 100x500mm timber infill. This should be drilled to fit over the studwork locking nuts.
4. 150x75x18mm UC steel beam galvanised. This should be suitable for a crossing up to 6m carrying a single pedestrian. Deeper beams are available for longer crossings or heavier loads.
5. 25mmx 150mm timber trim screwed to infill section.
6. 300x300mm section concrete abutment. Level will be determined by the position of the steel beam over the water level.

Figure 4.7 Timbers and steel spans

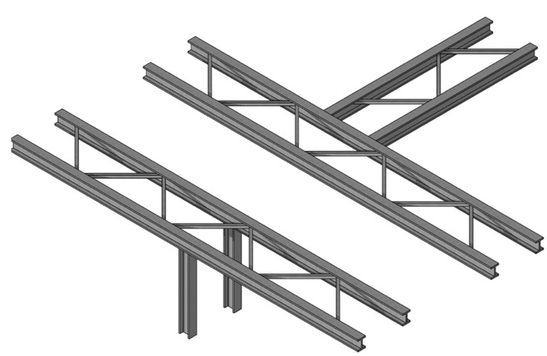
materials can be secured. Steel used in proximity to water should be stainless steel or galvanised. It is best to have regular holes drilled prior to galvanising to help secure the timber sections. This will prevent the steel rusting in situ and keep metal fragments/waste out of the water on site. The design of the bearings/abutments (concrete anchor at each end) should take into account the load imposed on the span as well as the bank topography.

Natural timber does not have the structural integrity of steel and walkways and platforms will require a substantial substructure. Engineered timbers such as Glulam are an exception, and can be treated as a steel replacement, these are used predominantly in commercial applications or for large-scale projects.

There are several species that are well suited to use in and over water: larch, sweet chestnut, Douglas fir and oak. Softwoods should be treated to class 4/5 and carry a strength class suitable for the application (e.g. C24 or equivalent).

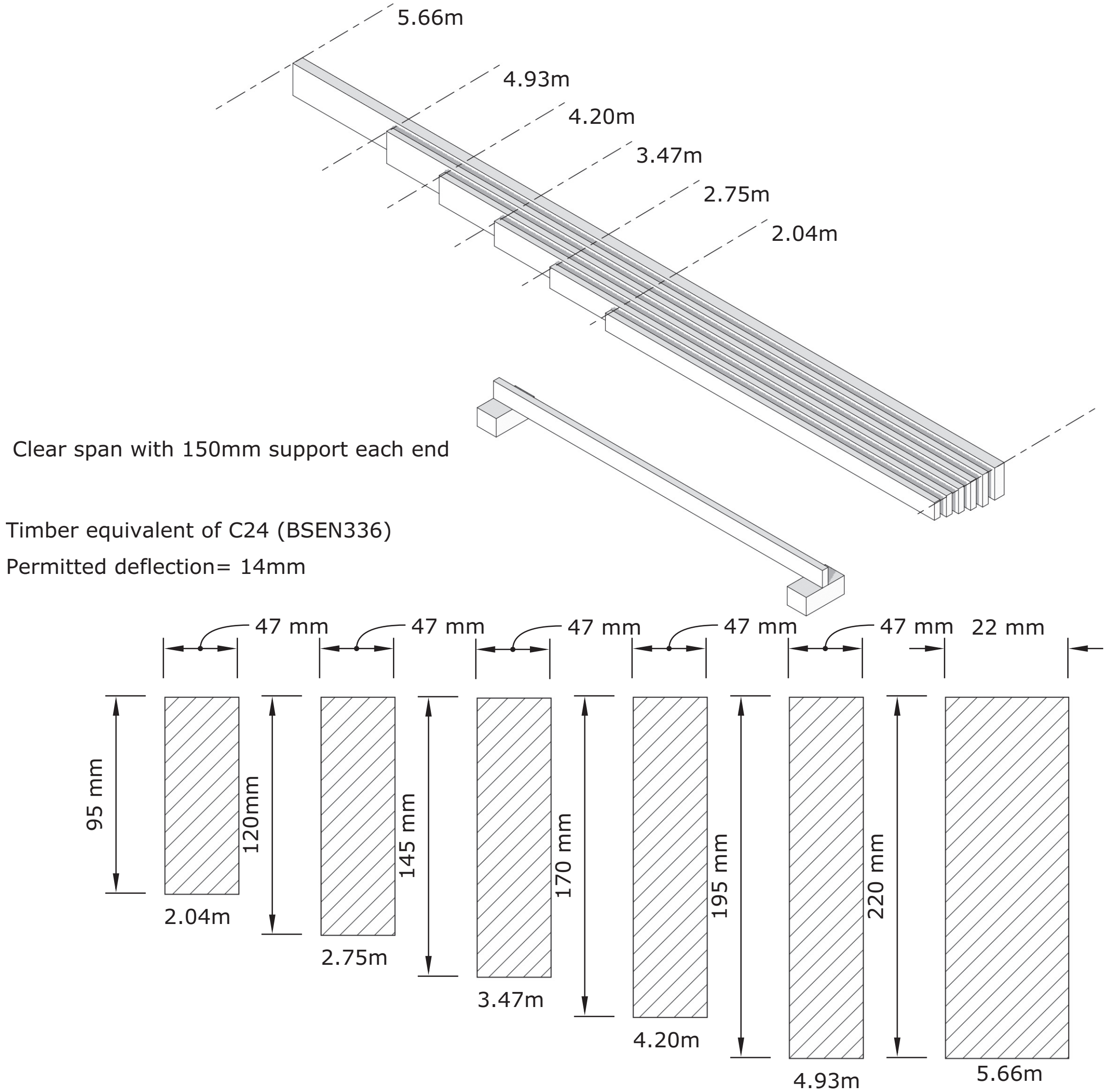
Paths and access routes are seldom level. Simple changes in levels may be resolved by steps and ramps but occasionally a more dramatic solution is required. Whilst large spans will require professional advice, smaller crossings are relatively simple to achieve and are increasingly supported by off-the-shelf solutions. "Standard" bridges should be supplied with all appropriate certification, whereas a custom bridge may require final inspection or testing. Professional indemnity (PI) cover may not extend to bridges and crossings and advice should be sought to ensure that it is permitted to design such structures, no matter how small.

A boardwalk can, for the purposes of construction and load bearing, be treated as if it was a bridge. Such low level bridges are frequently constructed of timber; driven piles, supporting beams and a decked surface. Piles for any structure need to be selected with care. Where ground conditions are favourable,



Long steel spans may require simple supports.
The junction of another structure can add strength and improve structural performance.

Figure 4.8 Steel walkways junction



Regulations:

Safety around water is a critical issue. Suitable safety features should be included that are relevant to the design and location of the water feature (e.g. a fence or handrail may be required). If the design of the feature crosses a body of moving water, the Environment Agency should be consulted to ensure that the structure does not impede any environmental areas or contribute to flood risks.

Figure 4.9 Timber spans

timber foundations are both economical and durable. They work well in areas susceptible to a high water table or where firm strata sits below a looser surface layer of sand/organic soil. Below the groundwater level, foundation timbers are slow to decay; it is the portion above this level that is vulnerable and requires the use of a preservative. Care needs to be taken in their selection. Where a structure spans water Copper Chrome Arsenic (CCAs) and creosote-based products should be avoided to ensure that there is no contamination. Where timber is given a generic UC4 or 5 classification, clarity may need to be sought on what method or chemicals have been used in the treatment of the timber.

A bridge/boardwalk may have a detrimental effect on a watercourse (e.g. forming a barrier for floodwater); guidance should be sought from the environmental protection agency (SEPA in Scotland) for any water crossings.

When considering a crossing, it is necessary to balance the needs of the site with those of the intended users. The ideal location may not ultimately be practical due to access. It is always worth designing for several locations before a final site is agreed. The location and use of the crossing will somewhat determine its design. Vehicular and equestrian access will require level paving from the access road, and banks of equal height should be sought; pedestrian routes can be more decorative and accommodate differing bank heights.

Being able to see a crossing's entire length from the approach is recommended and routes over water should preferably be on a straight section of a bank rather than on bends.

The disabilities act requires that all users of public facilities are treated equally. Whilst the act may not apply directly to a structure for private use, it does contain useful design guidance. Depending on what the bridge crosses (e.g. water), clearance criteria below the bridge might apply, e.g. canoeists.

The selection of walkway/paving surfaces should be fit for purpose for the intended users. Whilst vehicular use may not be a requirement, it is essential to anticipate such occasional unauthorised use and design the structure to either accommodate or include positive features to prevent such use (such as bollards). All surfaces should be slip and corrosion resistant. Noise attenuation may also be a factor, especially for crossings used by horses or stock animals. Whilst metal tread mesh is well suited to lightweight structures it is unsuitable for disabled access and animals. Resin bound gravels are possible over continuous surfaces and offer excellent slip resistance (such as Hi-Grip by CTS Ltd). Decking is probably the most common material. Grooved and slip resistant, exposed gaps should be set to a maximum of 12mm (5mm min) and all joints laid level, helped if heartwood is laid face down. Cross-boards are recommended, as tramlines may be both visually unnerving and a problem when wet. Water should not be allowed to gather on the structure's surface – any run-off should be managed and not discharged onto paths or highways. Where paving meets a bridge or boardwalk, the surface will wear

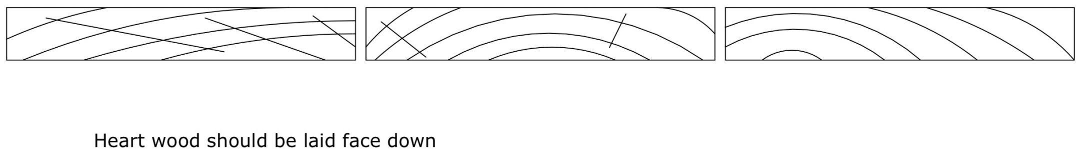


Figure 4.10 Timber decking

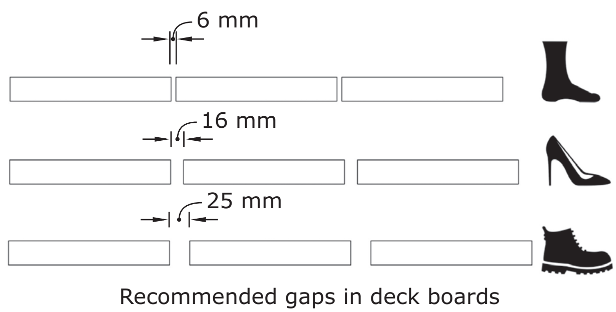


Figure 4.11 Recommended gaps in deck boards

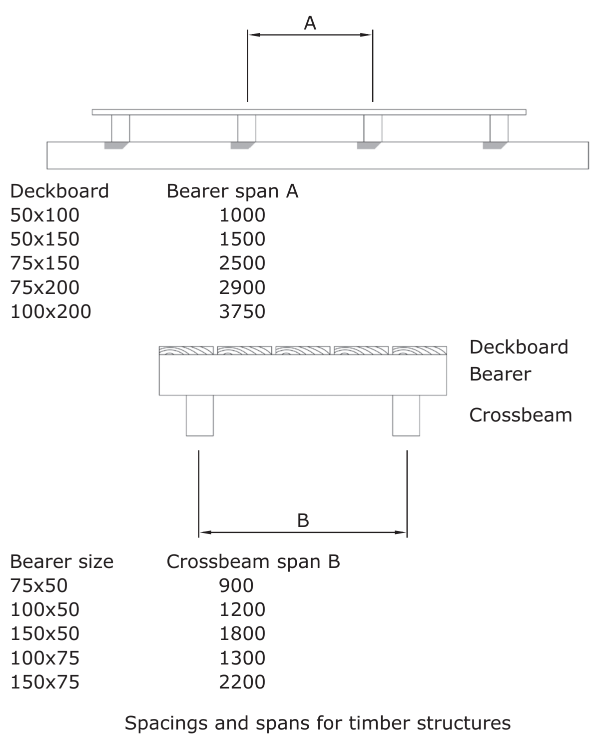


Figure 4.12 Spacings and spans for timber structures

disproportionately and it should be constructed accordingly.

Timber poles/trunks can also be used as the main beams for small spans. A maximum taper of 10mm/m is recommended. Round timbers can look good and have improved natural strength but they can be difficult to include in the overall construction and may dry out quickly. There are specific connection systems for round timbers. All end grain on structural elements should be protected by capping or sealing.

As an alternative to timber, fibre reinforced polymer (FRP) beams are very durable and lightweight. Virtually maintenance free, they are also well suited to remote locations where transport/access might be problematic. Steel, whilst the most structural suitable material is also the heaviest, with the additional burden of requiring treatment (usually galvanising or powder coating) to protect from corrosion. Timber facias can be used to disguise the main beams. Structural Timber Composites (STCs), such as Glulam, are becoming more prevalent and suit both flat and bowed bridge structures. Single spans up to 30m are possible but this will be determined by the final material and location – where possible interim supports should be included to make the bridge both stronger and more economical to construct.

Usually, the more beams used, the greater the load that can be supported. There should be a minimum of two, and using more may reduce the individual sizes required. Timber, however, can be very heavy and expensive at larger sizes; in such circumstances STCs may be a viable alternative.

Bearings (pads that facilitate movement) allow the bridge superstructure to expand and contract. For spans under 10m they are usually not required, but where there is increased vibration (e.g. equestrian use) they should be included on the foundation blocks.

Abutments (also known as bank-seats), the foundations of the bridge, are often substantial. The design of the bridge will determine their size and shape. For light

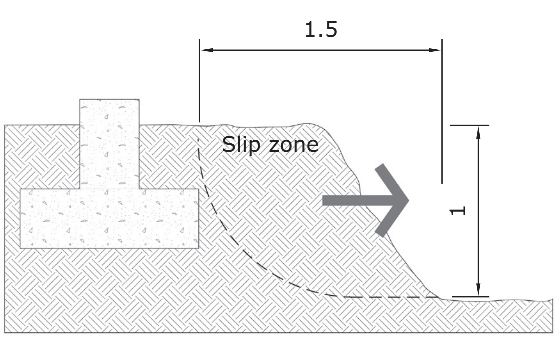


Figure 4.13 Locate abutments back from the slip zone

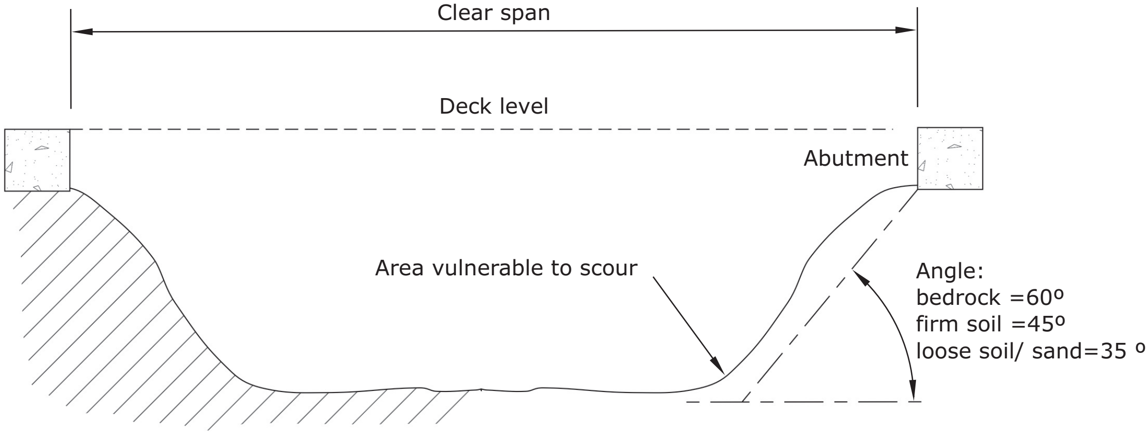


Figure 4.14 Slopeline

load bridges, the width of an abutment can be restricted to +500mm the width of the bridge. If an abutment is going to retain soil to a depth over 500mm, careful detailing is required to manage water pressure. A trail pit should always be dug to determine the soil profile.

Concrete sleepers make excellent bank seats; use only flat side down. Gabions do not make particularly good abutments but may be used to disguise any concrete surfaces.

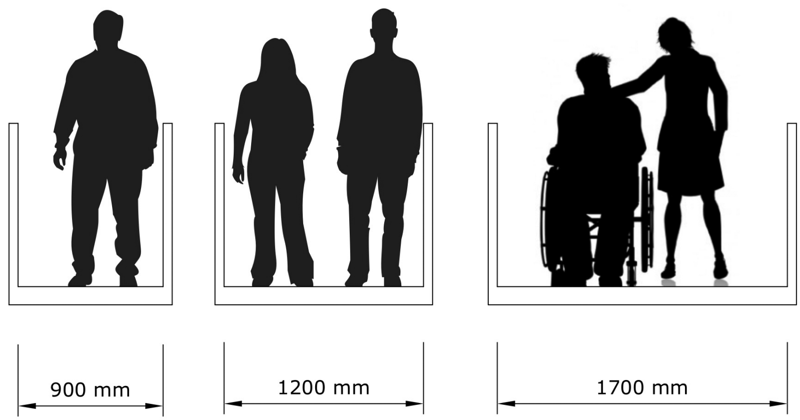
Any ramps, on either the approach or the bridge itself, should be as simple as possible; building regulations part K gives guidance on appropriate slope geometry (ideally not more than 1:20) and landings. BS 5395 outlines the design of public stairs: there should be no more than 13 risers in a single flight, each no more than 150mm with treads 300–350mm; the riser:tread ratio should be uniform.

All bridges/crossings used for public access should have parapets

Table 4.1 Bridge widths

Combined use bridges	Pedestrian path	Cycle path	Total width (min) for combined usage
When segregated by kerb not less than 50mm	1.8m	1.8m	3.6m
When segregated by railings not less than 900mm	2.0m	2.0m	4.0m
When segregated by white line or surface texture	1.8m	1.8m	3.6m
Unsegregated	–	–	2.0m (min disabled access width)
Equestrian			3.5m

Bridge/Boardwalk width (min)



Simple crossings and walkway widths for single use/route traffic
The ideal width is 1200mm. This allows for safe passage of two people, as well as wheelchair use. If the walkway has long sections without rest areas, passing places might be considered, approximately every 15m.

Figure 4.15 Walkway widths

(edge protection) and structures over water in a private garden should consider the risks associated with their exclusion. The height of these will depend on the intended users as well as the height of the bridge over the land below.

In general, pedestrians require 1150mm, cyclists 1400mm and equestrian users 1800mm. The bottom rail above the bridge surface must be 50–100mm and the gap between any vertical balustrade 100mm. Any glass used must be laminated, to ensure that it is retained in situ rather than falling off the bridge.

Bridges intended for equestrian use (see BD37 DMRB1.3.14) should have a mounting block at either end and where possible an area provided for horses to stand and wait for a clear deck. Such circumstances will require the provision of appropriate signage. In addition, safety advice and devices (such as lifebuoys) may have to be included as part of the parapet.

A jetty or landing is similar to a decked area on land and the principles of joists and noggins applies equally. Posts can be set on precast foundation slabs. Where these are used, braces should be attached just above the foundation pads to prevent lateral movement. Where ground conditions apply, timbers can be driven into the river/pool base to form the ground posts. Sweet chestnut in log form makes an ideal material, where available.

If there are any doubts about the requirements of a particular site, specialist engineering advice should be sought. Bridges and boardwalks may require planning permission and the local authority should be consulted, in addition to other interested bodies such as the

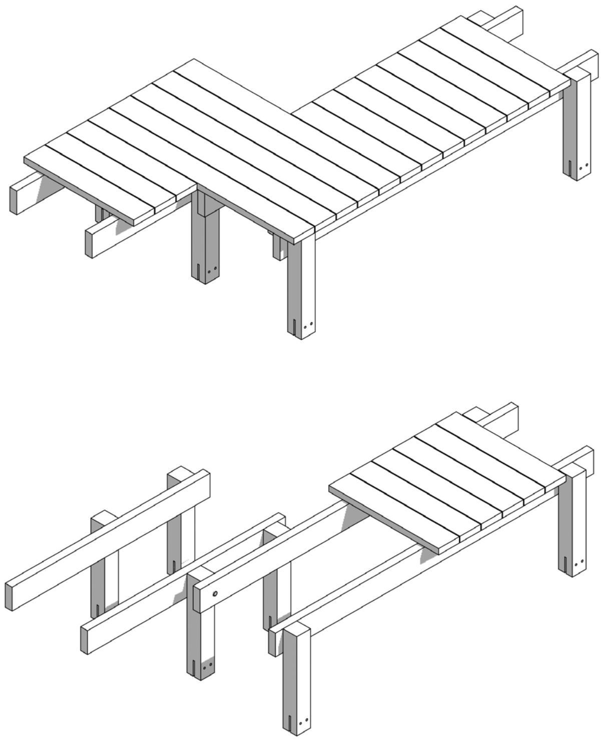


Figure 4.16 Boardwalk change of direction

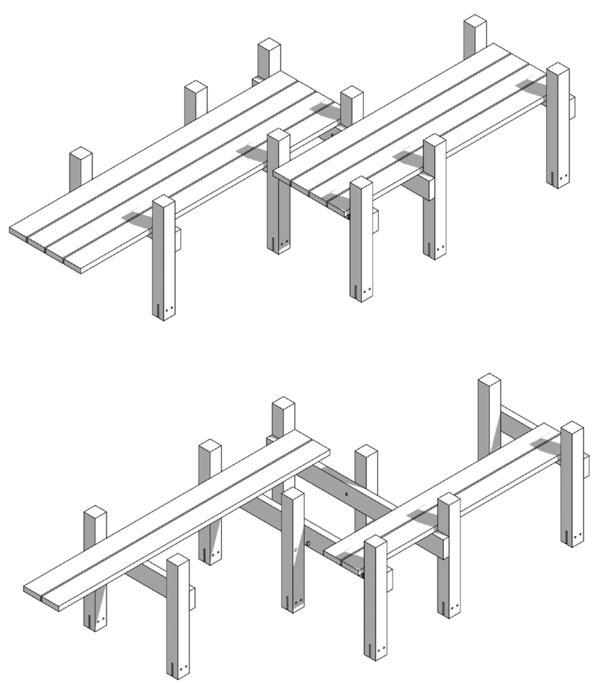


Figure 4.17 Boardwalk change of direction 2

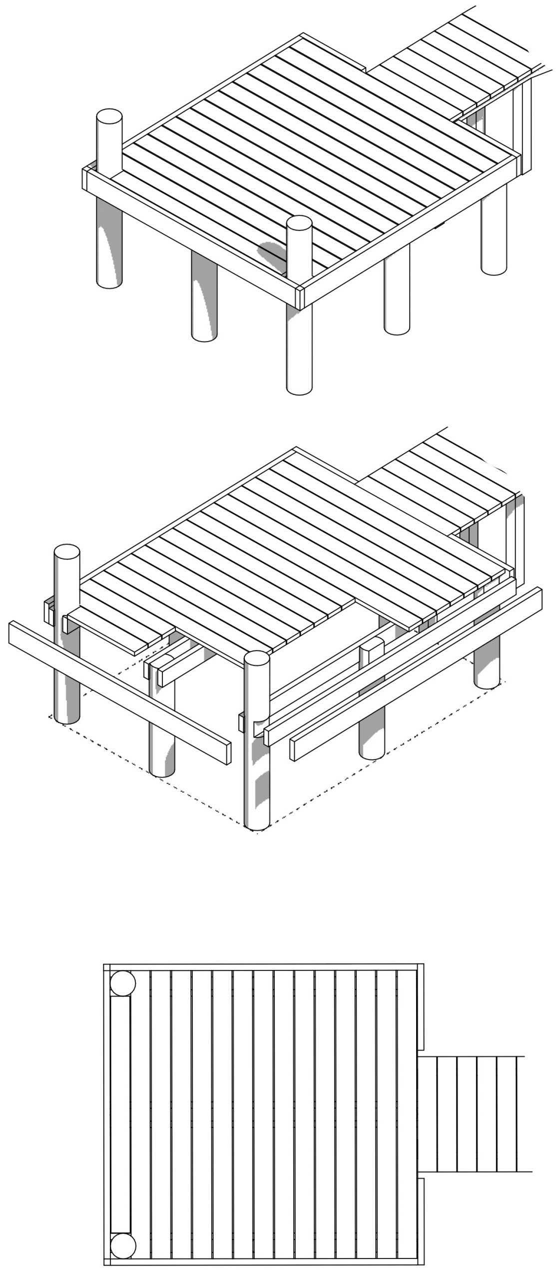


Figure 4.18 A timber jetty

Environment Agency. The designer or the agreed project manager should also assess all risks and ensure that CDM regulations are followed.

It can be logical and aesthetically pleasing to locate a water feature where there is a change in level. Steps that descend and end at a water feature,

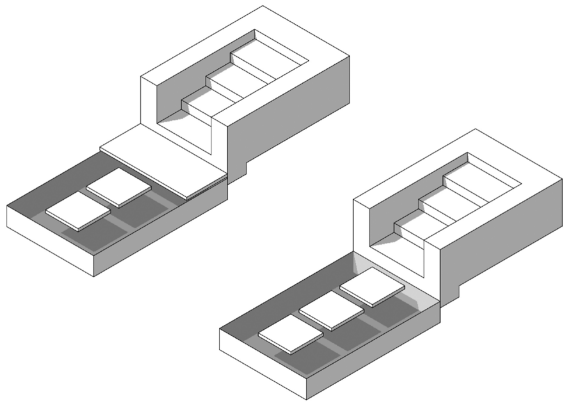
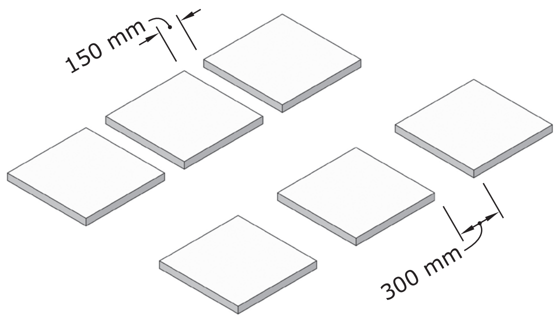


Figure 4.19 Stepping stones to steps

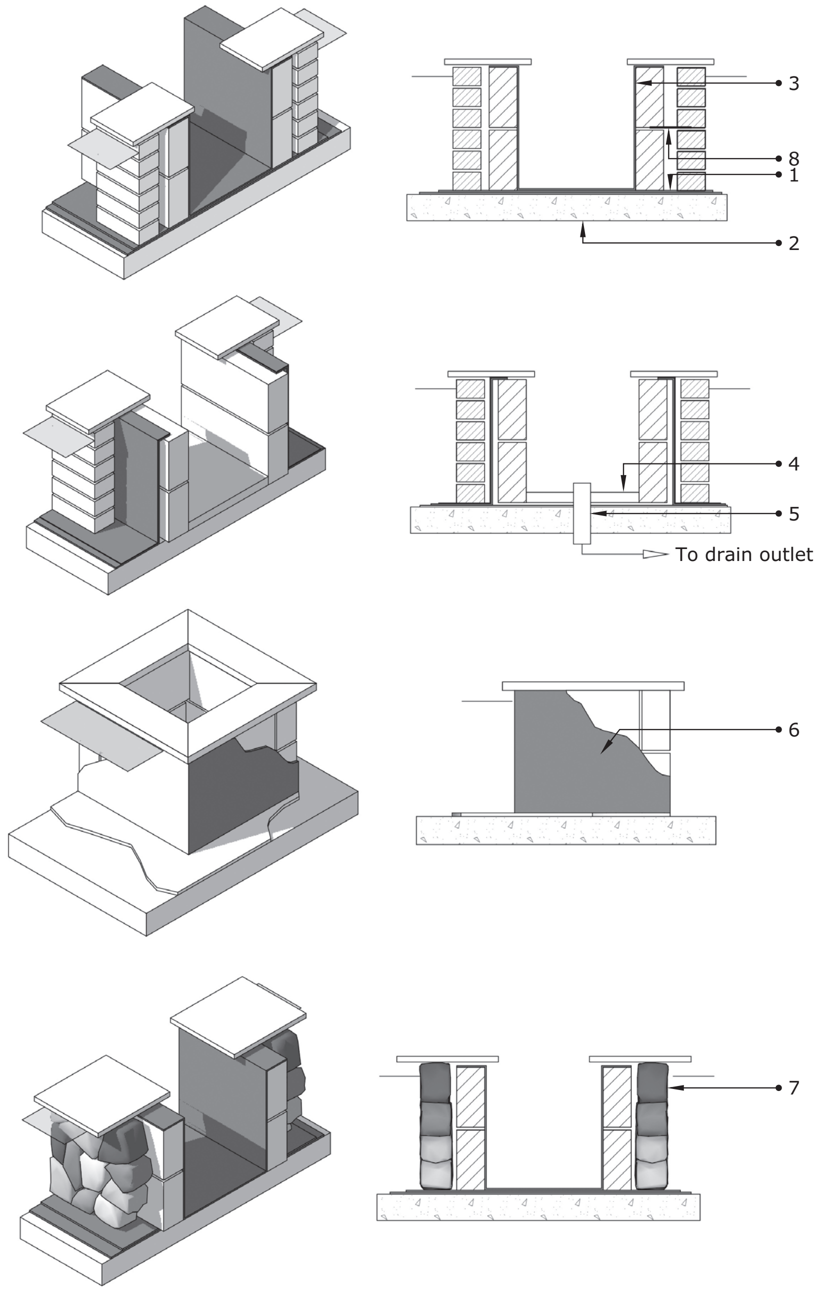


Stepping stones should be set with a gap that suits those who are going to use them – wide gaps suit taller people. There is no ideal space that is universally comfortable for all pedestrians. As a guide, the gaps should be more then 100mm and less than 350mm. Paving units of +450mm should be used and ideally +600mm. A 600mm paving slab will overhang by 25mm if a 440mm concrete paving block is used to create a square plinth (440mmm + 10mm gap + 100mm block thickness). On short runs, even an uncomfortable cadence will be tolerated, but for longer paths over water it can be useful to add stopping points where cadence can be adjusted before starting again.

Figure 4.20 Stepping stone spacing

and continue over the water as stepping stones should not be configured in a way that requires a pedestrian to move directly from the lower step onto a stepping stone. This can be an awkward manoeuvre and a little disconcerting. A better and safer design arrangement is to introduce a platform or widened step at the same level as the stepping stones that gives a firm and stable point to depart from and a wide target area to arrive at.

Creating an island within a water feature can take skill and requires early consideration in the design. It is possible to add planting beds into water features after they have been built but their success will depend on how the original pool was waterproofed.



1. Additional layer of liner and geotextile
2. Pond cast base
3. Internal waterproofing for planter (e.g. box welded liner/GRP/Pond sealer system)
4. Gravel drainage layer 50mm
5. Drainage pipe +40mm diam with geotextile filter cover
6. Two-coat render, sealed with pond sealer and paint system
7. Stone cladding
8. Stainless steel wall ties.

Figure 4.21 Planted islands

Where a planting bed or island is built over an existing waterproof surface, an additional covering of liner and geotextile is necessary. The walls should be built directly off this surface. Whilst they will not be in contact with the concrete base of the pool, their own weight will keep them in place. Whilst mortar can be used below water level, there are several adhesives that will bond masonry even underwater. The internal cavity of the built bed should be waterproofed. Larger planting beds can benefit from a box welded liner, one made to the exact three-dimensional shape of the bed. This can be fiddly for small planting pockets. GRP or a pond sealer might be more convenient.

A planted bed created at the time of the pond can be raised off the base of the pond and the pond waterproofing taken around the planter walls. This would suit a GRP-lined pool or one where a flexible liner is welded to shape. A consideration for planted islands within a pond is drainage. Left undrained, they can retain water and saturate the roots of the plants. This will cause failures if the planting is not suited to such conditions. A drainage hole would need to be incorporated at the time the base is cast (e.g. with a pipe). Ground conditions under the pond may force water up into a planter. Where there is a likelihood of this, the best solution is to connect the base drain of the planter to its own outlet. The drainage pipe should not be connected to any sub-base drainage channels.

CHAPTER 5

Rills, channels and cascades

A rill is a shallow stream or channel. They can be curved as well as linear and of any length. Unlike a pond, a rill is primarily concerned with moving water and it is the rill itself that is the feature. The rill has its roots in ancient metaphor and remains a potent and dynamic device even within the smallest space.

Water in channels may move with energy and vigour, creating noise and acting as an animated guide, or be silent and used as a division between spaces. Water may be diverted away from a visible sight line only to reappear further along a route, adding drama and a juxtaposition.

Rills and channels offer themselves to interaction, thirsty dogs and children wanting to float toys and play pooh sticks. Far from a simple narrow channel they offer experiences and, unlike more singular, isolated water features, the rill is something that encourages direction and therefore repeats and reinforces its presence in a way that only a stream or river can. They are essentially artificial streams.

The design of a rill will be informed by:

Rill length

Water entry

Depth

Material and aesthetics

Speed of flow required.

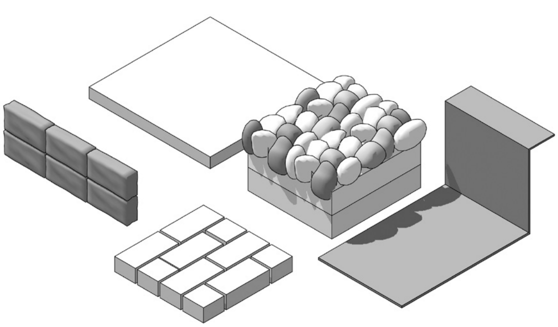


Figure 5.1 Materials

Table 5.1 Falls to the rill base

Internal rill finish	Typical fall	Actual fall over 5m length
Smooth: metals, porcelain	1:80	62mm
Sawn stone	1:60	83mm
Riven stone/brick	1:40	125mm
Pebbles/cobbles	1:20	250mm

Actual fall will be determined by the material, the method of laying and the required speed of the flow through the rill

The construction of a rill is determined by how it needs to look. Rills are rigid channels, in almost all cases a reinforced cast concrete base is necessary to prevent movement, cracks and loss of the structure's integrity. This also provides a firm foundation for the construction of the sides and support for any copings or edging. The depth of a rill can be used to control the visible effect of the moving water. Deeper rills will be slower and less dramatic than a shallow feature. The depth of the feature should be a function of the size (module) of the intended facing material. A brick-lined rill, for example, might use units on end (sailor coursed) for the sides and flat (stretcher coursed) for the base. A deeper rill might utilise additional brick courses, but perhaps laid flat on the side faces (stretcher coursed) to give a less dramatic incremental height increase.

Where large format facing materials are used (e.g. tiles/**porcelain paving**) these would require cutting to suit).

Where no liner is used, any mortar, adhesive or concrete should be waterproofed with additives (e.g. Sika ® Watertight Concrete System). Any joints in the concrete base must also be made watertight.

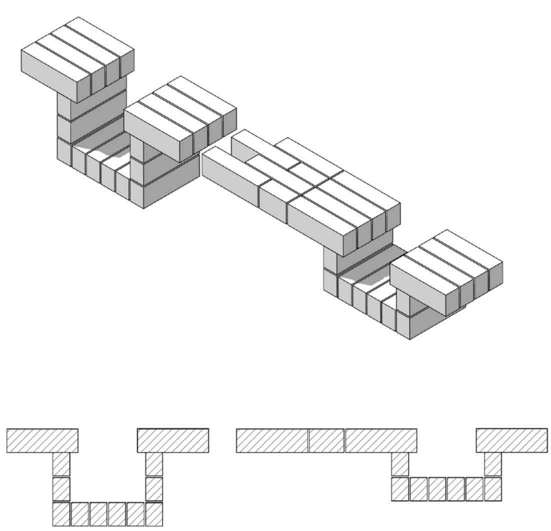
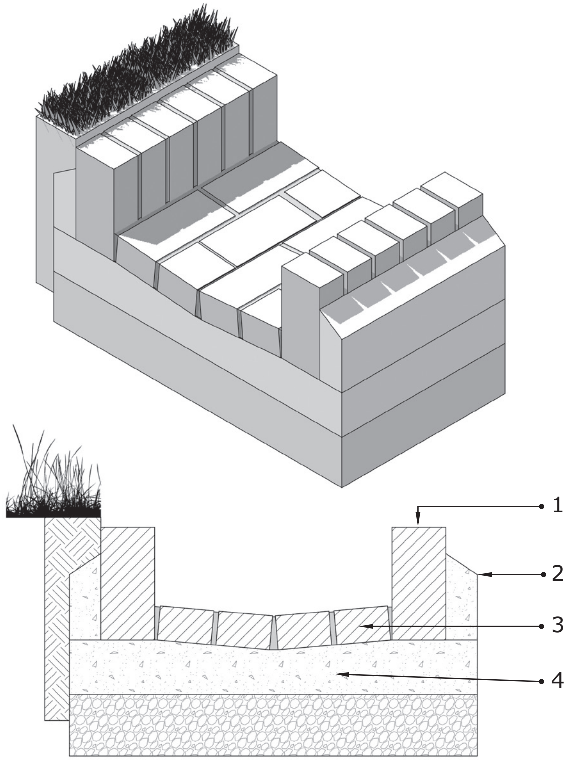


Figure 5.2 Rill depth

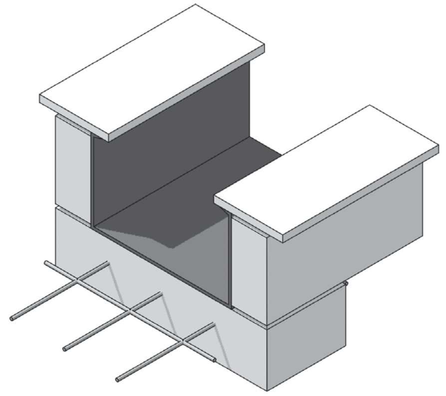


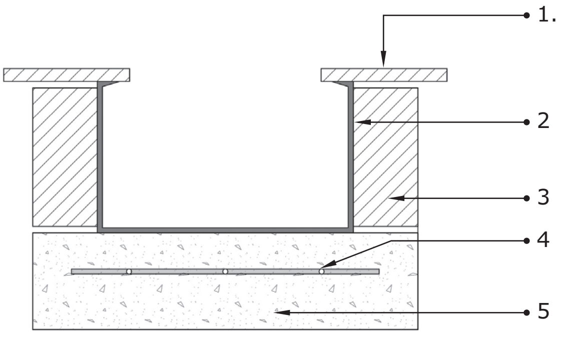
1. Brick edge (sailor course shown)
2. Concrete (C15) haunch to min 50% height of edging
3. Brick clad base, shown laid concave which will speed up the water flow
4. Reinforced concrete base (RC25) min 150mm, over DTp1 aggregate base.

Figure 5.3 Open brick rill

GRP (fibreglass) waterproofing systems are very adaptable and resilient. They work very well in rills and especially where a rill changes direction or is curved. The process requires the lamination of a resin and glass fibre mat over several courses. The final layer is where a coloured agent is added to give the final finish. Fibreglass can be added over most surfaces and masonry units such as concrete blocks and render to provide a robust substructure. GRP will pick up on any underlying bump, stray mortar or unwanted characteristic and its presence will be evident in the final coat. It is necessary to ensure that the surface it is applied to is smooth and free from blemishes. Whilst GRP can be applied directly to concrete block work, a render is frequently applied first to smooth the surface. A render becomes necessary where a curved rill is formed from flat-faced block work, removing the resulting facets.

The ability of GRP to adhere to most types of material allows it to be brought to the top of the rill and laid to the





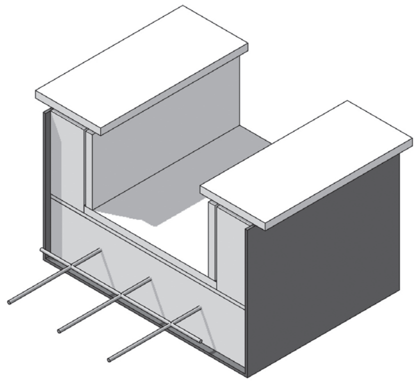
1. Surrounding paving
2. GRP (glass fibre). This may be laid over a mortar render
3. Supporting block work 7.3kN 100×440×215mm
4. Reinforcing (set min 50mm from the final edges and surfaces of the cast concrete)
5. Cast in place (CIS) concrete base RC25.

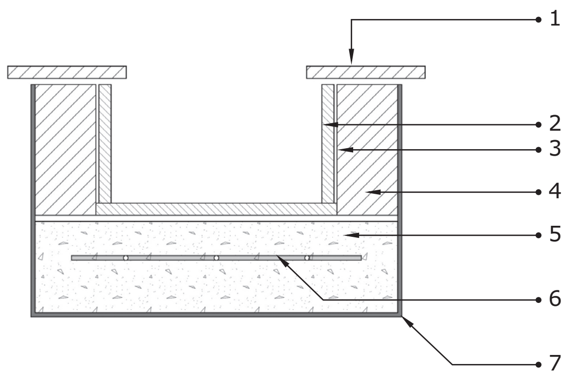
Figure 5.4 GRP lined rill

underside of the surrounding paving. GRP can be coloured to suit, although dark grey and black are currently the most popular.

A rill might be in contrast to the surfaces that surround it or it can be designed to complement or even copy those surfaces. Porcelain (vitrified) paving is a widely available material for paving. Typically 20mm thick and with an ever expanding range of styles it has very low water absorbency, making it ideal as a lining material for rills and ponds.

It should be laid over a solid concrete base. The characteristics that make porcelain such a good material for water features have a downside in that water-based adhesives such as mortar will not bond to them. It is necessary to add a bond bridge to the underside, prior to installing. This is effectively a primer

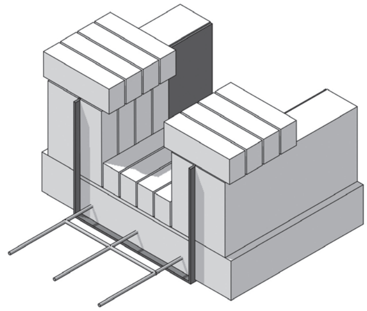


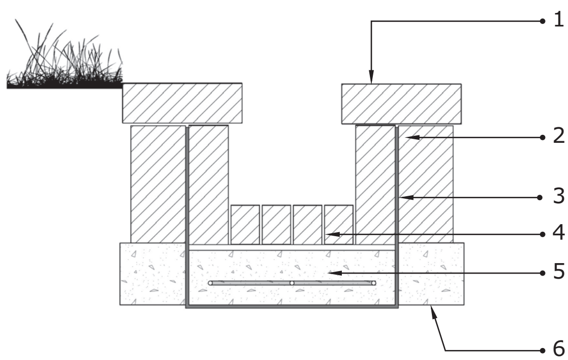


1. Paving material, this may match the porcelain tiles used in the rill.
2. Porcelain paving units 20mm thick cut to suit required rill depth. The rear of the porcelain must have a bridge bond added (e.g. SBR slurry coat) to secure it to the tile adhesive.
3. External waterproof tile adhesive (there are many suppliers e.g. Ardex, Bostik, Mapai).
4. Concrete block work supporting wall 7.3kN 100×440×215mm.
5. Cast concrete base RC25 150mm thick.
6. Reinforcing 50mm min from all faces.
7. Waterproof liner (e.g. EPDM) over a geotextile (220gsm).

Figure 5.5 Tile lined rill

that will adhere to the porcelain and allow other materials such as mortar to adhere to it. There are many products on the market, the tile supplier will be able to give their recommendation. The tiles should be attached to the vertical sides using an external waterproof tile adhesive, These are usually applied with a notched trowel to ensure a consistent thickness. A good high performance grout is a critical component which will retain water within the rill body. A waterproof membrane (such as EPDM) is not always necessary but it is a low-cost item that will ensure the feature remains watertight.



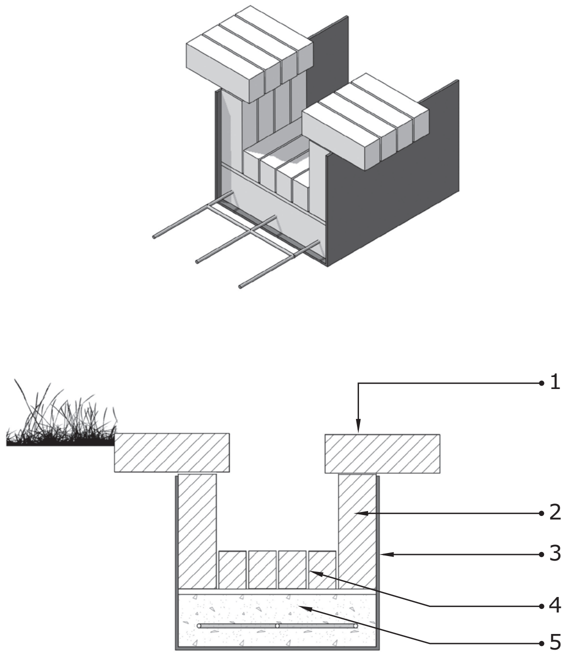


1. Coping or adjoining paving
2. Concrete block work 7.3kN 100×440×215mm
3. Flexible waterproof membrane (e.g. EPDM)
4. Material of choice to line rill base
5. Concrete cast base RC25
6. Concrete strip foundation for external block work C10.

Figure 5.6 External block support wall

The waterproof liner does not always have to sit outermost in the constructed layers of a rill. It can in some circumstances be used to waterproof a channel that has been excavated and then lined with block work. A concrete base is set over the liner and the material units built up off this. This method does not suit porcelain tiles which would not adhere to the liner. The sides could be left with only the liner and a material such as brick, cobbles or even porcelain tiles laid over the base, supported by and adhered to the concrete.

Where ground conditions are suitable, the effort and expense of a rill can be reduced to a lined trench with a simple internal construction. This does introduce the risk of the side walls moving or mortar joints cracking but where the rill is built into a paved surface the supporting material is likely to be DTp1 aggregate and in most cases will add sufficient support.



1. Coping or adjoining paving
2. Concrete block work 7.3kN 100×440×215mm
3. Flexible waterproof liner (e.g. EPDM) over non-woven geotextile (220gsm)
4. Material of choice to line rill over base
5. Concrete cast base RC25.

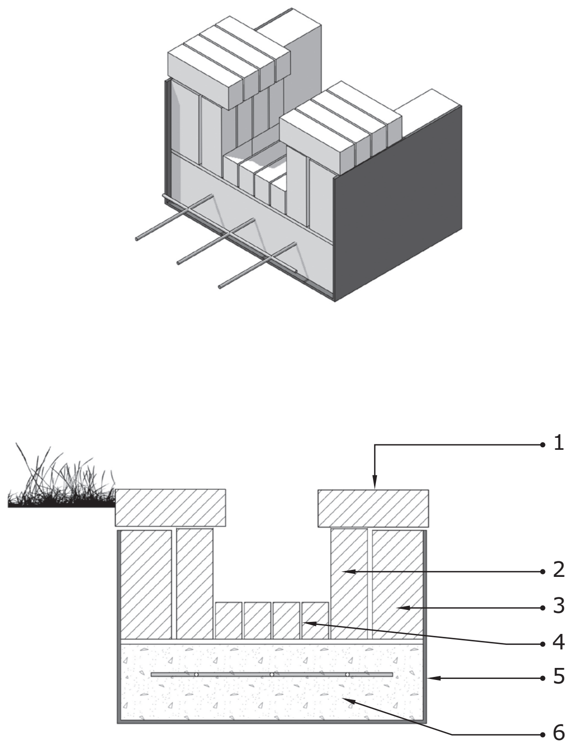
Figure 5.7 Base only rill

Some ground conditions will require a robust rill structure. A primary waterproof membrane is set into the excavated trench over a non-woven geotextile and the primary base cast in concrete with reinforcing. This extends sufficiently to accommodate an external support wall as well as the internal dressing face.

RILL CIRCULATION

A rill set above or below ground level can use several methods of water circulation. Water within a rill, if it does not support wildlife or feed into a larger water feature can benefit from a chemical treatment, in the same way that water bowls and fountains can to maintain clarity and water safety.

A simple recirculation system would be sufficient. Water is discreetly added at one end of the rill and pulled from the other. The pump would have to be located in an adjoining chamber so that it was not visible but this permits electrical supply and overflow to be also located away from the rill. Typically, such chambers are placed at the end of a rill, but can be positioned anywhere – within a paved area for example.



1. Coping or adjoining paving
2. Flexible waterproof liner (e.g. EPDM) over non-woven geotextile (220gsm)
3. Concrete block work 7.3kN 100×440×215mm
4. Material of choice to line rill over base
5. Waterproof membrane (e.g. EPDM) over non-woven geotextile (220gsm)
6. Concrete cast base RC25.

Figure 5.8 Internal support walls

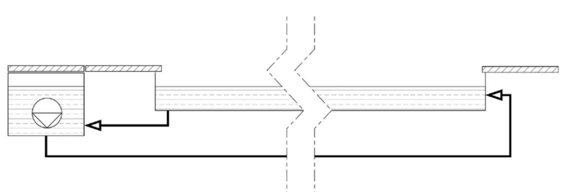


Figure 5.9 Simple rill circulation

The inspection chamber can be wet or dry, depending on the type of pump used. Where a wet chamber (sump) is created the structure will have to be waterproof. Standard plastic chambers are available that should suit. The chamber should have an access lid and therefore a 600x600mm recessed cover would be logical. The pump must be located below the rill water level to work effectively. The pipe connection in and out will be the same as are used in pond wall construction and pipe access (see Chapter 3).

An alternative circulation system is to have a sump within the rill at each end. These lowered areas allow the pump to be housed out of sight and the outlet to be lower than the main body of water, effectively acting as a drain. The pump would remain visible within its sump unless there is a disrupted surface above the pump such as that created by a cascade. The pump can be easily covered with a simple perforated metal grate or mesh over which are stones or pebbles.

The size of pump for a rill will be determined by the volume of water in the system, the speed at which the water is intended to flow through the rill and with consideration of friction that the facing materials will introduce. A rill lined with cobbles will require a higher flow to compensate for the turbulence created by the rough stone base. Water that takes an hour to circulate will move slowly and create a calm flat surface. Water that only takes 5 minutes to circulate will be faster moving and can be more turbulent.

Example

A rill with 250mm water depth, 400mm wide and 5000mm long = 0.5m^3 = 500L

+100L in the system = 600L

A minimum flow of 1000L/hr should be considered.

These values are intended as a guide and the design of the rill and materials used should inform the designer of the pump size required.

Whilst external feeds can be used to bring water into a rill, it can itself be used to move water into a large body of water, whether a large pond or as the head of a cascade or waterfall. The design principles remain the same although care

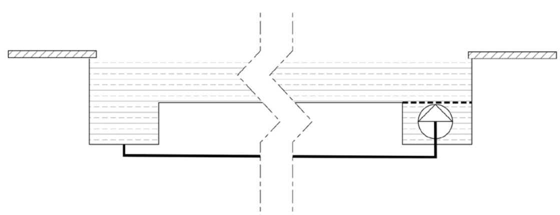


Figure 5.10 Wet sumps for pump

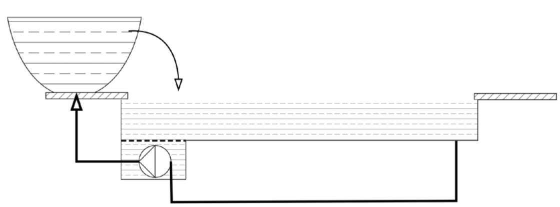
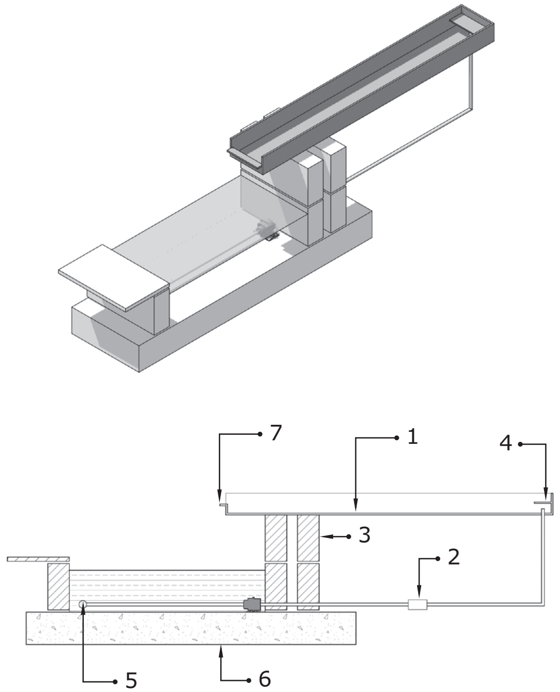


Figure 5.11 External refill



1. Rill
2. Non-return valve
3. Constructed wall to support rill end
4. Water entry diffused
5. Inlet pipe cover
6. Cast in place concrete base RC25
7. Weir/edge of rill.

Figure 5.12 Metal rill no sump

should be given to the spill-way or lip over which the rill empties. The rill should not have a simple flat exit. This would allow all of the water to drain out directly and there would be a minimal film over the base of the rill. Holding back a depth of water will create a contained volume, a weir, which in turn enhances the presence of water. Should the water feature ever be switched off this will prevent any feature lower down the system from becoming overwhelmed. There must also be a non-return valve on the outlet side of the pump.

A metal rill is shown lying at ground level but spilling over into a lower water body or pond. The water dropping into the pond will create a broken and mostly opaque surface and so a pump can be positioned directly underneath to disguise its presence. Water should be drawn into the pump from the furthest point to try and establish a cross-flow through the pond, with the intention of eliminating and reducing areas of unmoving or stagnant water. The cascade from the rill will oxygenate the water and this can be used to

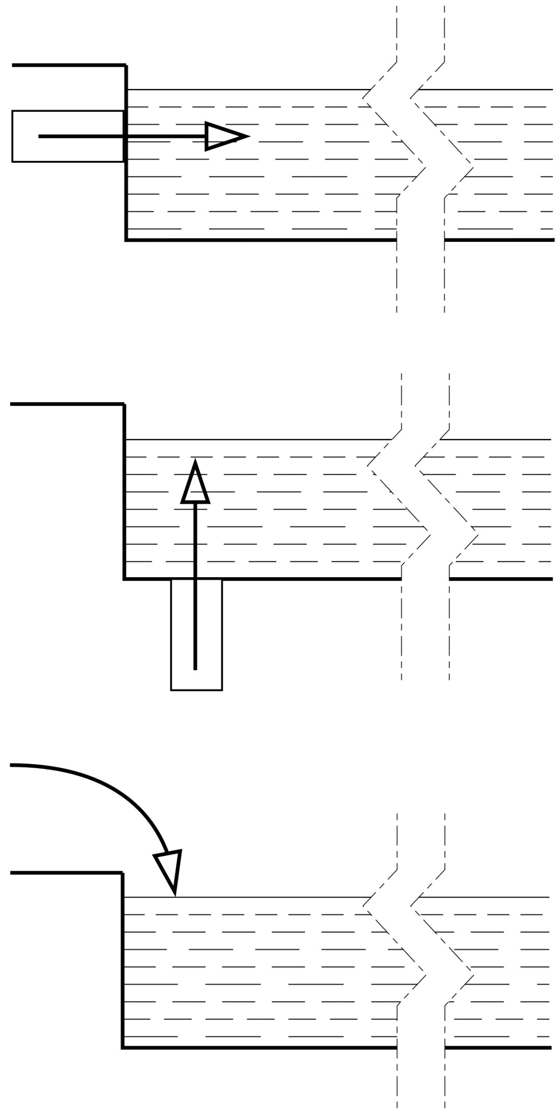


Figure 5.13 Water entry options for rills

support wildlife and plants if required.. The pump returns water to the head of the rill. If the vertical distance from the surface of the water where the pump is located to the outlet point is greater than 1.0m then the pump specification must be increased to take account of the effort required to raise water to the required height. There should be an inlet cover within the pond and a non-return valve on the outlet side to ensure that the water volume contained in the rill does not flow back into the pond. Left as a simple pipe outlet, water entering the rill may create an unwanted effect, such as a spout or turbulent flow.

A diffusing device will create a calming effect on the water and the rill will fill quietly and calmly. There are numerous ways to diffuse the energy of water, from bespoke caps to simple, custom-made plates.

The introduction of a sump at the point of entry for a water feature, whether a rill or a pond, can have a significant impact on the way water responds and behaves. A sump is a useful location to site a pump. It can be covered with a grate or perforated sheet and a large unit material such as pebbles laid over that for even greater discretion. The sump will also be the lowest point of a water feature and water will naturally accumulate if and when a feature is drained for maintenance. This makes emptying a pond considerably easier. A sump locally adds depth to a water feature. Water entering a shallow feature will generate more noise and splash than when it encounters a deeper basin. The splash in particular, can give an almost perpetual wet look to the surrounding materials which may be in stark contrast to those same materials where they are beyond the splash zone.

Where a pond or rill has no space or possibility to economically or physically include a sunken sump then an external chamber should be considered. This is frequently located at the end of a rill or local to the outlet. It can be either a wet/flooded chamber with a direct piped connection to the rill or receiving pond or it can be a dry built chamber if the

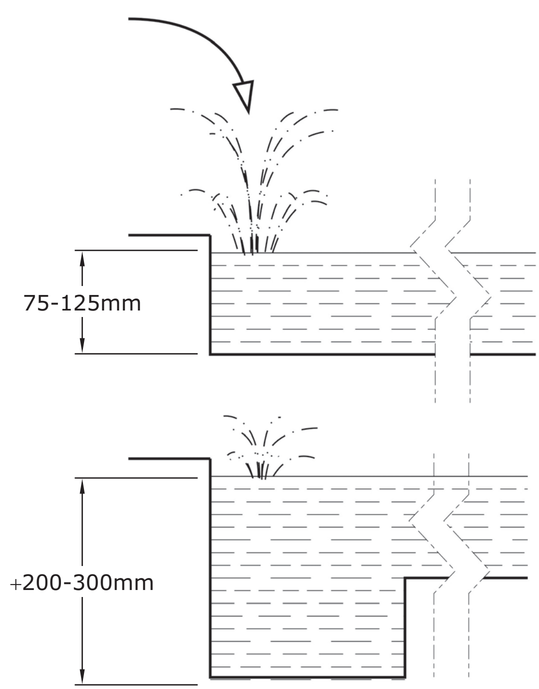


Figure 5.14 Water entry sump depth

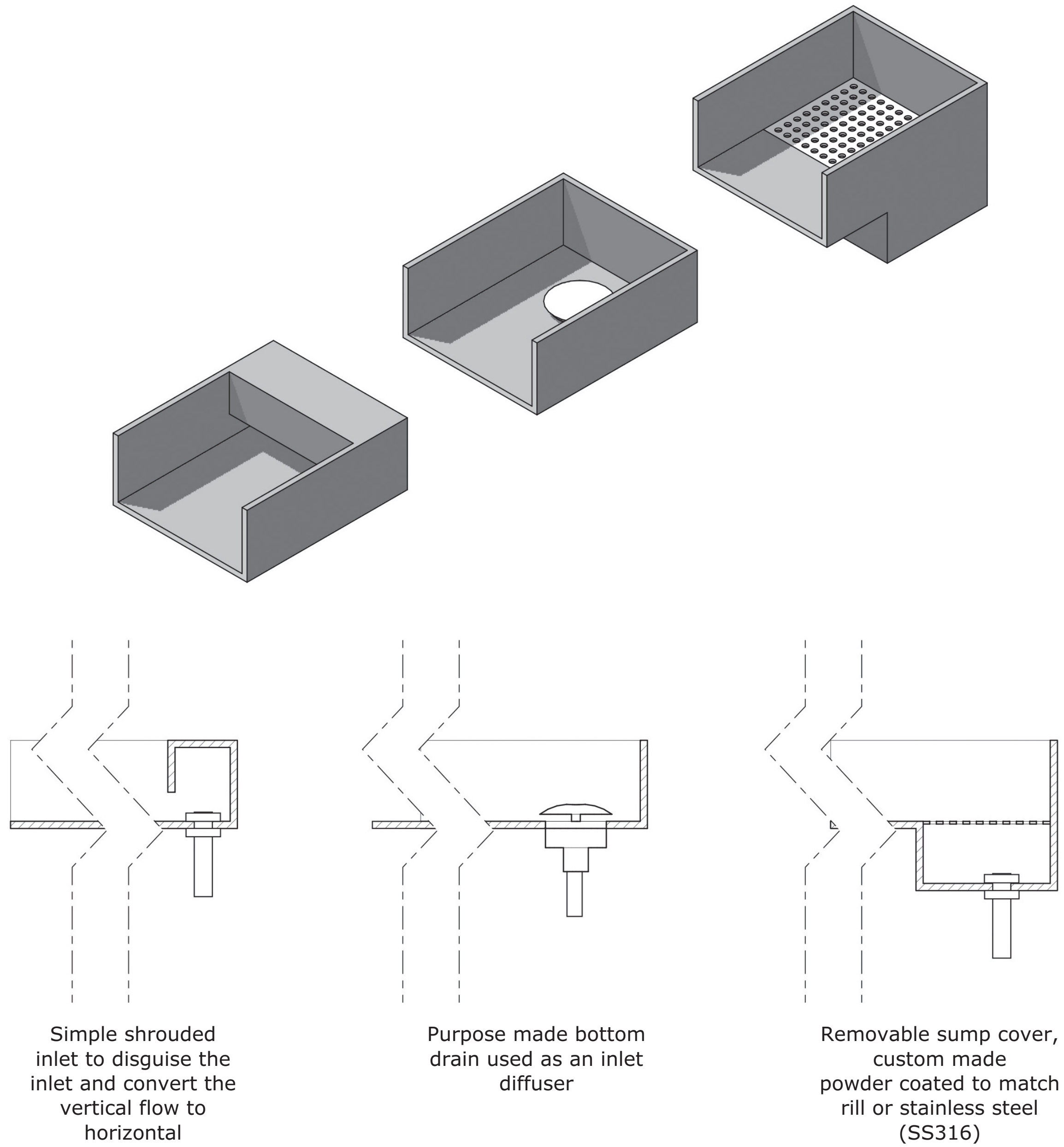


Figure 5.15 Metal rill entry diffusers

specified pump is designed to run without being submersed. The consolidation of all of the hydraulic components into a single chamber can be useful, overflow, pump, electrics etc. for servicing and simplification of the construction detailing.

CASCADES

A cascade can mean many things. To some it's a waterfall, others a sheet of falling water, sometimes vertical other times descending from one tier to another.

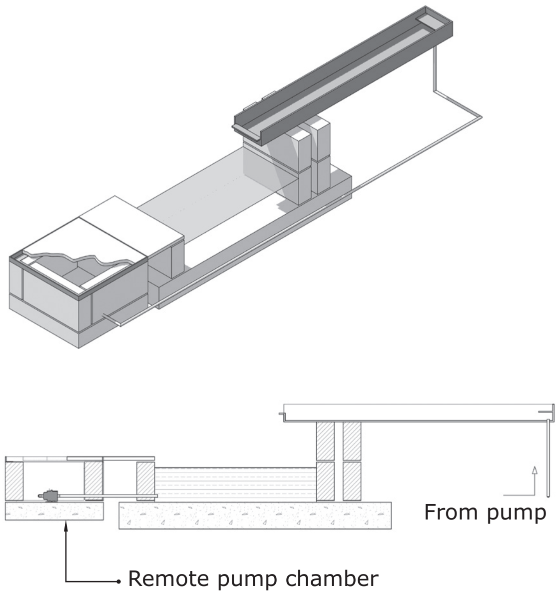


Figure 5.16 Metal rill with external chamber

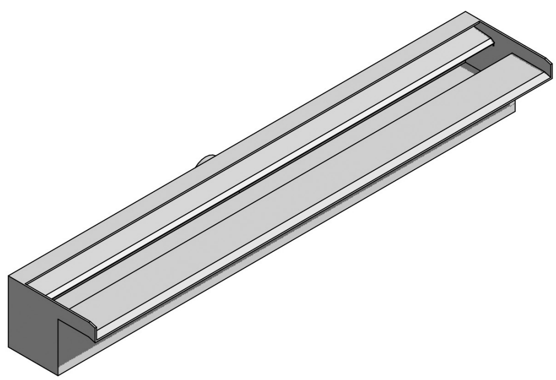


Figure 5.17 Water blade

In all cases a cascade invariably relies on gravity and probably creates a stream of water in free-fall.

Water blades are a convenient and simple way to generate a cascade. Controlled, predictable and effective. They are available in wide range of sizes and can be added to almost any style of feature from a naturalistic stream to a contemporary water wall.

Water blades, sometimes called troughs, are usually fabricated from stainless steel (SS316) and offered in incremental sizes of approx. 300mm up to about 1200mm. After this the hydraulics can be difficult to manage and either a custom made unit is required or multiples of smaller units can be aligned. Small troughs have a single water connector; the larger units can have up to three. The connectors can be through the base or on the rear wall and the orientation of the water feed should be determined before they are purchased.

In cross section a water blade consists of a series of baffles which calm the incoming flow. By the time the water arrives at the actual blade the water is flat and with little turbulence, spilling over the blade it will create a sheet or curtain of water. Simply adding a water inlet to the rear of a **wet sump** at the head of a water wall or behind a horizontally laid slab is unlikely to result in the desired effect. There may be too much energy in the water and this will create a turbulent flow. This can be satisfactory for a naturalistic stream but will not create a smooth curtain.

CALCULATING THE SIZE OF PUMP FOR A WATER BLADE

A simple formula helps in establishing the approximate flow of water required to achieve a pleasing cascade.

1000L/hr for every 100mm of water blade length

e.g. a 900mm water blade will require a minimum of 9000L/hr pump.

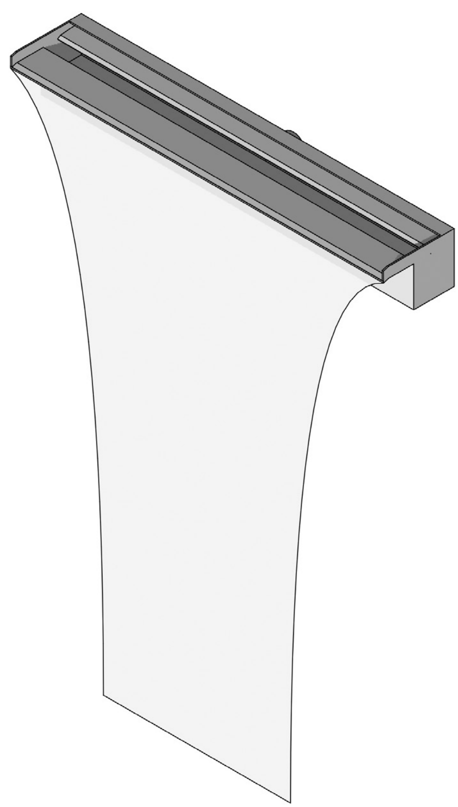


Figure 5.18 Water blade funnelling effect

The flow rate is usually much higher than expected. Without such a high flow the water curtain will start to break up and there may be areas where water does not flow.

The value of flow rate given by this formula will suit blades that are set to a maximum of 1.0m above the water level containing the pump. Greater heights (head) will require a higher specification pump. The pump specified for a cascade should have an integral regulator or be designed to allow regulation through a **gate valve** in the water line. It is not until a system is switched on that the appropriate flow rate can be fine-tuned.

As water falls from the rim of a blade towards the base reservoir or pond, it will narrow. The amount of the constriction can be as high as 50% of the initial water cascades width. This phenomenon can be calculated (apply Conservation of Energy), however it is simplest to appreciate the effect and account for it in the design. Water can be made to fall without this effect. It requires a larger flow of water and so the pump specification must be increased (where such an effect is required the preferred pump manufacturer will be able to give advice).

Whilst most water features should run 24/7, a water blade can be an exception. The noise generated from the cascade can be considerable. What might be acceptable during the day amid background noise can prove an irritation when things are quieter at night. A sheet of water can also be influenced to a remarkable degree by wind. The water will move like fabric and unless the catchment

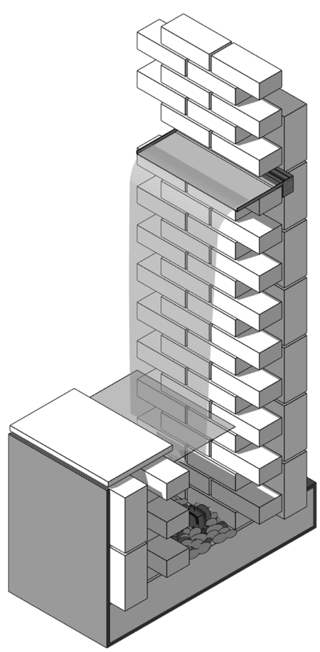
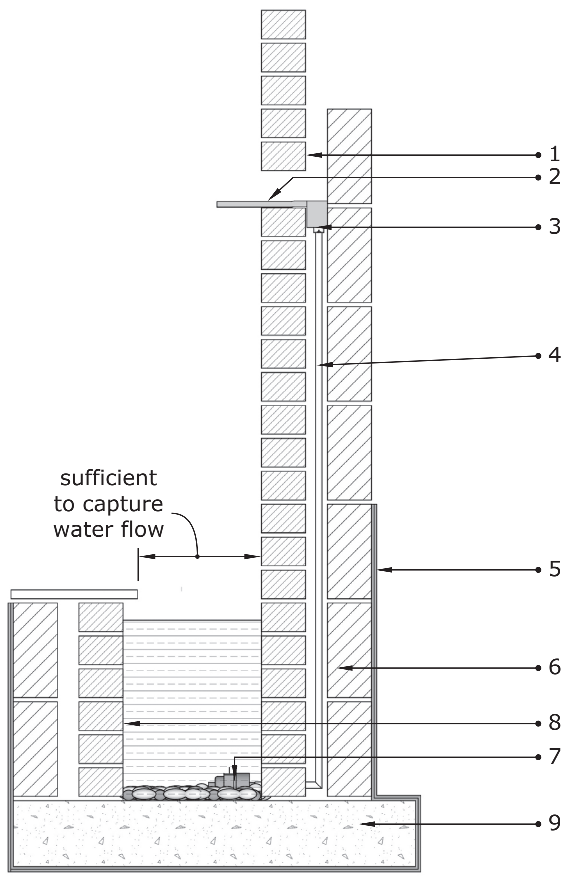


Figure 5.19 Simple cascade

area is quite large the water may land outside of the feature. Overnight and in windy weather a water feature with a cascade can empty itself.

A simple water blade cascade can be built alongside an existing structure or created as a freestanding entity. The height of the water curtain is a matter of choice but wind conditions should be taken into account and the height and/or the reservoir adjusted to accommodate the anticipated movement of the water. The water connection into the blade will be determined by where the blade unit is located within the construction. If it sits within a wall cavity



1. Facing material. This must be suitable for use in contact with water; e.g. bricks must be F class.
2. Water blade lip. Use an extended lip to keep the edge away from the facing material.
3. Water blade water connection, base or rear to suit.
4. Water inlet, the pump specification will determine the pipe bore.
5. Waterproof membrane (e.g. EPDM over a non-woven geotextile 220gsm).
6. 7.3kN dense concrete blocks.
7. Pump.
8. Facing materials set below water level. Ensure materials and mortar are suitable for use in contact with water.
9. Concrete base C25.

Figure 5.20 Simple cascade section

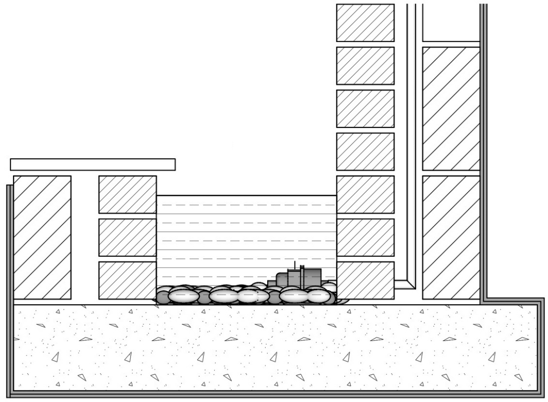


Figure 5.21 Simple cascade shallow sump

it can have a water-feed into its base. However, depending on the material used for the external facing wall, a standard depth lip (50mm) will not reach past the supporting wall face. Blades are often available with an option for a deeper lip (130mm) and this will usually be sufficient. Where deep facing materials are used (e.g. natural stone) it may have to be locally cut to accommodate the blade if the lip does not extend beyond the external face. The water curtain should enter a reservoir. Shallow reservoirs are likely to create greater splash than deeper water bodies. The reservoir is a convenient location for the pump to be located and once the pump is specified, the reservoir should be sized to accommodate it. The turbulent water surface will disguise the pump's location. An external chamber can also be used to locate the pump and the associated electrical connections. Any ornamental water body should have an overflow including reservoirs for a cascade, no matter how small.

A reservoir depth of two concrete blocks will hold sufficient water and depth for most sizes of blade length. A shallow reservoir may suit smaller water blades, but is unlikely to have sufficient volume for larger sizes. A non-return valve is essential in the outlet from a small reservoir, the water in the system can overwhelm it when the pump is switched off. A test should be carried out to help determine the most suitable depth for any given blade configuration.

Often a cascade is part of a larger waterscape, the feed for a rill or a pond. The reservoir receiving the water curtain can be made to spill by the simple addition of a spill-way set into the paving or a recess in the separating wall. This can be made from folded metal, or paving units set at the required water level within the reservoir. The pump can be set in either the reservoir or the pond but the water it draws must be from the pond volume. As described previously, the pump itself can be located within a

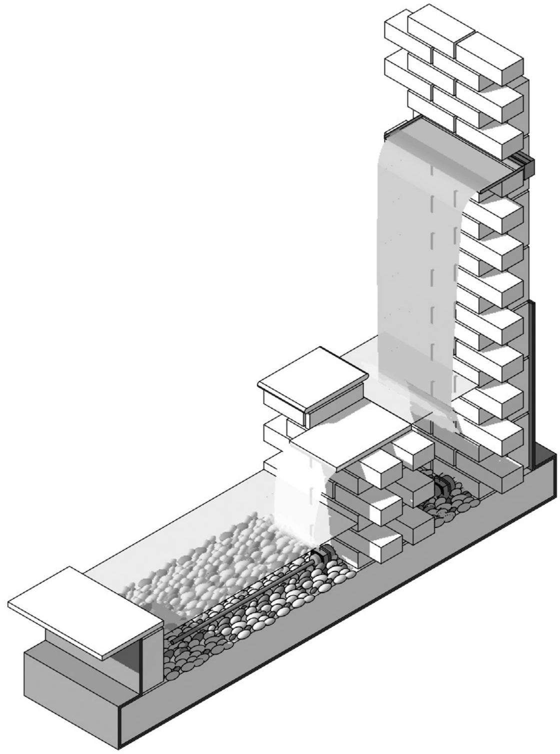
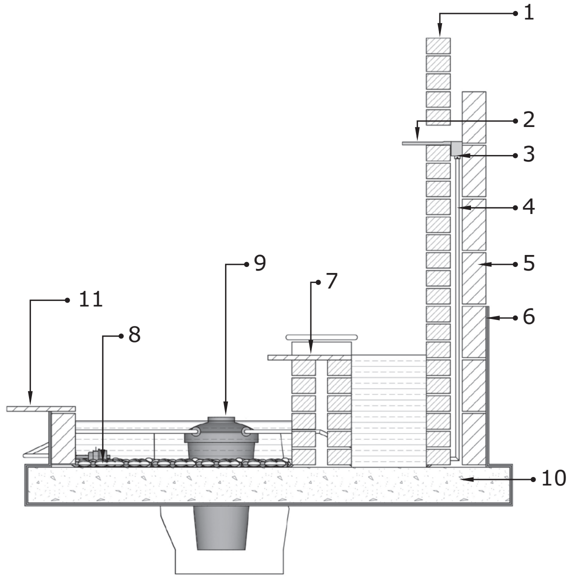


Figure 5.22 Simple cascade with reservoir overflow

sump in the pond with a grating/mesh cover or externally within a chamber.

Where a cascade is used to flow into and aerate a larger body of water, consideration should be given to how the water clarity will be maintained. Water can be kept clear through the use of chemicals or by using a filter. Small ponds can use a combined filter and pump unit; however, water volumes larger than about 9,000L (2,000 gallons) will require a separate filter and pump arrangement. The size of a filter will be determined by the water volume. The filter unit can be located some distance from the pond, subject to the correct pipe bore and pump specification. Pressurised filter sets have water pumped into them from the pump, which is either located in the water body or in a dry chamber with a connection hose into the pond. These filters can simply be buried in the ground and have an inspection chamber above for annual maintenance. The outlet from the filter is to the top of the cascade.

A cascade need not utilise water blade style devices. A simple low-flow stepped water feature can be created with a reservoir header and one at the collection point. The pump is located in the lower reservoir and water simply circulated into the header container.

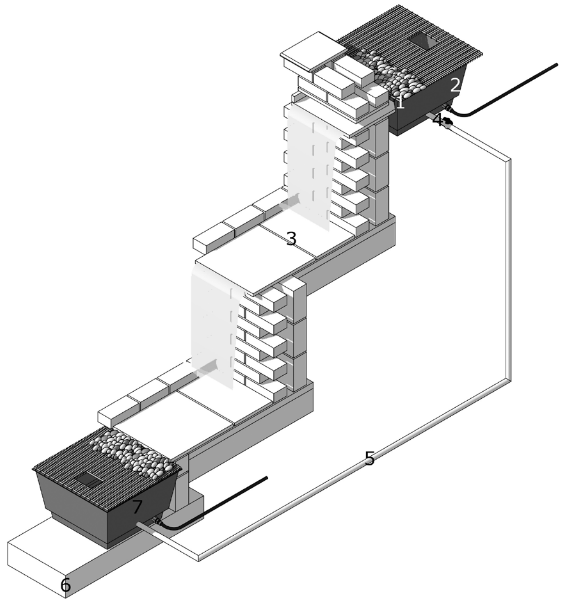


1. Facing material. This must be suitable for use in contact with water; e.g. bricks must be class F.
2. Water blade lip. Use an extended lip to keep the edge away from the facing material.
3. Water blade water connection, base or rear to suit.
4. Water inlet, the pump specification will determine the pipe bore.
5. 7.3kN dense concrete blocks.
6. Waterproof membrane (e.g. EPDM over a non-woven geotextile 220gsm).
7. Spill-way, can be a cut piece of the main paving material.
8. Pump.
9. Pressurised filter unit (e.g. Oase Filtoclear or similar).
10. Concrete base RC25.
11. Adjoining paving material.

Figure 5.23 Simple cascade with external filter

The overflow detail from this header tank requires detailing so that the water spills onto the chute or lip and then descends down the terraces. Sumps at the base of each fall would help create a less turbulent flow but are not necessary if the flow through the system is minimal. With reduced flow the water spilling from one terrace to another is unlikely to result in a sheet or curtain effect and may cling to the surface of the facing material. The materials used should be suitable for use in contact with water – highly textured surfaces can create a very appealing effect while running at a low flow.

A water wall is an effect where the water from a header tank or blade spills onto the facing materials and remains in contact with it for the height of the wall. The facing material can be almost anything and will be chosen to suit an aesthetic, style or effect. Stainless steel will give a different effect to brick. A stone sheet can be sawn with horizontal groves, a wire mesh held against the facing surface or random stone blocks, all create different effects. A low flow rate



1. Materials to cover header reservoir
2. Header reservoir (e.g. Ubbink 71x40cm with metal grate)
3. Spill-way/lip (e.g. paving material cut to suit)
4. Water inlet, the pump specification will determine the pipe bore
5. Non-return valve
6. Concrete base C20
7. Receiving reservoir/chamber.

Figure 5.24 Cascades with no sumps

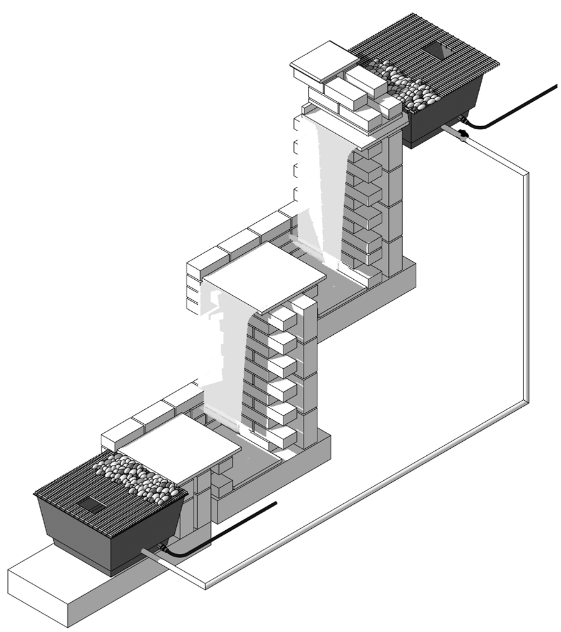
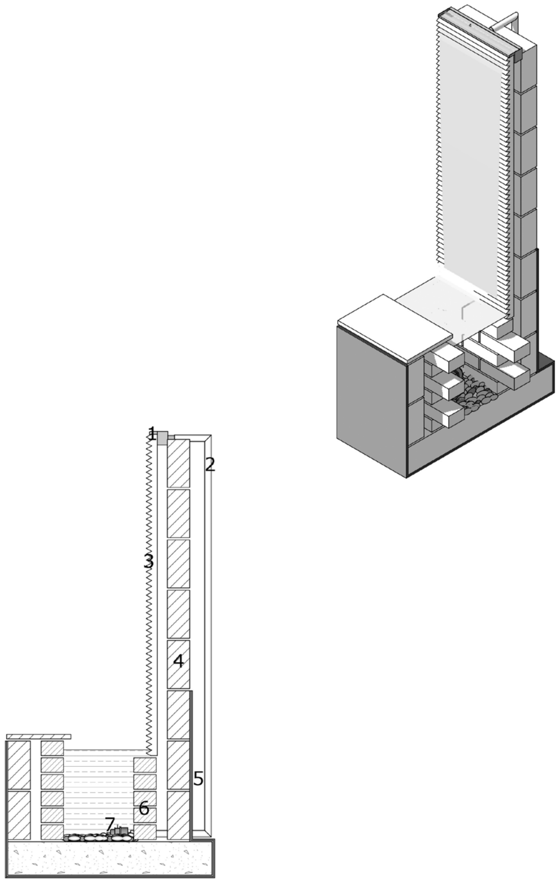


Figure 5.25 Cascades with sumps



1. Spill box or water blade.
2. Water inlet. The pump specification will determine the pipe bore.
3. Water wall facing material, attached to a solid support. This does not need to extend below water level.
4. Rear supporting wall e.g. 7.3kN dense concrete blocks.
5. Waterproof membrane (e.g. EPDM over a non-woven geotextile 220gsm). This should extend above the water level.
6. Facing material below water level, this may be different to the main water wall.
7. Pump.

Figure 5.26 Simple water wall

will give a subtle effect whereas a higher flow will create a much more dynamic, water fall effect. The wall need not be vertical. It can have a batter that creates a slope or an overhang. Water will remain attached to overhanging surfaces if they are smooth and without coarse textures. It is always worth experimenting with a simple rig to see whether the effect is suitable or as anticipated.

Cascades do not need to be large or dramatic. They can be used to create a simple flow into a water body. Several water blades or spouts can be connected to create an array over almost any distance. Where several blades or

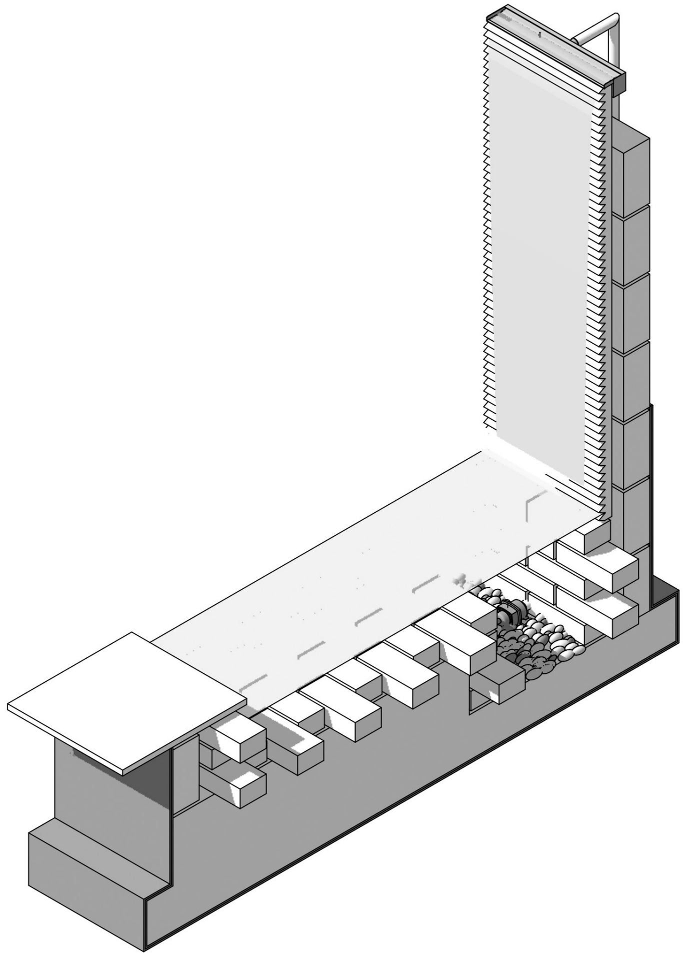


Figure 5.27 Simple water wall into pond

spouts are flowing simultaneously the pipe connections can be a little more complex than for a single feed. Water blades in particular require a high flow. It is possible to connect several to a single pump but the effect from each blade will differ unless a simple manifold is attached to the pump, effectively creating an individual pipe run for each blade. Where blades are running simultaneously but separated it may be better to run each from a dedicated pump. Waterspouts will require less flow and even where there are multiple outlets these can usually be driven from a single pump. A manifold should be located on the pump outlet, which will divide the outlet flow between the individual spouts. There should be a flow control valve as the pressure and flow to each outlet will vary. This will control the flow and help create a balanced effect.

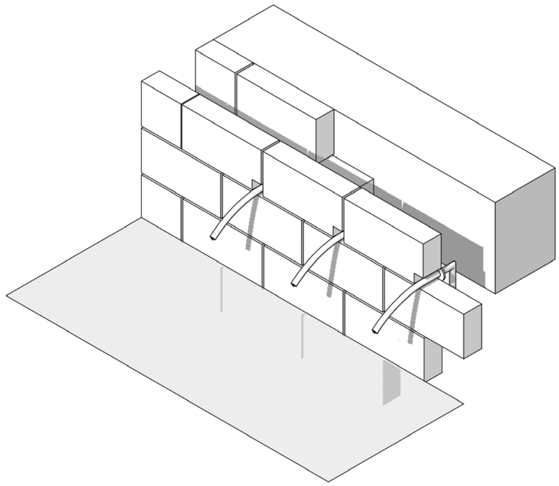


Figure 5.28 Multiple spout outlet

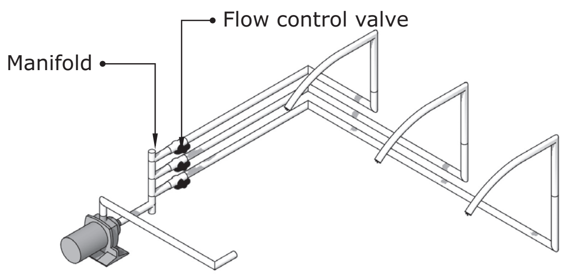


Figure 5.29 Individual pipe lines

APPENDIX 1

Simple calculations

APPROXIMATING A LINER SIZE

Most liner suppliers will have guidance on how best to calculate the amount of liner required for any particular pond. Simplistically:

Liner length:

Water feature length (maximum) + twice water feature depth + 300mm

Liner width:

Water feature width (maximum) + twice water feature depth + 300mm

Water feature volume

Maximum width (m) × maximum length (m) × maximum depth (m) = volume in cubic metres,

× 1000 (to give result in litres)

To convert to gallons (Imperial) × 0.26

To convert to gallons (US) × 0.22

SIMPLE FORMULAE

Area of a circle (e.g. water bowl)

$A= \pi \times \text{radius}^2$

(e.g. $A= 3.142 \times 0.35m^2 = 0.39m^2$)

Circumference of a circle (e.g. to calculate the rim of a water bowl)

$C=2 \pi r$

(e.g. $C= 2 \times 3.142 \times 0.35m = 2.12m$)

APPENDIX 2

Running costs for electrical devices

Table A2.1 Running costs for electrical devices (e.g. pumps)

W	hr	day	wk	mnth	yr
5	0.000625	0.015	0.105	0.456	5.475
10	0.00125	0.03	0.21	0.912	10.95
15	0.001875	0.045	0.315	1.368	16.425
20	0.0025	0.06	0.42	1.824	21.9
25	0.003125	0.075	0.525	2.28	27.375
50	0.00625	0.15	1.05	4.56	54.75
75	0.009375	0.225	1.575	6.84	82.125
100	0.0125	0.3	2.1	9.12	109.5
150	0.01875	0.45	3.15	13.68	164.25
200	0.025	0.6	4.2	18.24	219
250	0.03125	0.75	5.25	22.8	273.75

Prices given in £ (UK)

Based on 1kWh=12.5p 1W =1kW/1000 1W=0.0125p/h

(UK average early 2018 source www.ukpower.co.uk)

Very simplistically 1W = £1/year

Pump and filter systems are constantly improving. Recently the introduction of "eco" or economy design systems has seen their power consumption reduced significantly.

Unless there are specific circumstances or requirements pumps and filter units should be allowed to run 24/7. In winter, it may be necessary to switch off a system if the weather gets very cold, but even then a pump and filter are usually capable of operating well below freezing. Pumps positioned at the bottom of a pond are unlikely to encounter frozen conditions and the water in pipes is in constant motion which inhibits its ability to freeze. Only in prolonged cold periods and where the manufacturer recommends should a pump/filter be switched off. Be aware of the restart requirements, as these will vary between pump types.

APPENDIX 3

Standard pipe sizes for pond hose

Table A3.1 Standard pipe sizes for pond hose

Internal diameter (mm)	Internal diameter (")
12	0.5
20	0.75
25	1
32	1.25
38	1.5
51	2
76	3

APPENDIX 4

Pumps and filtration

The right pump can make the difference between a pond or water feature working as it was conceived or being a disappointment or at worst failing.

The type of pump needed will be guided by the application and style of feature. There are pumps to create waterfalls that filter as they pump, for fountains, for small features and for large lakes, pumps that are submersed in the water feature and ones that are surface mounted (dry pumps). In addition there is the need to consider filtration: pressure filters, air pumps and ultraviolet clarifiers (**UVCs**).

TYPES OF PUMP

Pumps are either submersible (i.e. run under water) or dry run, where they are located on the surface or in a dry environment such as a chamber. Dry run pumps are less common than submersible pumps for small applications, such as waterfalls and fountains. They are more common in large applications such as swimming pools, commercial plumbing and irrigation systems where several pumps can work together. Dry run pumps typically require a separate/remote "pump house/chamber" and are noisier than submersed pumps. An advantage is that they are easily accessed for maintenance and servicing.

WATERFALL PUMPS

As a general rule of thumb a waterfall requires a flow rate of 900–1000LPH (litres per hour) for every 100mm of pouring lip. For a faster flow this can be doubled. A thin curtain or veil of water can act almost like a curtain in even a slight breeze. It may move, creating spray and splash; increasing the flow can go some way to prevent this. It is useful to incorporate a tap/flow regulator or use a pump with a regulation device to fine tune the flow and effect from a waterfall or cascade during commissioning.

Waterfall and filter pumps should be capable of handling soft solids of 8mm to 10mm. If connected to a filter, general suspended plant and fish waste is captured and the intervals between cleaning are greatly increased. Waterfall pumps are invariably the submersible type.

All pumps lose performance when they have to pump water above the pond surface. For example, if a waterfall is 2 metres higher than the surface water in the pond, a pump, such as the Oase Aquamax Eco 16000, moves 16000LPH at the surface level of the pond; this drops to a rate of 9600LPH at 2m (this loss of performance is usually provided in tables by the individual manufacturers).

FOUNTAIN PUMPS

It is important with a fountain that the desired effect is fully understood from the outset. This will allow the correct pump, nozzles and dimensions of the pond to be specified early in the design process. Fountain pumps can only generally pass soft solids of up to 1mm to 2mm. If larger particle sizes are pumped then the fountain head might become clogged and the effect would be lost. If used in isolation these pumps invariably require more maintenance than waterfall pumps. However, they can be combined with a filter and separate circulation pump unit which will remove most of the pond debris and keep the fountain performing with less interruption. Some of the most popular styles are the "foam jets" (e.g. Oase Shaumsprudler) which produce a vertical column of foamy water, or those that have a 3-tier spray pattern (e.g. Oase Vulcan Type Jet). Laminar flow pumps produce a very smooth and even stream of water. These can be used to great creative effect, jumping or pulsing to give the appearance of an almost living bead of water. Such pumps are very specialised and considerably more expensive than simple recirculation pumps.

The depth of a pool is a key consideration if adding a fountain to an existing pond. Whilst some pumps have a telescopic riser pipe than can extend to about 1m, most will require a platform below the surface of the water on which to be securely mounted. A useful feature on fountain pumps is adjustable feet. These help enormously if the fountain needs to be vertical. An important consideration is water loss from spray – a 1 metre high foaming jet might require a 2 metre wide pool to prevent water being lost. The 3-tier jets (such as the Oase Vulkan 43-3 T), if mounted to a fairly powerful pump (such as an Oase Profinaut 21), will produce a fountain height of 3.25m and a fountain diameter of 1.4m; to avoid water loss a pool size of at least 5.4m × 5.4m would be required.

Small water features, such as an ornamental pond or water bowl, even with a few fish and plants may, if built and stocked with consideration, achieve a balance whereby mechanical or biological filtration is not required. The water may be a little cloudy and will need regular inspection to ensure things remain in balance but it is possible and sometimes desirable to leave nature unmolested. Larger features, well stocked with fish and/or plants are likely to need intervention to ensure that water clarity is maintained and that the pond or feature looks its best. Without filtration cloudy water and algae will develop and cause problems for the health and looks of the feature.

Glossary of common terms you will come across:

KWh – kilo watt hour, is the standard unit of electricity, 1kWh= 1000W

W – Watt is the description for the amount of power consumed by a device (e.g. pump), the larger the number of Watts the more energy is consumed

Pipe run – the length of the hose, from the pump to the outlet, the longer the hose/pipe the harder the pump has to work to overcome friction in the pipe

Hose/Pipe length

For every 10m of pipe the water has to travel through, add 1m to the head of water you need the pump to work at

To create a waterfall/cascade

A simplistic guide is that for every 100mm of pouring lip a flow rate of 900–1000L/h is required. This can be double if a faster flow is required.

WATER FILTRATION

ECOLOGICAL CONSIDERATION

Water is a precious resource. Only about 1% of the available water on the planet is fresh and even that is not readily available for consumption. Drinking water (potable) is used extensively in our ponds and water features and we should be mindful of the environmental impact.

Consideration should be given to the use of grey water sources, such as runoff from the house, bathing etc.

To treat and supply potable cold water for domestic consumption, 1.2kw of electricity is required for every 1000L; this amounts to about 0.7kg CO_2.

The average household consumption (UK) of water is 130L/day (Source: Defra) or 47,000L/yr or 33Kg CO_2. Cold water treatment and supply accounts for approximately 0.6% of the UK's energy consumption.

There are numerous techniques and systems to filter ponds and water features. In addition there are filtration devices that are peripheral but nevertheless essential. Not all ponds need filtration. If you are intending to have only high plant stocks it is possible to create a natural balance; however, this can take a considerable time to establish.

NATURAL SYSTEM

A pond system in balance is simply one where plants, insects and other wildlife are maintained in a self-sustaining ecosystem. These ponds do require a considered approach, experienced design and patience. Invariably naturalistic in appearance, they must be created in stages and plants need to be well established before fish should be introduced.

PRESSURE FILTERS

Pressure filters are compact easy to fit filters which are fully sealed. They can simply be buried to the cap separation line, in a suitable location, which must be accessible for maintenance. Water is simply pushed via a pump to the pressure filter, unit. The filter units do not require power themselves, relying on the water flow through them; the filtered water is then returned to the pool via an aquatic hose. This filtered water can also be returned via a waterfall if required. Pressure filters often come with built-in Ultraviolet light clarifiers (UVCs) for keeping the water free of the single cell algae which turns the water green. Where this option is included a power supply will be necessary. Certain systems such as Oase Filter Clear are very simple to maintain. Twice a year the internal foam filters need to be compressed via an external stirrup handle – no disassembly is required. The action releases the filtered waste and pond detritus into the main filter chamber which is flushed out. These filters are suitable for use in most ponds except where there are high fish stocks. The UV sterilizers on these units are relatively small, it is worth specifying a larger model filter if the water feature is approaching the limit of the filter. Filter units should usually be placed at or below the water level of the pool or pond.

PROFESSIONAL AND KOI FILTERS

Where there are large fish stocks or Koi are kept, the filtration demands are considerably increased to ensure fish health. Most systems employ a multistage approach to filtration using a variety of methods, including sand bed, pressure and vortex filtration. Some systems such as the Evolution Aqua Nexus range are self-cleaning. Multistage filtration systems can take up a considerable space.

RAINWATER PIPE FILTERS

Where run-off water (e.g. from a house roof) is directed to a pond, a rainwater pipe filter (that sits inside/in line with the pipe) is advisable.

Selecting the right pump and filter is not straightforward; there are several influencing factors that must be taken into account.

As an example:

A small pond requires a waterfall effect and filter to keep the water clear. The pond will not have fish or plants.

The waterfall is 1.4m above the surface of the water and is 600mm wide; the pipe length from the pump to the waterfall is 8.5m long.

The calculation:

The head (or height the pump needs to push the water vertically) is 1.4m, a pump capable of 2m would usually be adequate, however because of the pipe length an additional 1m of head has to be added, it is therefore best to select a pump capable of reaching 3m.

The width of the waterfall will give an initial indication of the flow rate required (a simple guide is 900–1000lph for every 100mm of width), 600mm = 5400lph, always err on the side of caution.

A pump capable of 6000–7000lph would be suitable for this application, that is until a filter is added to the equation.

To calculate the size of filter required, measure the volume of the pond; if it is an irregular shape and the profile of the bottom is unknown, be cautious and base the volume on a simple calculation:

Surface area (m) × max depth (m) x 67% ×1000 (to convert to litres)

(This gives two-thirds of the volume and allows for a shallow gradient between the edge and the deepest part)

E.g. 3.6m × 5.8m× 1.3m deep= 18,200 litres

A general rule is that the volume of the pond should pass through the filter every 1–2 hrs.

In this example the filter requirements are approx. 9000lph (min, i.e. one volume change every 2 hrs) and the waterfall requirements are 6000lph (min); the pump should be specified to suit the maximum effort, in this case the filter.

Sometimes the filter requirements are incompatible with the water effect/feature and in such cases it is worth considering using a separate pump for each job. As previously described, the energy consumed by the filter unit should be taken into account. Filters should run for 24/7 if not all year, certainly between March and October. Comparing the energy consumption and running costs will help in the final selection

Pumps and filters are constantly being developed. Advice is readily available from all manufacturers and independent aquatic suppliers.

APPENDIX 5

Pipe falls and gradients

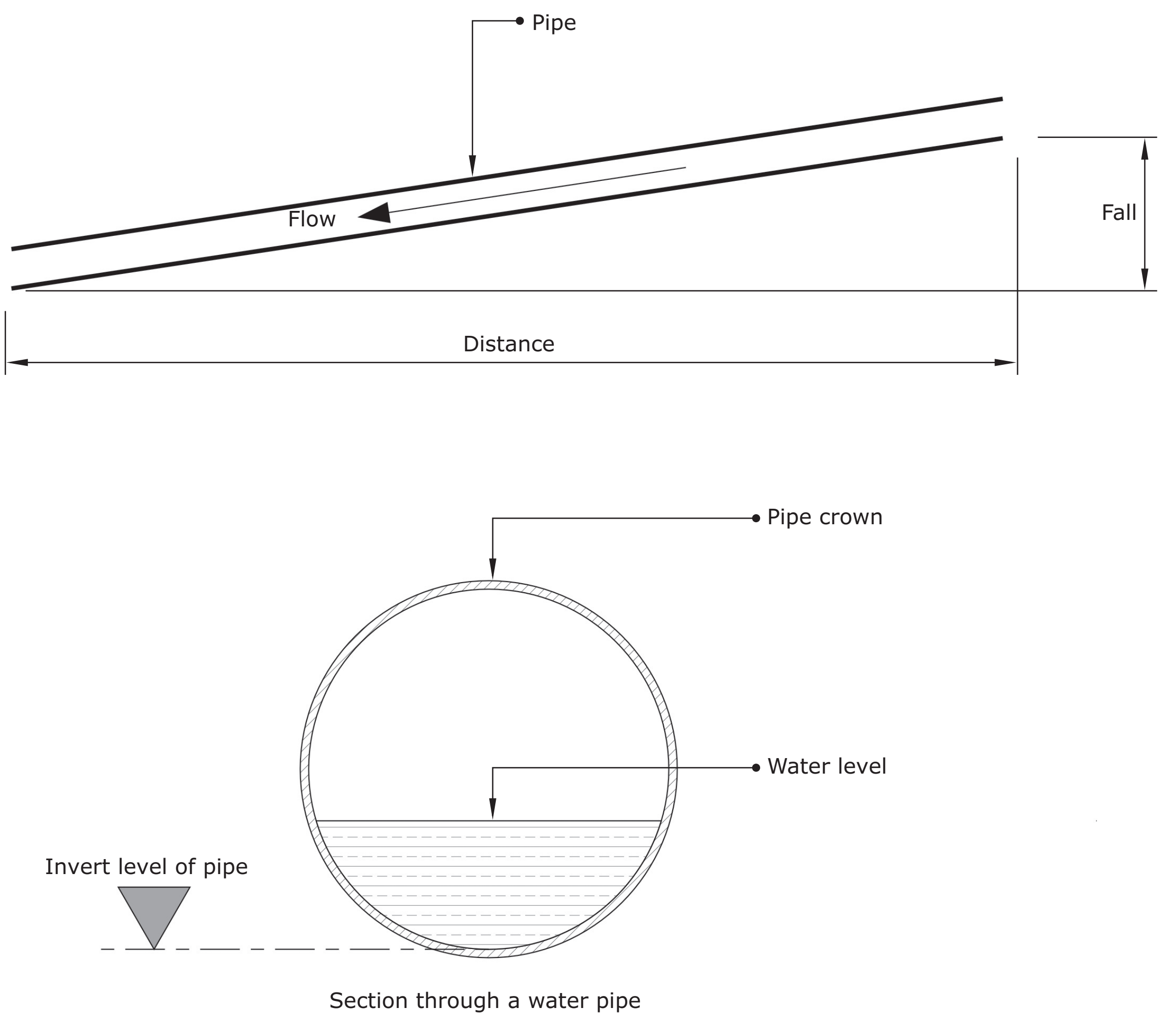


Figure A5.1 Drainage pipe fall and gradient

All drainage pipes, both above and below ground, should be laid to an adequate gradient.

GRADIENTS

A gradient of 1 in 40 to 1 in 100 will ensure adequate flow. Where a gradient is steeper than 1 in 40, water may flow faster than any carried solids or debris which could result in a blocked pipe.

> A gradient of 1 in 80 is a good reference to initially apply to drainage design schemes.

A gradient may be defined as fall divided by distance. GRADIENT = FALL/ DISTANCE

Calculating the gradient

Pipe length: 19 metre run (horizontal) of drainage/overflow pipe. Height above outlet: 0.45m

Gradient = fall/run

= 0.45/19

Gradient = 0.0237

To convert a gradient into a ratio

Gradient = 1/0.0237 = 42

Gradient = 1 in 42.

APPENDIX 6

Mortar mix for use below water level in ponds

There are several proprietary products that can be used to bond or secure masonry underwater.

It is important that mortars intended for submerged structures set slowly and without drying out too rapidly, in order to achieve a strong bond free from cracks.

A mix recommended by pond builders is

1:0.5:3

1 part Portland cement (Type N): ½ part masonry cement (type S): 3 parts soft sand

Waterfall foam is polyurethane structural foam that bonds almost anything to anything. It is a designed for use in water features and is eco-friendly.

APPENDIX 7

Materials for use in aquatic construction

Materials in water will always develop water-marks. Highly polished surfaces such as stainless steel will show up stains much more readily than more diffuse surfaces, e.g. brushed stainless steel/ matt textured plastics. Surfaces should be cleaned with a suitable agent that will not itself harm or degrade the ecosystem of a pond or water feature. Household cleaners are unlikely to be suitable.

Some materials are toxic to pond life (e.g. copper) and should be used with care, if at all. Oak can leach tannins although this is only temporary. The problem can be avoided by pre-soaking the oak.

Larch and sweet chestnut do not contain such tannins, are less expensive and almost as durable as oak for construction in or over water.

Galvanised steel will dull down quickly in water but remains a very effective coating for large fasteners and supports. Screws and bolts should be stainless steel (316-suitable water immersion).

APPENDIX 8

Maintenance

Every water feature will require maintenance, often simple and no more demanding than what might be expected as typical for a garden: plant maintenance, feeding fish, leaf removal, algae treatment; work that in itself will prevent specialist intervention or any curative or remedial work.

Clients and owners should, as a minimum be passed all of the details of the materials and equipment that have been used in their project and, where it is appropriate, given some instruction on how to care for and maintain their investment.

At its simplest this might take the form of a hard landscaping schedule. A simple document that outlines the water feature and the details of the materials used. Any user manuals and equipment specifications for the pump and any filters should be included, along with their guarantees and where additional information can be found (for instance at the manufacturers website/YouTube etc.). The schedule should include the principle maintenance activities and whether any special equipment might be required.

AN EXAMPLE OF A HARD LANDSCAPING MAINTENANCE SCHEDULE FOR A WATER FEATURE

Project reference:
Hard Landscaping Schedule

Insert diagram of the pond or water feature here

Detail: Pond area

Location: Rear garden main terrace

Completion date: February 2018

All construction of hard landscaping materials undertaken by:

Big Garden Landscaping
Website: www.biggardenlandscape.co.uk
Contact:
Tel:

Period of guarantee on all constructed elements: 2 years from completion of garden (20 March 2018)

Materials:

Pond edging:

Sawn sandstone, 30mm thick product ref: SS beige 30

Supplied: Southern Stone Supplies
Website:
Tel:

Care and maintenance:

Stone to be swept clean as required. Liquid spills to be removed immediately. Algae and greening may occur and should be removed with an ecological cleaning agent such as: (insert stone supplier's recommended cleaning agent).

The pointing between stone slabs may crack and become loose. Should this occur within the period of guarantee, the landscape contract will undertake any remedial work. After the period of guarantee, pointing can be repaired/ replaced with a proprietary pointing compound, such as: (insert stone suppliers recommended pointing compound or the product details of the compounded originally used).

The stone must NOT be cleaned with a jet wash or abrasive cleaning agent. Where there are stains/spills that are unacceptable or there are broken paving units, replacement should be considered.

Pond liner:

The pond is lined with a sheet material: EPDM. This is a rubberlike 1mm thick material that is specifically designed for use with water.

Period of guarantee against manufacturing problems: 20yrs

EPDM manufacturer: Firestone, product reference: Pondgard 1mm

EPDM supplier: South Western Pond Suppliers

Care and maintenance:

The liner will give a life in service of in excess of 20yrs.

Should an accident occur and the liner becomes damaged or punctured, it is possible to repair it. A specialist repair kit is available from the supplier. Alternatively, the landscape contractor should be contacted to assess and undertake any remedial work.

The sides of the pond will develop a coating of both algae (biofilm) and to some extent a deposit of calcium, due to the hardness of the local water supply. The liner is best cleaned with a sponge or cloth. No chemicals should be used as these may be detrimental to the liner. If it is not possible to manually clean the sides and the base of the pond, a "pond-vac" might be considered, there are several types available. These are useful for clearing up debris and removing string algae. A normal internal vacuum cleaner must not be used.

Frequency of cleaning:

Late autumn to remove any leaf debris.

Monthly during late spring and summer, as algae becomes established. If there are fish in the pond then their faeces should be removed every few weeks.

Pond pump:

The pond uses a combined pump and filter unit. This is located in the pond.

It is powered through an underground connection to an electrical socket in the garage. The socket there is marked "Pond Pump". The pump filters and kills bacteria through an internal UV lamp.

Pump unit:
Aquamax Eco premium 10000
Supplier: South Western Pond Suppliers
Website:
Tel:

Care and maintenance:

The pump should be removed for inspection and maintenance at least once a year.

To lift the pump, first switch it off at the mains outlet. The pump can be lifted by its electrical cable. It is advisable to allow the pump to drain before it is lifted clear of the pond. A plastic sheet should be used to cover the paving to avoid staining. The pump handbook gives details of the care requirements for this pump.

1. Remove the outer cover and check for debris
2. Remove the impeller and wipe the bearing surface and socket clean
3. Replace the UV lamp as directed in the handbook.

The pump supplier has demonstration videos on YouTube (insert the YouTube links here).

The UV lamp must be replaced annually.

The pump should be left to run 24/7, 365 days a year to ensure the clarity of the pond water. Only in severe periods of cold weather should the system be switched off and then only until the weather improves.

Period of guarantee: 5 years.

A new pump can be fitted without additional remedial work. The landscape contractor, or other specialist installer should be approached when this is required.

It is a legal requirement that external electrical systems and appliances are installed and compliant to building regulations and electrical safety codes.

Pond overflow and drain:

The pond has an overflow installed. This is locked in the top left-hand corner and is identified as a small black plastic pipe breaking the surface.

Under normal weather conditions this overflow will cope with rainfall and maintain the established level of the pond.

Care and maintenance:

Frequently (weekly) check that the overflow is not blocked with debris; this is especially important during autumn when leaf fall from trees and plants in close proximity may cause a blockage.

The overflow has its outlet in the rear garden drainage chamber. This should be checked annually for debris and blockages.

Pond drainage:

To drain the pond, unscrew the overflow pipe. This is connected to an outlet low on the pond wall and by removing it the pond will drain down.

Water remaining in the bottom of the pond can be brushed up with a dustpan and brush. If it is necessary to enter the pond then “soft” footwear (e.g. flip flops/ sandals) should be used and checked for any sharp stones etc.).

The overflow should be reattached prior to filling the pond back up.

It is necessary to undertake some simple frequent maintenance for any water feature. The type and frequency will depend on the nature and scale of the feature but simply:

1 year:

Change UV lamps in filter sets

Purge filter sets and boost pro-biotics if required

Inspect hose connections, electrical leads and outlets

Inspect pond walls and coping surrounds and timber structures (e.g. decks)

Monthly:

Check overflow for debris

Remove fish faeces, plant matter in ponds that are not required or desired

Remove algae and duck weed as it appears

Change water in unpumped features

Weekly:

Small water features that do not use a pump (e.g. water bowls) will require a change of water in warmer months

Remove leaf debris during tree/plant leaf fall

Pond-vacuums are a relative luxury but considerably ease the burden of maintaining a large pond. There are several types and the prices vary depending on functionality and brand. A mid-priced unit will remove water continuously (rather than filling a chamber until it is full and then switching off), the filtered water being directed back into the pond. Various heads are supplied that allow the sides and corners to be cleaned as well as the removal of large debris such as leaves.

Plant debris must be removed quickly; it will decompose and in some circumstances alter the chemistry of the water (e.g. falling berries or pine needles which can prove toxic to fish).

APPENDIX 9

Drain pipe discharge capacities

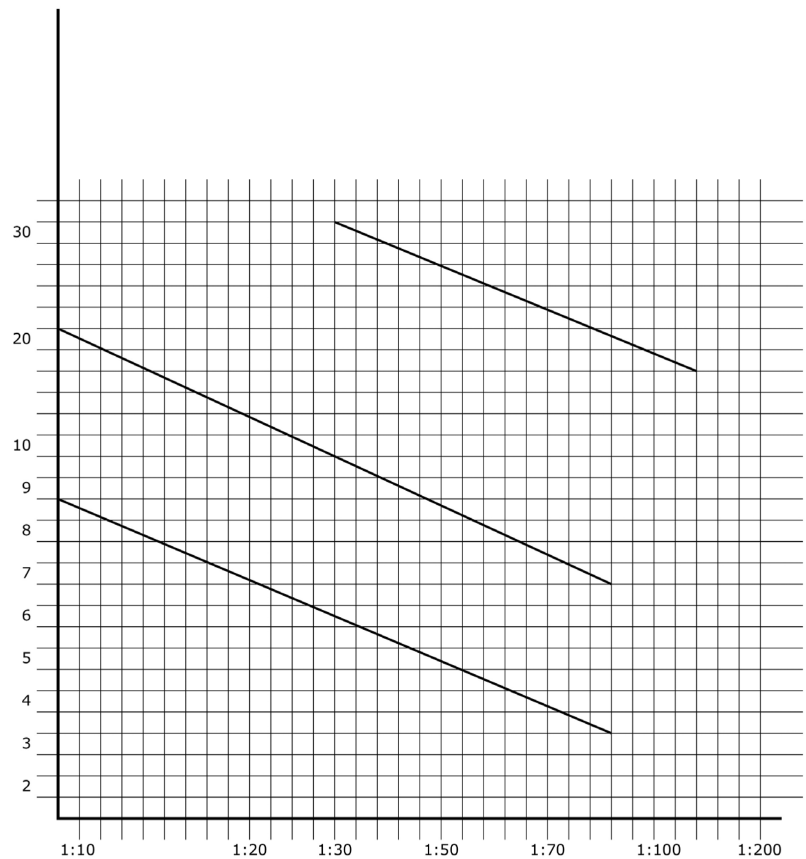


Figure A9.1 Drain pipe discharge capacities

APPENDIX 10

Water pipe runs near buildings

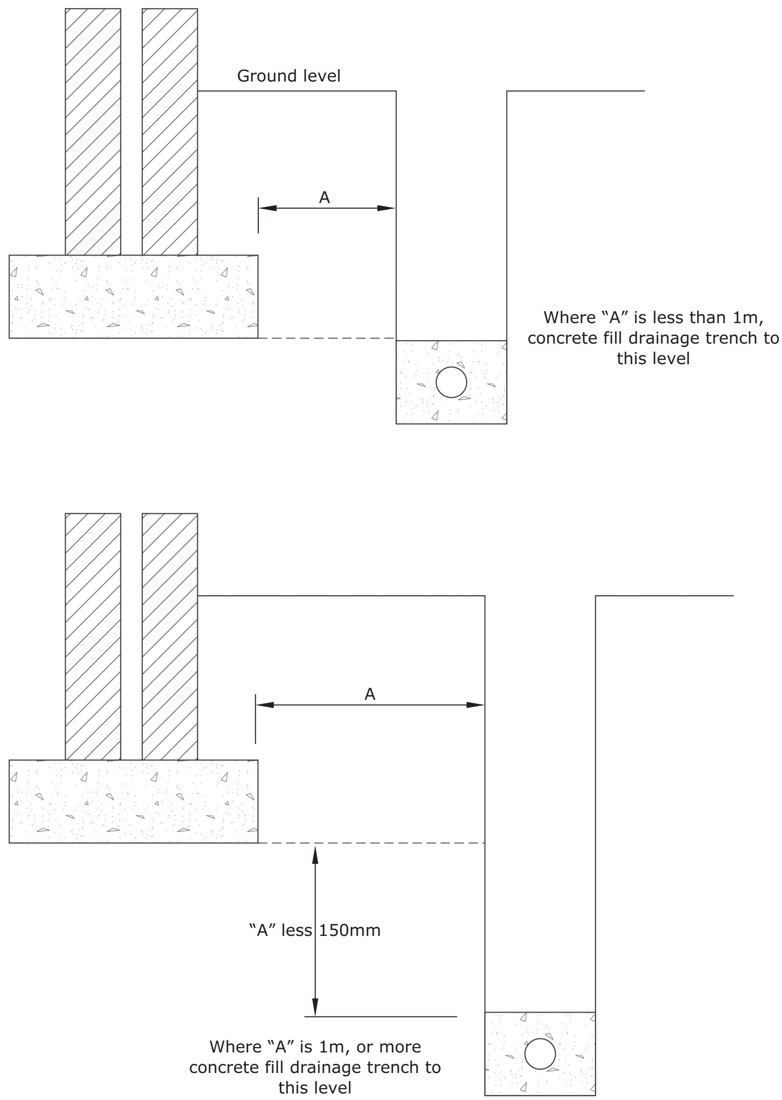


Figure A10.1 Water pipe runs near buildings

Glossary and common terms used in water feature creation

Air stones Also referred to as aeration stones or discs. These are small porous structures, attached to the end of a narrow airline and submersed into a water feature. They allow air to be pumped into the water, through the use of a simple air pump located outside of the water feature. The resulting bubbles help oxygenate a body of water and thereby help in supporting pond life in the warmer summer month and the control of algae. Air pumps do not need to be used in the cooler months.

Algae Usually single celled, simple organisms. They are present in any external body of water. They can cause intermittent problems when conditions in a water feature provide them with an excess of nutrients, resulting in an algae "bloom". This can be treated through the use of filters or chemical interventions.

Ammonia Organic matter decaying in water generates ammonia, in particular foetal matter from fish. High levels of ammonia can be toxic to fish. A biological filter will help remove excess ammonia.

Balance tank/chamber See also **Wet sump**
A balance tank is a waterproof chamber located remotely from the main water feature. Its main function is to ensure that the water level required in the feature is maintained. This is achieved through the controlled addition of water via a connection to a mains inlet. There may be additional services located in/around the balance tank, such as pumps, filters, overflow, electrical connections, dosing.

Bog garden Plants that thrive in wet, often saturated ground with a low pH (i.e. acid loving). Whilst moisture is retained in the soil, it will percolate into the sub base/drainage layers.

Bond bridge A coating applied to the rear of a material to aid bonding to other surfaces. A primer. This is most often used on the rear of paving units that themselves do not readily bond to the bedding layer, e.g. porcelain. There are many propriety primers or bond bridge products available. SBR is a common additive used with cement to form a slurry mix used as a bond bridge

Chlorine Commonly used to cleanse water (for example in swimming pools). Chlorine is present in tap water (in the UK). Whilst it dissipates within 48 hours it can be harmful to fish. If chlorinated water must be added to a pond, never add more than 15–20% of the final volume at once. Freshly filled ponds should be left at least 72 hours before being stocked.

CDM Construction Design Management Regulations (UK) that aim to improve health and safety in construction projects through the planning, design and construction phases. The regulations require that projects of a certain size, determinded by duration of number of man days required, are notified to the Health & Safety Executive (HSE).

For a water feature, which might be part of a larger project, CDM requires that the designer must consider the hazards and the risks associated with the construction, use, maintenance and final demolition of the feature, regardless of whether the project is notifiable or not.

www.hse.gov.uk/construction/cdm/2015/index.htm

Discharge rate The rate at which a fluid will leave a pipe. Fluids under pressure, whether pumped or from gravity, will discharge at a faster rate than those where there is no pressure.

E.g. the water spilling over an infinity edge pool is being pumped into the water chamber, at say 20,000L/h. There should be sufficient capacity in the collecting drains to return the water to the filter chamber without the gutter and pipes becoming overwhelmed. The discharge rate (i.e. the rate at which water is returned) of the drains will be determined by the gradient of the foul water pipes and their diameter. Most drainage pipe below grade (ground) is 110mm diameter.

A table is used to give the discharge rate for a given diameter and gradient (see Appendices 3, 5, 9).

E.g. a 110mm diam. pipe at 1:70 gradient will return 7 litres per sec = 25,000L/hr at 0.75 proportional depth.

Whilst ×1 drainage pipe might seem to handle the rate of water input, consider the risks of blockages and storm water events. +2 drainage outlets would be prudent.

Double check valve A simple valve that is added to a pipe run or the end of a pipe. It prevents water from returning back along the pipe in the event of an air pocket or syphon being created.

Flow valve A type of valve that requires continual rotation to close off the flow of water, an outside tap is an example of this type of valve.

Footings An alternative term for foundation/s. Usually applied to a cast concrete base over which brick or block-work walls are constructed.

Gate valve A type of valve that requires only a small degree of rotation to close off the flow.

Geotextile Sometimes referred to as a geo-membrane or "fleece".

Geotextiles that are suitable for use in underwater features are of the "non-woven" type. They are permeable, whilst retaining larger particles. Thin geotextiles 110gsm (referenced by their weight, e.g. g/sm) are used for example as a barrier layer below sub base layers in construction. Thicker geotextiles (250gsm) are used as an underlay below flexible liners. These protect the liner from indentations and compression tears.

GRP Glass reinforced plastic (also known as glass fibre). Liners for ponds can be made from GRP, either as a prefabricated structure or applied in situ. It is a more expensive system than other methods of lining but has distinct advantages. It is infinitely flexible and will smoothly line any form, it is rigid and robust and can be coloured.

Head This refers to the vertical height, from the *surface* of the water (anticipated water level) to the outlet point of the discharge pipe. The position of a pump beneath the water level is irrelevant for assessing head. The performance of a pump will be given by the manufacturer, with an assumed head of operation. A performance graph is given for every pump and for a given flow rate at height (head) of water. The higher the water must be lifted by a pump the lower the flow rate.

Nitrites Nitrites result from the decomposition of ammonia. They can be toxic to fish.

Nitrates Nitrates are essential nutrients for plants. Excess nitrates can encourage algae.

Porcelain paving Also referred to as vitrified or ceramic paving. These are typically 20mm thick and are technically a tile. They are available in an ever-expanding range of colours and surface finishes. Porcelain will not readily adhere to cement based mortars. A bridge bond should always be used.

Proportional depth This is a value assigned to foul drains and pipe work to enable the flow and discharge rate to be calculated. The typical value assigned is 0.75, meaning that the pipe has the capacity to contain air pockets as well as fluids (i.e. a pipe is calculated as 75% full).

Sintered see **Porcelain paving**.

SUDS Sustainable Urban Drainage System.

Approaches to manage surface water that take account of water quantity (flooding), water quality (pollution), biodiversity (wildlife and plants) and amenity are collectively referred to as Sustainable Drainage Systems (SuDS).

www.susdrain.org

Tank connector These types of connectors allow cables and pipes to enter water-filled containers. They typically comprise of a two-piece threaded connector that fits through a hole in a thin walled container; the halves are screwed together to form a watertight seal. The centre of the connector contains a rubber plug with a hole and a cable or pipe is inserted prior to tightening.

UVCs Ultra-violet clarifiers are lamps used within some filter sets that help control the growth of algae. Lamps typically last for 12 months. They should be replaced as part of a pump and filter annual maintenance schedule.

Wet sump This is a waterproof chamber located either within the base of, or close to a water feature. When it is remote it is connected to the main body of water through a large diameter pipe; the water level in both the sump and the feature are equal. The sump permits inlet, pumps, filters, overflow and electrical connections to be located out of sight.

References

USEFUL SOURCES OF INFORMATION

For information on risk assessments visit the UK Health & Safety Executive.

www.hse.gov.uk/risk/risk-assessment.htm
www.hse.gov.uk/risk/fivesteps.htm

Fish welfare standards

OATA – ornamental aquatic trade association
https://ornamentalfish.org

REGULATIONS AND SAFETY

There are many regulations that can apply to the delivery, use and disposal of water. The most common ones that should be considered when planning a feature are:

Planning

Some local planning authorities treat water features as engineered structures. They may count towards permitted development* and in some areas (e.g. National Parks, Conservation Zones) may require planning permission regardless of permitted development rights. It is always useful to submit a DINPP (Do I Need Planning Permission) request in advance of starting any work. Some authorities make a charge for this service.

*www.planningportal.co.uk
NRA National Rivers Authority, Department Environment

If a watercourse is to be impeded, altered or even improved regardless of whether it flows through private property, permission will be needed before any work can be started. An inspection is likely in order to obtain agreement for the proposed work. The Department of the Environment will be able to advise whether additional authorities will require consultation.

Drainage

Building regulations (Approved Documents) part H: are concerned with the drainage and disposal of wastewater. Old properties will usually have a combined surface and foul outlet and as such an overflow can be connected to it. Newer properties will have a separate surface and foul water systems. It is not permissable to connect the overflow of a water feature to the surface water system. Connection to the foul system may require the permission of the local building control department and/or the utility provider. Advice should always be sought. Where available, connection to a soakaway or water attenuation system is preferred.

Water supply

Whilst a small feature can be topped up manually, this can be a chore. Larger features will have to employ a hosepipe. The overflow from a water feature is classed as category 5 hazardous waste (Water Supply Regulations 1999). As such, a water feature should not be directly connected to mains water. If mains water is to be used to top up a water feature it is necessary to install a break between the supply and the water body, created by ensuring a minimum gap of 50mm (Type A) above the maximum water level. This is to prevent backflow of contaminated water. An anti-syphon valve (NRV- non-return valve) is also required.

Electrical safety

A competent and professionally qualified electrician should undertake all electrical works.

National Inspection Council for Electrical Installation Contracting (NICEIC)

Electricians registered with a Government approved scheme such as NICEIC www.niceic.org.uk

All external electrical systems should be connected to a Residual Current Device (RCD); this protects both the cabling and equipment installed. The RCD will immediately cut off the electricity supply if a fault is detected or the circuit is inadvertently broken. A qualified electrician will be able to advise on the number of separate circuits required for the intended design and what loading is acceptable. Water features are frequently powered off mains supplies and any externally located sockets must be weatherproof and approved for such use.

Most electrical systems in gardens and landscapes are channelled underground.

On completion, all external electrical works and connections must be certified and the contracting electrician should issue a Certificate of Compliance, confirming the works meets the requirements of relevant Building Regulations (also known as Approved Documents); this is known (in the UK) as a Part P certificate.

Safety considerations

Use care, consideration and common sense when following advice from this book or any other source.

Establish the location of underground services and utilities before designing or siting a water feature. Follow the utility provider's guidelines for safe construction distances.

Consider the use of non-toxic methods of dealing with unwanted plants, diseases or problems (such as algae).

Always wear gloves when moving materials, inspection covers or exploring water features. Even if the gloves get wet they will offer some protection against abrasions and sharp objects and bites.

Royal Horticulture Society (RHS) guideline on water safety
https://schoolgardening.rhs.org.uk/resources/info-sheet/health-safety-in-the-garden
Royal Society for Prevention of Accidents
www.rospa.com/leisure-safety/water/advice/pond-garden-water
Child accident prevention trust
www.capt.org.uk/Pages/Category/safety-advice-injury-types
National water safety forum
https://nationalwatersafety.wordpress.com
Water supply regulations
Water supply regulations (1999–2018) UK
www.legislation.gov.uk

WATER SUPPLY REGULATIONS SUMMARY

- Wastewater is categorised 1–5 (5 is the worst)
- Output from an irrigation system or discharge from a pond is categorised at level 5 (hazardous to human health)
- All external mains water outlets must have a double check valve fitted
- It is a requirement to notify the water utility provider if a pond or feature of volume greater than 10,000L is to be replenished by automatic means (not from a spring or bore hole)
- Every pond should have an impervious liner.

Health & Safety

www.waterfeaturedesign.co.uk/health-safety/

Pumps and filters

Water consumption

www.defra.gov.uk/sustainable/government/progress/regional/summaries/16.htm
www.parliament.uk/documents/upload/postpn282.pdf
www.water-guide.org.uk/tips-garden.html (water saving tips)

Comparative energy consumption

www.carbonfootprint.com/energyconsumption.html
www.waterfootprint.org

Suppliers

www.oase-livingwater.com
www.watermaticltd.co.uk
www.Hozelock.com
www.landscapeplus.co.uk distributor and free advice

www.water-garden.co.uk distributor and free advice

David A. Dec "why can't I just use any pond for my pump" 2001 (US units, very technical but thorough calculations)

Materials

Paving

www.paving expert.com/stains (paving stains)

Concrete

www.hycrete.com (concrete waterproofing additive)
www.fishtastic.net (all this pond and water)
www.ftsaquatic.com (liquid liners)
www.waterproofconcrete.co.uk (waterproof render)

Membranes and drainage boards

www.deltamembranes.com

Geotextiles

TERRAM

www.terram.com/products/geotextiles/

Geotextiles and geogribs

WREAKIN

www.wrekinproducts.com

Geosynthetics

www.geosyn.co.uk

Preformed GRP liners

www.worldofwater.com

Flexible liners

Butyl Products Ltd
www.butylproducts.co.uk
Gordon Low Products Ltd
www.gordonlowproducts.co.uk
Stephens Industries
http://stephens-industries.co.uk

Bentonite liners

Rawell Environmental Ltd
www.rawell.co.uk

Paintable waterproofing materials

Gold label pond paint

www.huttonaquaticproducts.co.uk

Epoxy pond paint

www.kingfisheruk.com

A1 Pond paint

www.antel.co.uk

Bondaglass G4 pond sealer

Every pond paint or sealer varies by its chemical composition and application process. The details of coverage, suitable surface types and preparation required should be consulted and followed to achieve a waterproof finish.

Water bowls

Suppliers

Cranborne Stone:
www.cranbornestone.co.uk

Cast stone products including traditional and contemporary water features and surrounds

Urbis
www.urbisdesign.co.uk/what_we_do.html

Glass reinforced concrete planters that can be adapted to retain water. Surfaces can be treated to simulate anything from copper to corten steel.

The Pot Company
www.thepotco.com

Aluminium and weathering steel (corten) water tables and vessels

Solus Decor
www.solusdecor.com/product-category/water-features/

Plastic water bowls

Crescent
www.instantpotsandplants.ie/index.php/crescent-garden-planters

Rotationally moulded plastic containers, made in the US. These are textured to look like a range of materials and are supplied with holes and connection kits for pumps and lights.

Reservoirs

Ubbink pond reservoirs

Available in rectangular or circular containers with or without a supporting metal grate

UK distributors:

www.landscapeplus.co.uk
www.water-garden.co.uk

Water treatment products and suppliers

Blagdon: Barley straw Extract
www.blagdonwatergardening.co.uk
Hydra: Fountain Clear
www.hydra-aqua.com

Hydra also make a Dyes for water features, water colourants for the main water body or leak detecting dyes to help trace faults.

Primrose: Ambiente Fountain safe (powder)
www.primrose.co.uk

Earth bag systems

Deltalok
www.ahs-deltalok.co.uk
www.earthbagbuilding.com
www.lowimpact.org/lowimpact-topic/earth-bag-building/

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