Smarter Plumbing for Architects

Design Strategies to Maximise Space

GEBERIT

Introduction

Maximising spatial efficiency is a growing priority in architectural design. As urban density increases and site constraints intensify, every square metre reclaimed from services infrastructure offers measurable commercial value, whether through enhanced net lettable area or increased design flexibility. However, conventional hydraulic systems are often a challenge in this regard. Traditional vented stacks, oversized pipework and sizeable plant rooms often impose limitations on ceiling height, layout and inter-floor spacing.

Emerging plumbing solutions offer architects new tools to address these limitations through intelligent specification. Innovative drainage technologies, such as siphonic roof drainage and single-stack systems, dramatically reduce vertical and horizontal service footprints. In-wall fixtures and concealed cisterns further streamline spatial integration by reducing cavity depth and improving visual clarity in high-use areas such as hotel bathrooms, corporate end-of-trip facilities and retail amenities. These same benefits extend to retrofit projects, particularly in heritage and adaptive reuse applications, where compact systems allow modern services to be integrated within existing structures without intrusive bulkheads or structural alterations.

Across every stage of the hydraulic network, from roof drainage, to fixture specification, to infrastructure, thoughtful integration of plumbing design can unlock significant spatial and efficiency gains. This paper explores the spatial implications of plumbing systems in architectural design and presents strategies for optimising space through informed hydraulic specification.

Plumbing systems and their impact on space

Hydraulic systems have a direct impact on ceiling heights due to the space required for graded pipework and service coordination. Gravity-fed drainage systems, in particular, rely on minimum fall gradients, which can demand significant vertical clearance across horizontal pipe runs. This requirement, combined with the size of vented stacks and branch connections, often results in deeper ceiling voids that reduce available headroom. In multi-storey buildings, these space demands accumulate, limiting the number of floors within a fixed height envelope or forcing compromises in ceiling height and interior volume.

This issue is further compounded by regulatory requirements around minimum ceiling heights. While the National Construction Code (NCC) sets a minimum ceiling height of 2.4 metres for habitable rooms,[1] most state guidelines recommend more generous clearances. Both the NSW Apartment Design Guide[2] and Victoria's Apartment Design Guidelines[3] suggest 2.7 metres as a preferred minimum to improve livability and daylight access. Achieving this standard is complicated by the need to route drainage and water supply systems through ceiling voids, often alongside HVAC, data, and electrical services. In tightly stacked floor plates, even small miscalculations in pipe size or routing can force costly redesigns or reduce internal ceiling heights below desired levels.

Contemporary design trends, particularly the shift toward minimalist, open-plan interiors, place increasing pressure on the spatial footprint of building services. This challenge is equally relevant in heritage retrofit projects, where internal layouts are modernised while preserving the external structure. Architectural elements such as exposed soffits, tight ceiling profiles and concealed junctions leave limited space for traditional plumbing infrastructure. Vented stacks, large-diameter horizontal pipework and standard bulkhead configurations often conflict with these visual and spatial expectations.

Plumbing fixtures also play a crucial role. The selection and configuration of fixtures, such as toilets, basins, tapware and showers, directly affect wall cavity depth, circulation space and fixture clearances. For example, floor-mounted toilets with exposed cisterns project further into the room and occupy more floor area, which can limit functionality in narrow or accessible bathrooms. Efficient fixture specification can improve compliance with AS 1428.1 for accessible design and reduce the need for costly structural adjustments during construction.

Optimising plumbing for space efficiency

From the roof to the underground drainage network, every stage of the plumbing pathway imposes demands on space that must be addressed during the early design phase to maintain ceiling heights, reduce service zone depth and maximise usable floor area. Through the careful selection of systems and fixtures, architects can significantly improve spatial efficiency without compromising performance or compliance.

From the roof

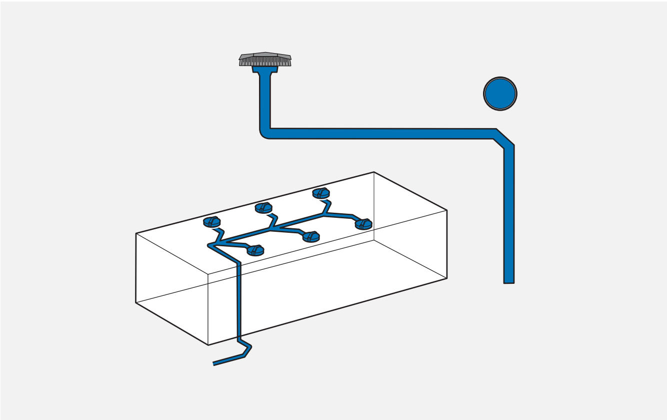
Traditional roof drainage relies on gravitational flow, requiring large-diameter pipes, consistent gradients and vertical downpipes spaced across the roof plan. These systems introduce several architectural constraints, including bulky pipe runs with reduced ceiling clearance and the need for large internal shafts. Flat roof designs are particularly vulnerable to ponding and structural loading due to slow water movement (the airflow in pipes slows water velocity), especially in regions with high rainfall.

Siphonic roof drainage systems offer a compact alternative by using negative pressure to create a fully filled pipe flow. Siphonic roof drainage is an engineered stormwater management system that uses the principles of negative pressure (siphonic action) to rapidly evacuate rainwater from flat or low-pitched roofs through fully filled pipework. Unlike traditional gravity drainage systems, which rely on pipe gradients and airflow to move water, siphonic systems eliminate air from the pipe via an anti-vortex plate at the roof drain, creating a vacuum-like effect.

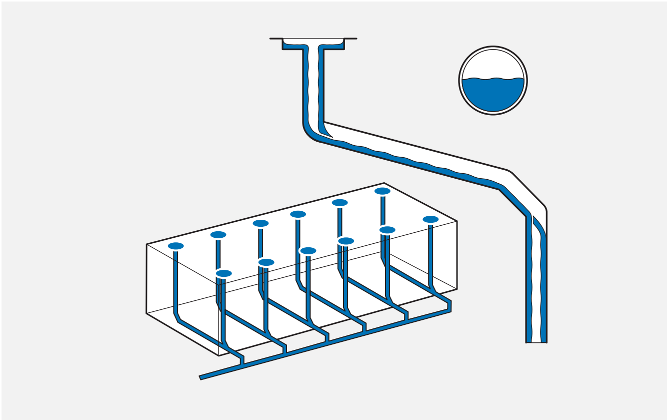
By eliminating air from the equation, this reduces pipe sizes and as siphonic systems do not require sloped horizontal pipework, they provide greater design flexibility by freeing up ceiling space and reducing the depth of service zones. This allows for shallower ceiling voids, higher internal ceilings and more efficient floor-to-floor heights. Additionally, fewer downpipes, up to 40% less compared to conventional systems, are needed, minimising the number of vertical penetrations and risers in the building.

It is critical to treat siphonic drainage as a fully integrated hydraulic system, rather than assembling standalone components. Proper performance depends on precise hydraulic modelling, coordination with storm intensity data and close collaboration with hydraulic consultants during early design stages.

Figure 1. Siphonic roof drainage vs. conventional stormwater roof drainage



Siphonic roof drainage.



Conventional stormwater roof drainage.

Through the building

In multi-storey buildings, “stacks” refer to the vertical pipes that transport wastewater and vent air between floors. Traditional drainage systems typically rely on fully vented stacks, which use separate discharge and vent pipes to manage airflow and stabilise pressure. While effective, these systems require larger vertical shafts, multiple floor penetrations and substantial horizontal branch pipework, all of which reduce usable floor area and complicate layout planning.

To address these challenges, modern sanitary drainage solutions such as **single-stack systems**, uses a single vertical pipe (the “stack”) to carry both wastewater and sewage from the various floors of a multi-storey building to the in-ground drain. These systems combine sewer, waste and ventilation in a single pipe and use flow dynamics to maintain stable internal air pressure. This eliminates the need for a parallel vent stack required in “conventional” systems and allows for narrower risers. By reducing both the shaft size and the number of required floor penetrations, single-stack systems also help reclaim space, simplify coordination and improve serviceability. Their compact form makes them well-suited for tight structural grids, prefabricated wall assemblies, bathroom “pod” applications and slim core configurations.

Further improvements can be achieved using **self-ventilating fittings**, which integrate discharge and ventilation in a single unit. Without the need for a secondary vent line, these fittings reduce the number of inter-floor connections and slab penetrations. In projects with restricted ceiling zones or a preference for shallow service cavities, these compact fittings provide a practical solution. Early coordination with hydraulic engineers is essential to ensure these systems meet the pressure and flow and loading requirements set out in AS/NZS 3500 while aligning with broader spatial and design objectives.

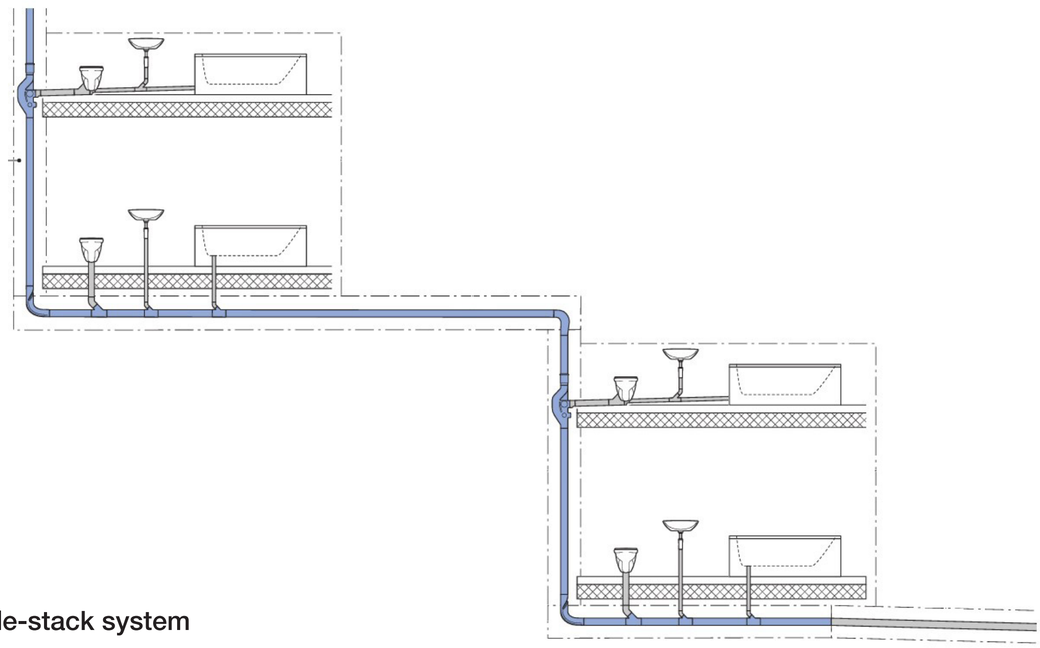


Figure 2. Single-stack system

From the toilet/washbasin

Toilet and basin selections play a critical role in spatial planning, particularly in compact or high-amenity bathrooms. Traditional setups with visible cisterns mounted directly on floor-mounted pans are cost-effective and relatively easy to retrofit. However, exposed pipework and bulky cisterns can disrupt clean sightlines and conflict with contemporary design expectations. They also occupy valuable floor area and reduce circulation space in narrow layouts.

Modern alternatives, such as **in-wall cisterns**, provide a more refined and space-efficient solution. These systems conceal the cistern within the wall cavity or a services duct, enabling the use of wall-hung pans that improve floor access and visually expand the space.

For architects, concealed cisterns provide a clean, minimalist aesthetic and the space to comply with accessibility standards. Modern cisterns also offer enhanced water efficiency, typically with dual flush ratings such as 4.5/3 litres. However, these cisterns require early coordination to ensure sufficient cavity depth and allow for maintenance access, usually via a discreet panel behind the flush plate. The design allows the cistern to be fully serviced through the flush plate opening in a matter of minutes, ensuring quick and efficient maintenance.

Concealed Cistern installed in 1964 at Hotel Eiger Switzerland

Renovation in 2014 with original Concealed Cistern still in good condition

Post-renovation with an upgraded concealed cistern—ready for another 50 years of performance.

To the underground

PVC (polyvinyl chloride) remains one of the most commonly specified materials for underground plumbing due to its affordability, availability and ease of installation. It performs well in standard residential and light commercial applications. However, from an architectural and performance standpoint, PVC has notable limitations. It is sensitive to high temperatures and chemical exposure, making it unsuitable for environments where trade waste or aggressive substances are present. Additionally, the integrity of PVC joints can vary depending on site conditions and installation quality, introducing long-term maintenance risks. In areas subject to physical stress, such as driveways, commercial basements or plant zones, PVC may be more prone to cracking or failure under impact.

For higher-performance or multi-storey projects, **HDPE (high-density polyethylene)** offers a more robust and versatile alternative. With excellent resistance to chemicals, abrasion and impact, HDPE is particularly well-suited for trade waste systems, industrial facilities and commercial kitchens. Its flexibility and weldable joints make it easier to route through congested or shallow underground service corridors. HDPE's lightweight nature also reduces installation complexity and craneage requirements in constrained sites.

In addition to its physical performance, HDPE offers notable sustainability, safety, and health benefits that make it a preferred material for environmentally conscious building projects. It produces lower embodied emissions than many other plastics and performs better in fire scenarios, emitting non-toxic fumes compared to standard PVC. HDPE is free from chlorine, plasticisers and heavy metal stabilisers, chemicals commonly used in PVC that are linked to the release of dioxins and other carcinogenic compounds during manufacturing, installation or combustion.

HDPE systems, including pipework, fittings, and in-wall cisterns, are capable of being recycled within closed-loop systems under suitable collection and processing conditions, aligning with circular economy goals. With its streamlined polymer structure and reduced reliance on additives, HDPE supports cleaner material recovery and higher recyclable quality.

In contrast, PVC often contains a variety of additives (e.g. stabilisers, plasticisers, flame retardants) and has a chlorine backbone, making its advanced recycling more technically demanding. HDPE formulations typically feature low-impact additives and are designed with life-cycle performance in mind, helping to support sustainability certifications such as Green Star, LEED, and WELL (subject to project documentation and independent verification).

“Innovative drainage technologies, such as siphonic roof drainage and single-stack systems, dramatically reduce vertical and horizontal service footprints.”

Geberit: Advanced drainage and sanitary systems for space-efficient design

Geberit is a global leader in sanitary technology, offering high-performance drainage and plumbing solutions that prioritise reliability, spatial efficiency and system integration. With over 150 years of global experience and more than two decades in the Australian market, Geberit’s systems are trusted by architects, builders and hydraulic consultants for a wide range of residential, commercial and institutional projects.

Geberit’s space-saving technologies are particularly suited to vertical and high-density construction. The **Geberit SuperTube** system is a hydraulically optimised, single-stack sanitary drainage solution for multi-storey buildings that eliminates the need for parallel venting. It delivers a discharge capacity of 12 L/s* using a consistent d110 pipe diameter and allows horizontal runs up to six metres without a slope, reclaiming valuable floor space and reducing riser bulk. Its performance is made possible through a system of engineered fittings: the **Sovent** and **Geberit HDPE BottomTurn** and **BackFlip** bends, which control flow dynamics and maintain a stable air column. When used alongside the **Pluvia** siphonic roof drainage system, which reduces downpipe quantities by up to 40%, Geberit enables comprehensive drainage strategies that optimise usable space.

Geberit’s drainage offering is enhanced by its HDPE discharge piping system, engineered for long-term durability and chemical resistance. Suitable for building drainage, siphonic and conventional roof drainage, land drainage and industrial or laboratory applications, **Geberit HDPE** is impact-resistant, suitable for casting in concrete and withstands up to 100 °C in short-term exposure.

For bathrooms, Geberit delivers space and design flexibility through Duofix installation frames and concealed cisterns, compatible with 90 mm wall cavities and WELS-rated for water efficiency. A wide range of flush actuator plates, including touchless options, offers hygienic, design-conscious solutions for both residential and commercial projects. Together, these integrated systems enable high-performance, space-optimised plumbing and hydraulic design from roof to outlet.

*Planning rules in accordance with Geberit and DIN EN 12056-2:2001-1.

Design flexibility for new builds and retrofit applications

While these systems are widely adopted in new builds, they also provide strategic advantages in retrofit applications, particularly in heritage retrofit projects where facades must be preserved and internal layouts reconfigured. The compact nature of Geberit’s drainage and piping systems supports modern design objectives such as open-plan floorplates, industrial aesthetics and minimal visual clutter. Reduced pipe diameters, horizontal runs without fall and the elimination of secondary ventilation allow services to be integrated with tight ceiling zones or concealed entirely.

This flexibility extends to specialised applications, including exposed services in industrial-style interiors, low-profile bathrooms in aged care or accessible housing, and complex service corridors in transport or public infrastructure. By minimising the spatial and visual impact of hydraulic systems, Geberit empowers designers to deliver technically sound outcomes without compromising on form, function or compliance.

“Every stage of the plumbing pathway imposes spatial demands that must be addressed during the early design phase.”

REFERENCES

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2. NSW Government. “Apartment Design Guide.” NSW Government. https://www.planning.nsw.gov.au/policy-and-legislation/housing/apartment-design-guide (accessed 24 July 2025).
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