Engineer's Design Aid Notes:

Sizing of current arch systems:

Tunnelwell® arches have been designed to hold their volume for each lineal metre of arch. No tricks, no hidden calculations or supplier spreadsheets to download for you to calculate required quantities.

Example: 1m3 arch holds 1000 litres or 1.0m³ of effluent per lineal metre

See table below:

Product Code Number	Capacity per lineal metre (litres)	Width (mm)		Height (mm)	Effective length (mm)	Infiltration area of base	Inlets sizes provided (UPVC - mm)
		Internal	External				At top of arch section
TW 1000	1000	1313	1740	1087	1000	1.52m²/m	150/225
						2.53m²/m*	

*Note: The additional sidewall infiltration area from the integrated louvres as calculated by the Department of Health is 1.01m² for leach drains. Total infiltration could be calculated at 2.53m²/m.

Removal of debris or pollutants:

Tunnelwell® is not designed to remove debris or pollutants so it is recommended that the design engineer cover all these issues within their designs prior to discharging any stormwater to the Tunnelwell® Arch System.

Excess soil calculations:

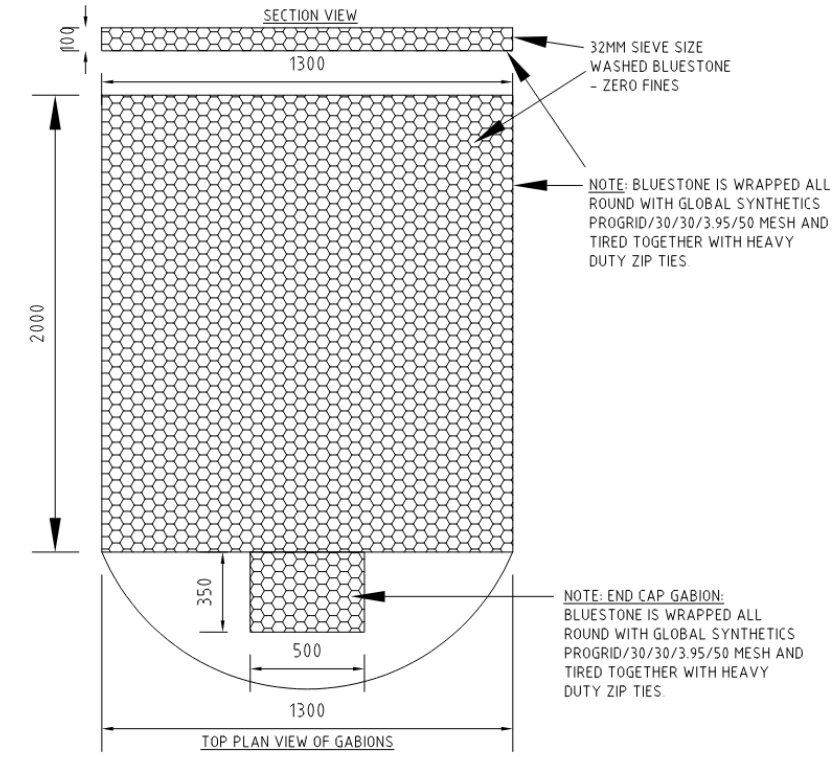
You only remove the actual arch volumes and allow for a bulking factor. This is 40% less than competitor arch systems using stone/gravel support.

Deceleration Chambers and or Gross Pollutant Traps (GPT):

GPT's should be installed on every project to intercept debris caught in the stormwater system as well as remove any suspended solids and hydrocarbons. Furthermore, the design engineer should also calculate the flow/discharge rate of the stormwater entering the Tunnelwell® Arch System. If no GPT is included in the design, the design engineer should incorporate deceleration chambers or both to the design to decrease flows into any arch chamber system. This is particularly important in manifolded arch systems.

Preventing gouging of arch bases at inlet locations:

A combination of 100mm thick stone/gravel (blue-metal – sieve size 32-50mm) and a geogrid wrap is used to prevent gouging the bases where inlet pipes are connected to the arch system and caps like a gabion concept – the dispersion mat. The design engineer should calculate both the velocity and the distance the rainwater will travel along the arch from inlet point until normal gravity flows occur after deceleration and then specify the blue stone and geogrid for that set distance. For example, if an inlet has a velocity of $2m^{-1}$, then the dispersion mat should be not less than 2m long and preferably 4m long as minimum distance and so on. Tunnelwell's research shows that blue stone, other than 32-50mm sieve size is carried and or suspended by larger water flows and can be easily dislodged from the original placement positions unless contained within a gabion concept design mat. Tunnelwell® recommends the following geogrid – Global Synthetics Progrid 30/30/3.95/50 mesh and tired together with heavy duty electrical zip ties. Refer to Gabion detail drawing.



DETAIL OF TUNNELWELL GABIONS FOR 1M³ ARCH SIZE - NTS

Note: for invert level connections the gabion must be cut into the soil base so the inlet pipe is flush with the top of the gabion. For overt level connections the gabion may sit on top of the soil base area.

For vertical connections through the top of the arches, pipes up to 150mm NB diameter, blue stone is deemed unnecessary, but that must be the decision of the design engineer. For pipes 150mm-225mm NB diameter, stone/gravel should be placed under every connection at a minimum of 150mm thickness. It is recommended that not less than 32mm sieve size stone/gravel be specified for vertical connections only, at 800mm wide from centreline be incorporated. Note: Tunnelwell® has tested blue stone for floatation performance issues and has found that the only sieve size that does not float in large volumes of rainwater run-off having a run-of-the-mill velocity is 32-50mm blue stone railway ballast. All stone/gravel should be washed and have <2% fines.

Other services adjacent or crossing the arch system:

Because of the unique design characteristics of Tunnelwell®, all services (third party) can be run adjacent but set at 600mm away from the bottom outer arch edge or over the top of the arches at 90°, depending on cover requirements for both the services and Tunnelwell®. If proper coordination between contractors is organised such as electrical contractors and civil contractors, electrical conduits (cover requirements must be observed) can be run at any angles across the top of the arches provided final backfill by civil contractor has not occurred and the civil contractor agrees to undertake final backfill and compaction processes. This also saves costs to developers and construction companies as it allows for common trenching principles to be adopted.

Note: any services installed in or around a Tunnelwell® Arch System must have the Tunnelwell® design engineer's approval as well as the services design engineer's approval to be installed near the

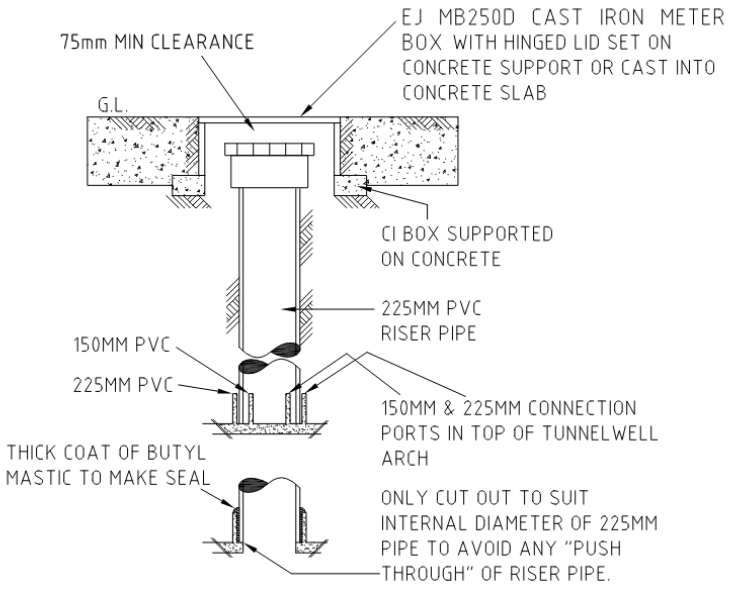
Tunnelwell® Arch Systems. The installation and backfill requirements of those third-party services must comply with Tunnelwell® installation instructions and meet all services manufacturer's installation requirements.
Note: Tunnelwell® does not accept any responsibility or claims whatsoever for any arch failures related to any third-party services installations within or around a Tunnelwell® Arch System. Failure of third-party services rests entirely with the project services design engineers or installing contractors.

Inlet connection sizes:

Top of arch inlet sizes are:

150mm and 225mm UPVC spigot connections. Smaller connections can be provided using reducing sockets such as 90mm and 100mm UPVC. Cut a hole in the top of the arch using internal diameters only to suit inlet connection diameter.

NOTE: cut a hole in the top of the arch using internal diameters only for pipes of 150mm or 225mm diameter so the OD of the pipe meets the outer rim of the hole so that a mastic seal can be effective and the pipe rests on top of the arch to avoid "push through" where loads could be applied.



DETAIL OF TUNNELWELL ACCESS POINT FOR INSPECTION AND CLEAN OUT (NTS)

NOTE: The diagram above shows 225mm diameter pipe connection. Use the same principles to install smaller diameter pipe sizes.

End Cap pipe inlet sizes - REV 0		
Pipe diameter mm (ND)	**Pipe OD mm**	**Material type**
90	91	UPVC
100	110	UPVC
150	160	UPVC
225	250	UPVC
300	315	UPVC
300	339	ENVIROPIPE PE
375	425	ENVIROPIPE PE
450	508	ENVIROPIPE PE
525	595	ENVIROPIPE PE

NOTE: End caps with pipe sizes of >100mm can be ordered with Enviropipes PE pipes butt welded into the end caps to ensure a perfect seal and no sand ingress later after backfilling due to settlement or earth movements breaking mastic seals on larger systems. It is a Tunnelwell® mandatory requirement to have the spigots welded in on any commercial installation – Tunnelwell® will include these costs when quoting such large systems. If a Contractor is using UPVC pipes where PE spigots have been but welded onto the end caps, they must supply a slip coupling to connect to PE spigot and switch back to UPVC pipework. The slip couplings are available from Reece or Galvins but only come in 100mm and 150mm sizes. Alternatively, the switch can be done by connecting the UPVC pipe to a GPT or deceleration chamber and then connecting from that chamber to the Tunnelwell® Arch System using PE corrugated pipes using a PE socket.

Flow rates for horizontal stormwater discharges into Tunnelwell® Arch System end caps should be ≤1.00ms^{-1} for all pipe sizes.

This criteria may involve the installation of a deceleration chamber(s) depending on the inflow rates of the designed system catchment(s). Apparatus such as concrete liners* or certified plastic pits * sized for appropriate catchment inflow with suitable lids or concrete liners* with baffles installed are an acceptable method for velocity reduction of inflow stormwater.
* Denotes that concrete liners or pits need to be adequately vented to allow for air relief to prevent any backpressure on the upstream catchment systems.

Flow rates for vertical stormwater discharges into Tunnelwell® Arch System arch crest inlets (pre-set at 150mm or 225mm NB) should be ≤1.00ms^{-1} for all pipe sizes.
NOTE: All inflow discharges into Tunnelwell® Arch Systems must occur over a correctly sized stone/gravel and geogrid combination dispersion mat (Gabion) with the length taking into consideration the discharge velocity rate for the distance that stormwater will travel before settling on the base of the arch system to avoid any scouring of the base soil upon which the arches are laid.

Note: Siphonic discharges are not permitted directly into Tunnelwell® arches whatsoever. They must be decelerated through a chamber first to ≤1.00ms^{-1}.

Balancing pipes:

Balancing pipes are only required where more than one Tunnelwell® Arch System is manifolded together or where the design engineer wants to balance overflow/excessive water flows between

multiple arch systems. The balancing pipe size is 100mm diameter UPVC size and must fit into the top of the arch chamber by not less than 100mm before being sealed. The number of balancing pipes required is at the discretion of the design engineer.

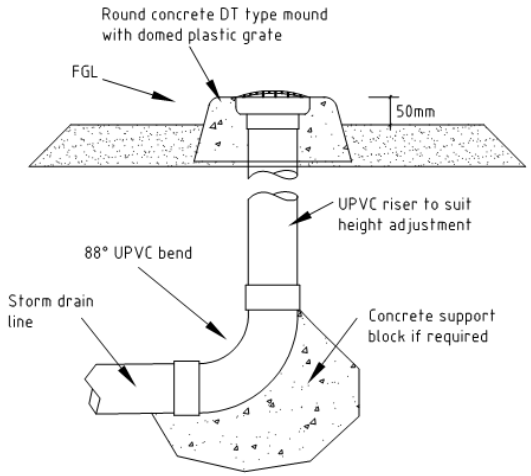
Note: The balancing pipe inlet may also be used as the air relief connection point if the required pipe cover is not available for a top arch connection point. The height of the balancing pipe IL is 820mm above the bottom of the arch.

Air relief provisions:

Rainwater runoff entering a Tunnelwell® Arch System, compresses the air inside the chambers which needs to be displaced by venting each row of arches to atmosphere as is the case with any other well designed buried underground storage system.

All sealed rainwater chambers should be designed to allow air to expel from within the chamber to prevent any backpressure on the upstream discharge pipe systems connecting to the rainwater storage system or roof gutters. If access manhole chambers are not designed into a Tunnelwell® Arch System, then vents should be incorporated using the pre-set holes in the top of each arch section to connect onto that opening provision and extend a 150mm pipe to the surface and provide a vented connection to the Tunnelwell® Arch System – refer to Diagram 1 below. The number of vents should be established by the design engineer. If no engineer is engaged for the design or installation processes, provide at least 1 x 150mm air relief vent to each 30m3 of storage capacity provided or 2 x 150mm air relief vent to each 50m3 of storage capacity provided.

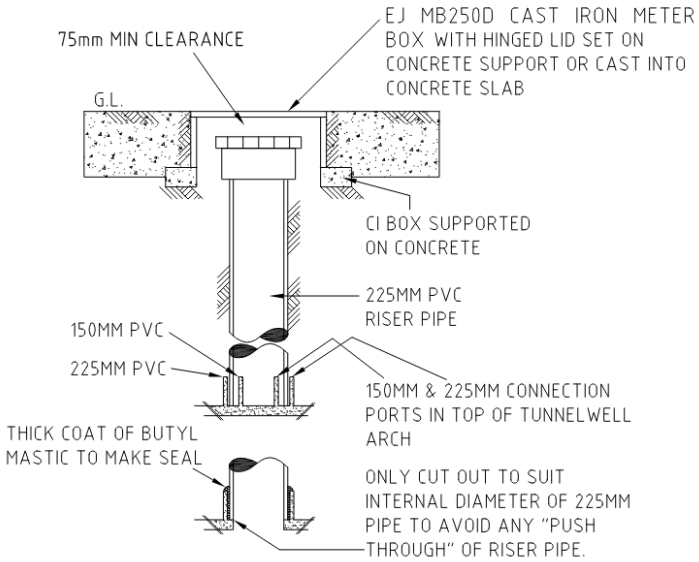
DIAGRAM 1



Detail of Tunnelwell Air Relief Grate in Concrete Mound (nts)

Note: UPVC pipe manufacturer's installation and cover requirements are to be adhered to. An alternative method of venting can be concealed below ground level as shown in Diagram 2 but change sealed cap to a grated outlet.

DIAGRAM 2



DETAIL OF TUNNELWELL ACCESS POINT FOR INSPECTION AND CLEAN OUT (NTS)

NOTE TO DIAGRAMS 1 & 2: cut a hole in top of arch for 150mm-225mm diameter so the OD of the pipe meets the outer rim of the hole so that a mastic seal can be effective and the pipe rests on top of the arch to avoid "push through" where a load could be applied.

Cleaning/Maintenance of Tunnelwell Arch Systems:

A Tunnelwell® Arch System can be accessed by two methods:

1. Design in a concrete manhole chamber section to allow for human entry; or
2. Provide inspection/access opening in the top of the arches for cleaning and maintenance as per diagram 2 above.
   Note: The above will allow digital camera access for sighting the arch systems.

Inspection or Cleaning Access

All buried rainwater chambers should be designed to allow for inspection/monitoring and or cleaning provisions. An inspection access should be incorporated using the pre-set holes in the top of each arch section. Connect to that opening provision and extend a 225mm pipe to the surface and provide an inspection point to the Tunnelwell® Arch System – refer to Diagram 2 above. The number of inspection points should be established by the design engineer. If no engineer is engaged for the design, provide at least 1 x 225mm inspection point to each 20 metres of arch chambers as a recommended minimum requirement.

Important Design Note: Access for any maintenance of any buried storage system is paramount!

Tunnelwell® Arch Systems have been designed without the need for any geotextile cloth surround or bluestone/gravel support. Proper maintenance on competitor systems is not possible as geotextile cloths can never be reinstated to their original performance criteria without retrofitting that cloth or the entire system installation. Tunnelwell® claims it has a >50year performance life cycle but in order for that to occur, Tunnelwell® Arch Systems need to be serviced as required over the >50 year cycle like any other system. Each Tunnelwell® Arch System should be designed for end cap access in the

future so that the arch end cap can be excavated and accessed via removal of the end cap to allow a mechanical rake to turn over the soil to break up any hydrocarbon films built up over the soil base and remove any debris which may have entered the arches. Once this has occurred, the soil will infiltrate the stormwater as it did when initially installed. Recommended frequency of maintenance/servicing is 5 years, but a minimum period of 10 years should be observed to achieve the >50 year life cycle performance target.