DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery

Aquifer Recharge (AR)

and Aquifer Storage and Recovery (ASR)

Reduce surface runoff
Mitigation the probability of flooding caused by heavy rain

DMWS-Drainage Mesh Wells System

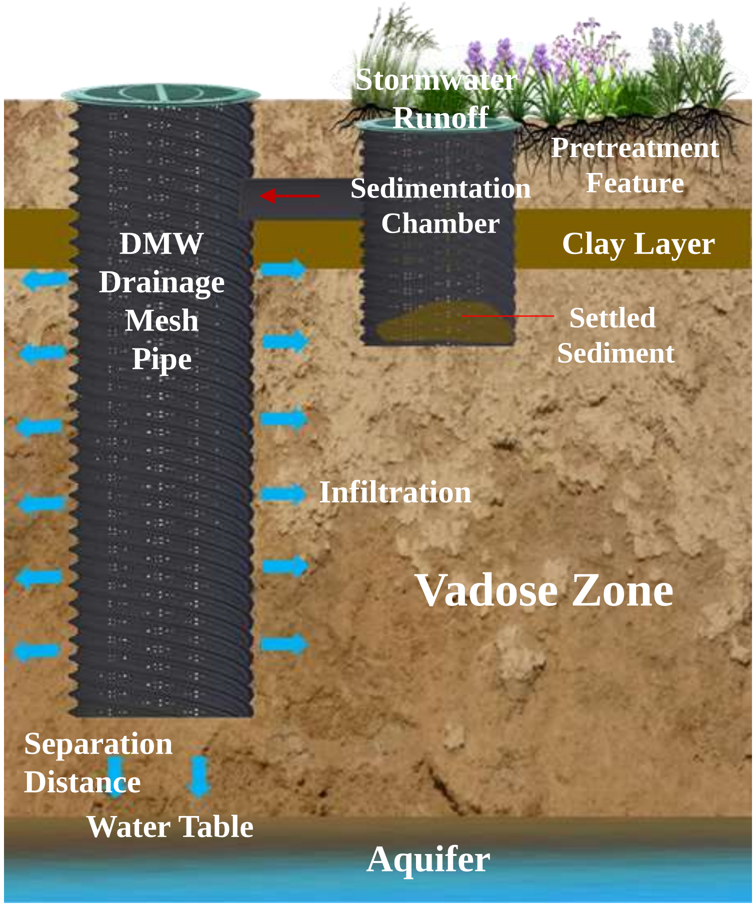
Aquifer Recharge Aquifer Storage and Recovery

Provide the most economical and simple solution

DMWS-Drainage Mesh Wells System

Reduce the probability of flooding caused by heavy rain

DMWS-Drainage Mesh Wells System that is used to transmit surface water underground and is deeper than its width at the surface (see image, below). Most Rainwater Conservation Mesh Wells are 5 to 20 meters deep and 4” to 12”diameter Mesh Drainage Pipe. They are lined with anti-clog Mesh and can be filled with gravel or rock or left empty. Today, Rainwater Conservation Mesh Wells usually include some form of pretreatment to remove oil, particles, and associated contaminants, reducing the risk of clogging the wells and of transporting contaminants underground.



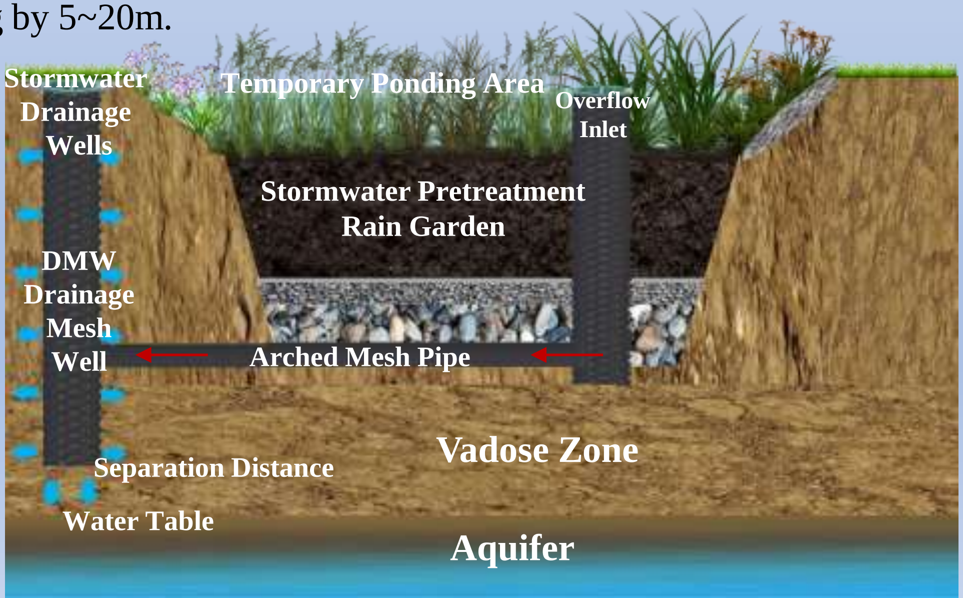
Environmental and Human Benefits

DMWS-Drainage Mesh Wells System can be used to Reduce the probability of flooding caused by heavy rains and reduce the adverse effects of stormwater runoff on streams and rivers. Capturing urban stormwater prevents the runoff from entering streams and lakes where contaminants could cause pollution and erosion could damage aquatic habitats. Rainwater Conservation Mesh Wells can also be used to return water to aquifers, Rainwater Conservation Mesh Wells can transmit typically aim for a lot of rainwater. This ability to recharge local groundwater supplies can help increase water resource security by mitigating the effects of drought or excessive groundwater extraction.

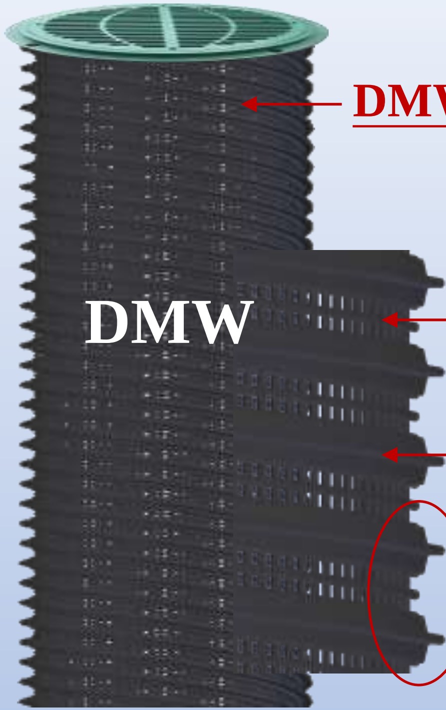
DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery

DMWS-Drainage Mesh Wells System-Structure

- The right kind of Aquifer. Bedrock or unconsolidated aquifers may both be suitable for ASR, but ideally the target aquifer would be bounded by geologic faults or other barriers that limit the flow and loss of stored water in storage before it is recovered from the aquifer.
- Source water of suitable quality. This is typically surface water from rivers or streams, but with the appropriate water quality treatment and permitting process can include stormwater runoff, remediated groundwater, reclaimed water, and industrial process water. These sources should be chemically compatible with ambient groundwater and do not contain constituents that would violate the State groundwater quality standards, including the antidegradation standard, or can be treated to meet these standards.
- A way to put water in and to take it out. This means infrastructure for ASR source water diversion, treatment (as needed), conveyance, and injection to the subsurface through one or more wells, with subsequent pumping to recover stored water. Stormwater Pretreatment filtration facilities: Rain gardens, flood ponds, Curb opening and other filtration systems.
- Rainwater Conservation Mesh Wells (Anti-Clog Mesh pipe): Generally, the sand layer, rock layer and groundwater level information are obtained from geological drilling by 5~20m.



DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery



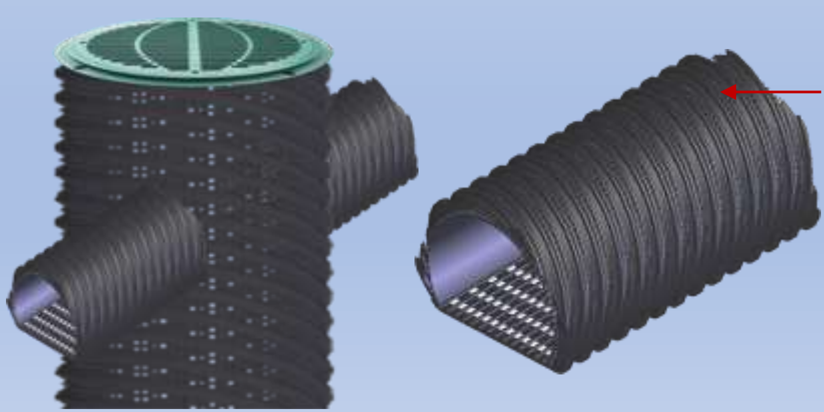
DMW-Drainage Mesh Wells–Unique Characteristics

The sidewall openings are fine mesh design.

The sidewall has T-type thread design and high compressive resistance.

Mesh Well sidewall is Anti-Clog and minimizes soil entry without extra filter material, such as non-woven fabric.

Anti Clog Mesh Well Model Experiment



AMP-Arched Mesh Pipe –Unique Characteristics

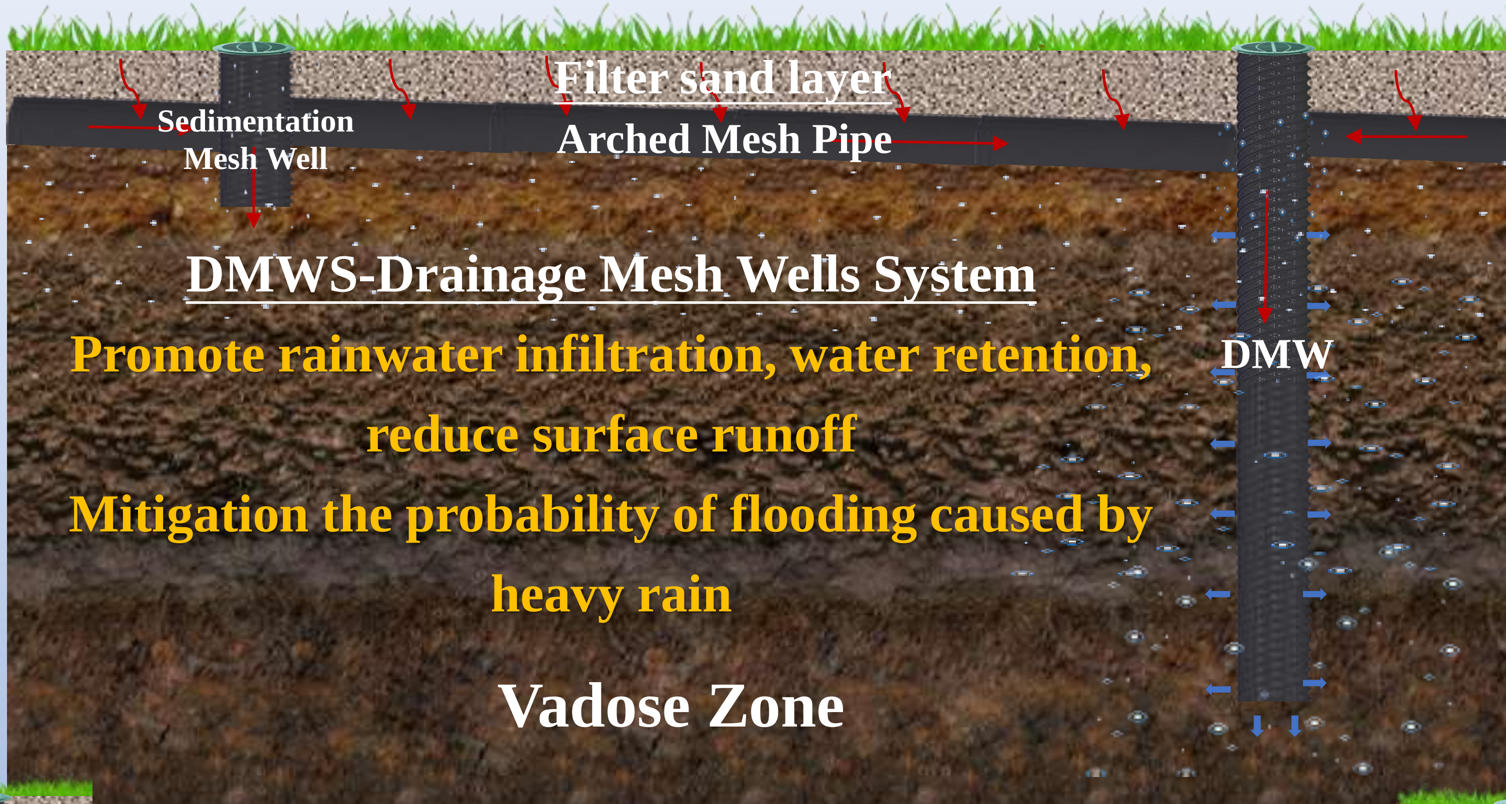
AMP-Arched Mesh pipe does not need to use gravel, grading, non-woven fabrics and other filter materials, The Mesh Pipe is not blocked, and the ecological engineering method is the best underground collection and drainage material.

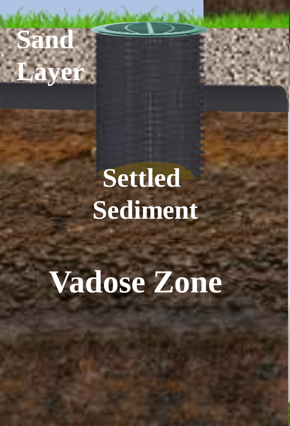
Risks to Groundwater Quality

Deep Drainage Well use has been limited in some places by the concern that Deep Drainage Wells could contaminate groundwater, including drinking water, by reducing the distance contaminated stormwater must travel through sediment in order to reach groundwater. Surface soil and underground sediment remove contaminants by acting as a natural filter, but Deep Drainage Wells allow stormwater contaminants to bypass many underground layers. Groundwater contamination has occurred in the past when surface contaminant spills have entered Deep Drainage Wells, or when substances have been illegally dumped into open Deep Drainage Well. However, groundwater contamination is rare when Deep Drainage Wells are used as intended and when appropriate precautions are taken. Contamination risk can be reduced by using Deep Drainage Wells at sites where spills are unlikely or installing emergency shut-off valves to keep out contaminated water.

DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery

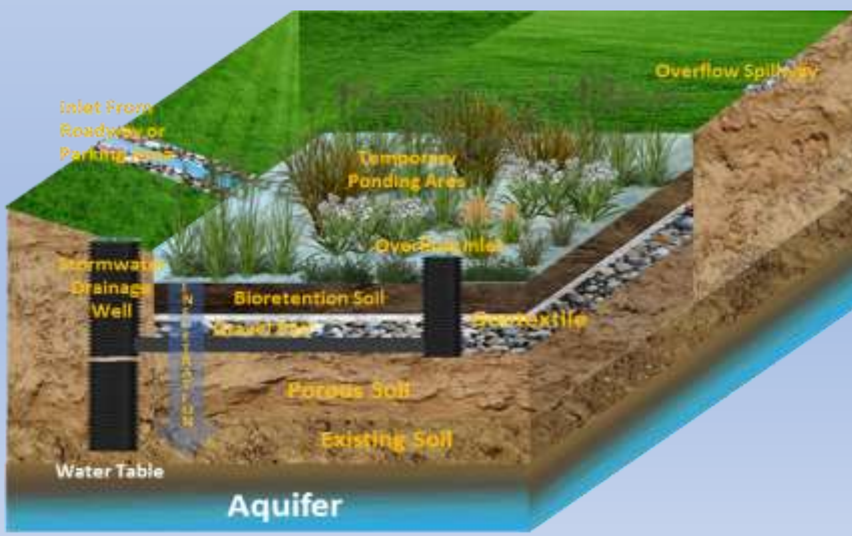
Stormwater Pretreatment filtration facility – Filter Sand Layer





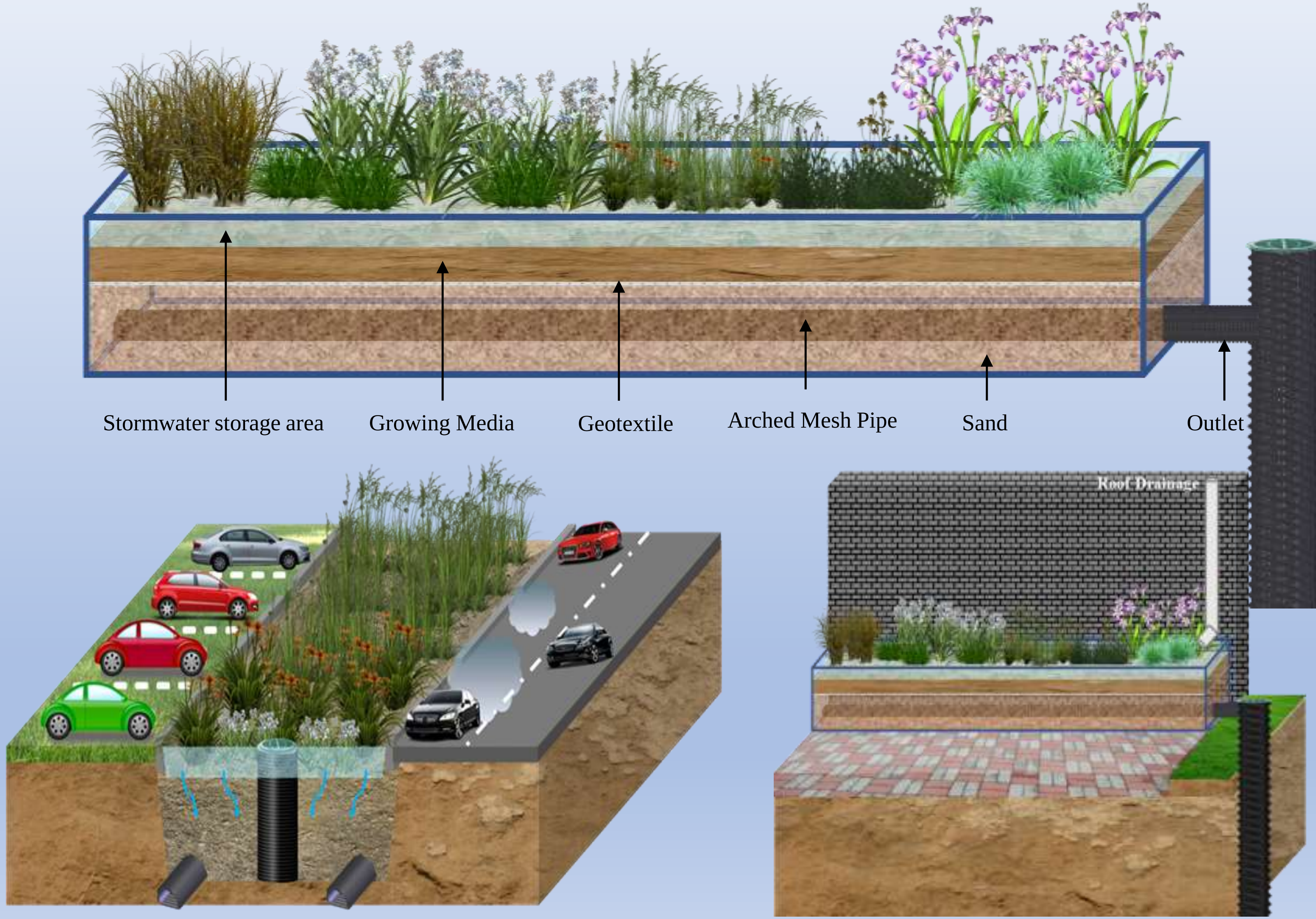
DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery

Stormwater Pretreatment filtration facility – Rain garden



DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery

Stormwater Pre-treatment filtration facility – Bioretention

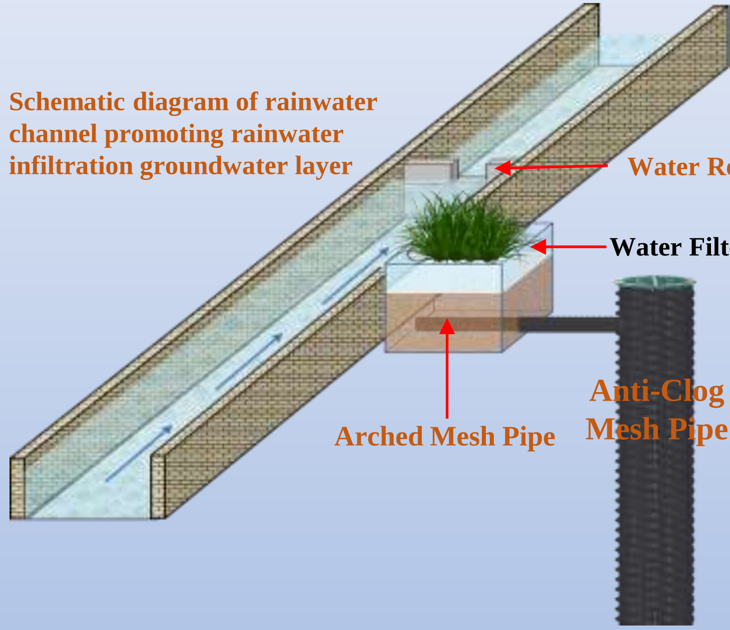


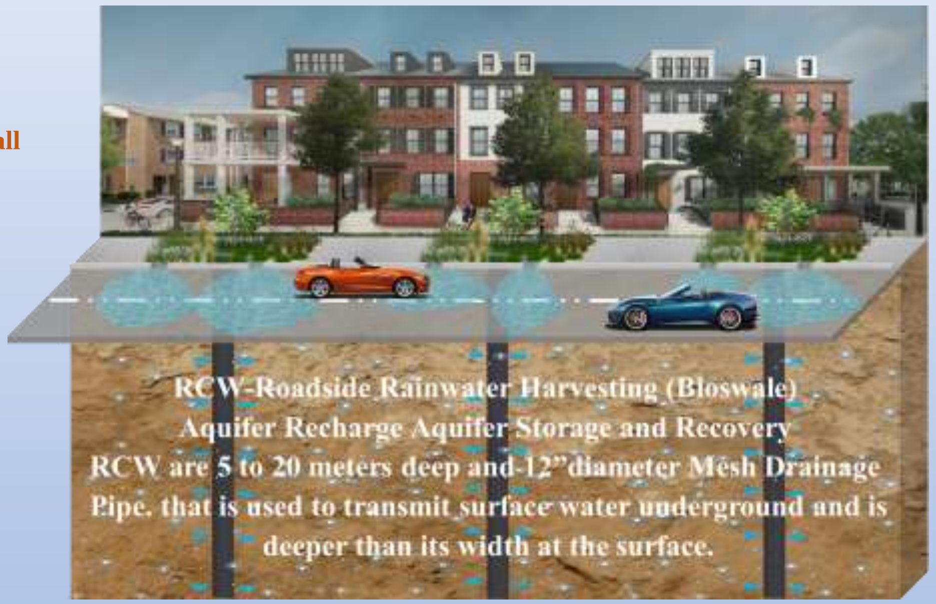
DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery

ECO-MESH

DMWS-Applications - Road Safety Island Drainage
Roadside Rainwater Harvesting (Bioswale)

DMWS-Applications





Stormwater Drainage Wells-Application

DMWS-Stormwater Harvesting (Bioswale)

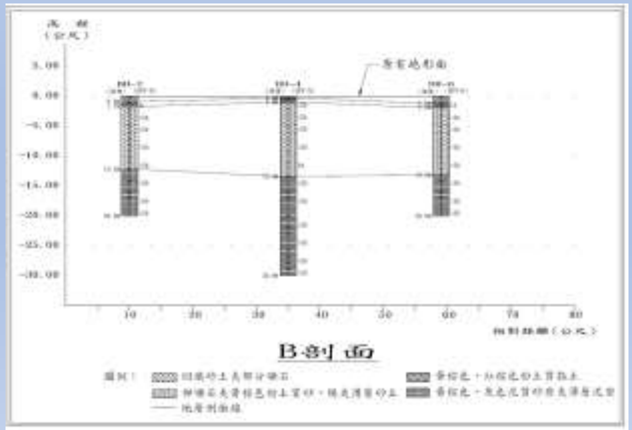
DMWS-Drainage Mesh Wells System-Planning and Design

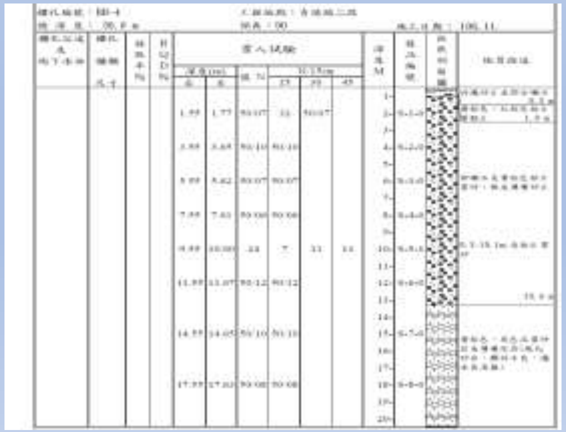
Aquifer Recharge (AR)

and Aquifer Storage and Recovery (ASR)

Steps 1 : Geological drilling

Permeability - the capacity of a rock or sediment to transmit a fluid.
Porosity - the ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.
Water well - an artificial pit, hole, or tunnel, drilled, dug, driven, or jetted into the ground to a depth that penetrates a water-yielding formation to allow water to flow or to be pumped to the surface.



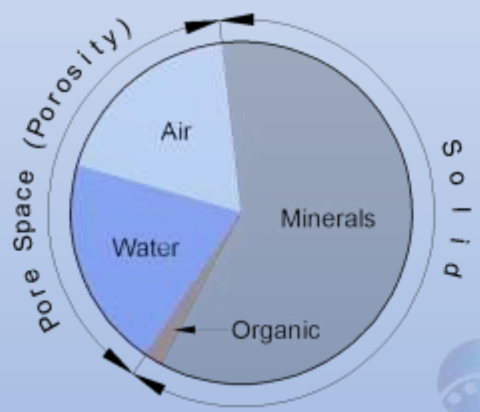


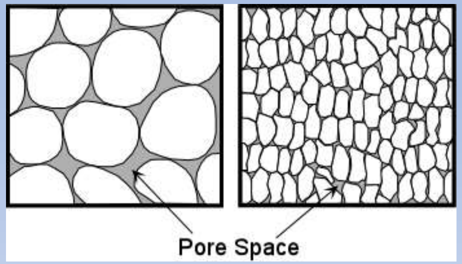
The Groundwater System

Groundwater resides in the void spaces of rock, sediment, or soil, completely filling the voids. The total volume of open space in which the groundwater can reside is ***porosity***. Porosity determines the amount of water that a rock or sediment can contain.

Aquifers

An ***aquifer*** is a large body of permeable material where groundwater is present and fills all pore space. Good aquifers are those with high permeability such as poorly cemented sands, gravels, or highly fractured rock. An ***aquitard*** is a body of material with very low permeability. In general, tightly packed clays, well cemented sandstones, and igneous and metamorphic rocks lacking fractures are good aquitards. Large aquifers can be excellent sources of water for human usage such as the High Plains Aquifer (in sands and gravels) or the Floridian Aquifer (in porous limestones).





Description	Porosity
Sand; Coarse	0.26 - 0.43
Sand; Fine	0.29 - 0.46
Sand/Gravelly Sand; Well Graded; Little to No Fines	0.22 - 0.42
Sand/Gravelly Sand; Poorly Graded; Little to No Fines	0.23 - 0.43
Silty Sands	0.25 - 0.49
Clayey Sands	0.15 - 0.37
Inorganic Silt/Silty Sand; Slight Plasticity	0.21 - 0.56
Gravel	0.23 - 0.38
Gravel/Sandy Gravel; Well Graded; Little to No Fines	0.21 - 0.32
Gravel/Sandy Gravel; Poorly Graded; Little to No Fines	0.21 - 0.32
Gravel/Silty Sandy Gravel	0.15 - 0.22
Clayey Gravel/Clayey Sandy Gravel	0.17 - 0.27
Inorganic Silt; Uniform	0.29 - 0.52
Clay/Silty Clay/Sandy Clay; Low Plasticity	0.29 - 0.41
Organic Silt/Silty Clay; Low Plasticity	0.42 - 0.68
Silty Clay/Sandy Clay	0.2 - 0.64
Inorganic Silt; High Plasticity	0.53 - 0.68
Inorganic Clay; High Plasticity	0.39 - 0.59
Organic Clay; High Plasticity	0.5 - 0.75

DMWS-Drainage Mesh Wells System-Planning and Design

Runoff volume
Expected Rainwater calculation formula

$\boldsymbol{Q_f = C \times I \times A}$	Q_f : expected Rainwater (m^3/hr) C : runoff coefficient I : Rainwater intensity <mm/hr> A : Base area <m^2>

Design Rainwater runoff volume

The calculation of the runoff area, the surface characteristics, the Rainwater intensity, etc. by calculating the rainwater runoff, the runoff calculation formula is as follows.

$Q = \dfrac{C \times I \times A}{360}$	Formula： Q : Runoff (m^3 / sec) C : Runoff coefficient I : Rainwater duration, average Rainwater rate in t minutes (mm/hour) A : The drainage area (hectare)

Runoff coefficient reference value

The surface runoff coefficient C is worth reference to the table below, but the C value in development is calculated as 1.0.

Catchment status	Runoff coefficient without development area	Development of runoff coefficient after land preparation in the whole region
Steep mountain	0.75~0.90	0.95
Mountain area	0.70~0.8	0.90
Hilly land or woodland	0.5~0.75	0.90
Flat cultivated land	0.45~0.6	0.85
Non-agricultural use	0.75~0.95	0.95~1.0
Mountain river	0.75~0.85	
Flat river	0.45~0.75	
Most of the rivers are flat	0.5~0.75	

Case Study : Underground Drainage

Name：OO park
Land area：10000m^2

The Rainwater assessment

$\boldsymbol{Q_f = C \times I \times A}$

Q_f：Expected Rainwater（m^3/hr）

C：Outflow coefficient

I：Rainwater intensity〈50mm/hr〉

A：Base area〈10000m^2〉

$Q_f = 0.9 \times (50/1000) * 10000 = \mathbf{450.0 m^3/hr}$

Arched Mesh Pipe Flow Rate & Flow Volume

Arched Mesh Pipe Flow Rate & Flow Volume (water depth d / Pipe diameter high h = 0.75 non-full flow) roughness coefficient n = 0.015

管徑	坡度	1/50	1/100	1/200	1/250	1/300	1/400	1/500	1/600	1/700	1/800	1/900	0.0010
2"	Rate m/sec	0.545	0.385	0.272	0.244	0.222	0.193	0.172	0.157	0.146	0.136	0.128	0.122
	Volume L/sec	0.792	0.560	0.396	0.354	0.323	0.280	0.251	0.229	0.212	0.198	0.187	0.177
3"	Rate m/sec	0.679	0.480	0.339	0.303	0.277	0.240	0.215	0.196	0.181	0.170	0.160	0.152
	Volume L/sec	1.967	1.391	0.984	0.880	0.803	0.695	0.622	0.568	0.526	0.492	0.464	0.440
4"	Rate m/sec	0.813	0.575	0.407	0.364	0.332	0.287	0.257	0.235	0.217	0.203	0.192	0.182
	Volume L/sec	4.076	2.882	2.038	1.823	1.664	1.441	1.289	1.177	1.089	1.019	0.961	0.911
6"	Rate m/sec	1.090	0.771	0.545	0.488	0.445	0.385	0.345	0.315	0.291	0.273	0.257	0.244
	Volume L/sec	12.897	9.120	6.449	5.768	5.265	4.560	4.078	3.723	3.447	3.224	3.040	2.884
8"	Rate m/sec	1.256	0.888	0.628	0.562	0.513	0.444	0.397	0.363	0.336	0.314	0.296	0.281
	Volume L/sec	23.995	16.967	11.997	10.731	9.796	8.483	7.588	6.927	6.413	5.999	5.656	5.365
10"	Rate m/sec	1.535	1.085	0.767	0.686	0.627	0.543	0.485	0.443	0.410	0.384	0.362	0.343
	Volume L/sec	50.483	35.697	25.241	22.576	20.609	17.848	15.964	14.573	13.492	12.621	11.899	11.288
12"	Rate m/sec	1.689	1.194	0.845	0.755	0.690	0.597	0.534	0.488	0.451	0.422	0.398	0.378
	Volume L/sec	77.056	54.487	38.528	34.461	31.458	27.244	24.367	22.244	20.594	19.264	18.162	17.230

Arched Mesh Pipe Flow Rate & Flow Volume (water depth d / Pipe diameter high h = 0.9 non-full flow) roughness coefficient n = 0.015

管徑	坡度	1/50	1/100	1/200	1/250	1/300	1/400	1/500	1/600	1/700	1/800	1/900	0.0010
2"	Rate m/sec	0.538	0.380	0.269	0.241	0.220	0.190	0.170	0.155	0.144	0.135	0.127	0.120
	Volume L/sec	0.901	0.637	0.450	0.403	0.368	0.318	0.285	0.260	0.241	0.225	0.212	0.201
3"	Rate m/sec	0.670	0.474	0.335	0.299	0.273	0.237	0.212	0.193	0.179	0.167	0.158	0.150
	Volume L/sec	2.225	1.574	1.113	0.995	0.908	0.787	0.704	0.642	0.595	0.556	0.525	0.498
4"	Rate m/sec	0.802	0.567	0.401	0.359	0.328	0.284	0.254	0.232	0.214	0.201	0.189	0.179
	Volume L/sec	4.608	3.258	2.304	2.061	1.881	1.629	1.457	1.330	1.231	1.152	1.086	1.030
6"	Rate m/sec	1.076	0.761	0.538	0.481	0.439	0.380	0.340	0.311	0.288	0.269	0.254	0.241
	Volume L/sec	14.623	10.340	7.312	6.540	5.970	5.170	4.624	4.221	3.908	3.656	3.447	3.270
8"	Rate m/sec	1.240	0.877	0.620	0.554	0.506	0.438	0.392	0.358	0.331	0.310	0.292	0.277
	Volume L/sec	27.026	19.110	13.513	12.086	11.033	9.555	8.546	7.802	7.223	6.756	6.370	6.043
10"	Rate m/sec	1.515	1.071	0.758	0.678	0.619	0.536	0.479	0.437	0.405	0.379	0.357	0.339
	Volume L/sec	57.270	40.496	28.635	25.612	23.381	20.248	18.110	16.533	15.306	14.318	13.499	12.806
12"	Rate m/sec	1.667	1.179	0.833	0.745	0.680	0.589	0.527	0.481	0.445	0.417	0.393	0.373
	Volume L/sec	86.955	61.487	43.478	38.888	35.499	30.743	27.498	25.102	23.240	21.739	20.496	19.444

Slope determination

The pipe inclination (water flow direction) is determined by the topography and the mesh pipe flow rate, and the slope of the pipe is designed according to the terrain condition and the slope of the surface.

Mesh pipe water flow speed range: The mesh pipe flow rate (0.2m/sec) or more can remove the deposits in the pipe, and the mesh pipe flow rate (1.0m/sec) or more may cause vibration.

ECO-MESH

DMWSM-Rainwater Conservation Mesh Wells Module
Aquifer Recharge Aquifer Storage and Recovery

Mesh Wells Water permeability

Well permeable surface area (Aw)=Well area+ Bottom area = Well Water permeable area (m^2)

πR x (Well Length) +πR^2=Water permeable area (m^2)

A_w Well permeability surface area

Code	Φ	ID/m	L	L	L	L	L	L	L	L
			0.6m	1m	5m	10m	15m	20m	25m	30m
WSO-150	6"	0.148	0.296	0.482	2.341	4.664	6.988	9.312	11.635	13.959
WSO-200	8"	0.193	0.393	0.635	3.059	6.089	9.120	12.150	15.180	18.210
WSO-250	10"	0.239	0.495	0.795	3.797	7.549	11.302	15.054	18.806	22.559
WSO-300	**12"**	**0.290**	**0.612**	**0.977**	**4.619**	**9.172**	**13.725**	**18.278**	**22.831**	**27.384**
WSO-400	16"	0.390	0.854	1.344	6.242	12.365	18.488	24.611	30.734	36.857

Q_w : A_o x k x t

12" Well permeability (Soil permeability coefficient K：10^{-5}m/s Clay Soil)

Code	Φ	ID/m	Pipe Depth	Pipe surface	Volume	Volume
			m	Area	M^3/hr	M^3/day
WSO-300	12"	0.290	0.6	0.612	0.022	0.53
			1.0	0.977	0.035	0.84
			5.0	4.619	0.166	3.99
			10.0	9.172	0.330	7.92
			15.0	13.725	0.494	11.86
			20.0	18.278	0.658	15.79
			25.0	22.831	0.822	19.73
			30.0	27.384	0.986	23.66

12" Well permeability (Soil permeability coefficient K：5*10^{-5}m/s)

Code	Φ	ID/m	Pipe Depth	Pipe surface	Volume	Volume
			m	Area	M^3/hr	M^3/day
WSO-300	12"	0.290	0.6	0.612	0.110	2.65
			1.0	0.977	0.176	4.22
			5.0	4.619	0.831	19.95
			10.0	9.172	1.651	39.62
			15.0	13.725	2.471	59.29
			20.0	18.278	3.290	78.96
			25.0	22.831	4.110	98.63
			30.0	27.384	4.929	118.30

12" Well permeability (Soil permeability coefficient K：10^{-4}m/s)

Code	Φ	ID/m	Pipe Depth	Pipe surface	Volume	Volume
			m	Area	M^3/hr	M^3/day
WSO-300	12"	0.290	0.6	0.612	0.220	5.29
			1.0	0.977	0.352	8.44
			5.0	4.619	1.663	39.91
			10.0	9.172	3.302	79.25
			15.0	13.725	4.941	118.58
			20.0	18.278	6.580	157.92
			25.0	22.831	8.219	197.26
			30.0	27.384	9.858	236.60

DMWS-Drainage Mesh Wells System

Roof Drainage

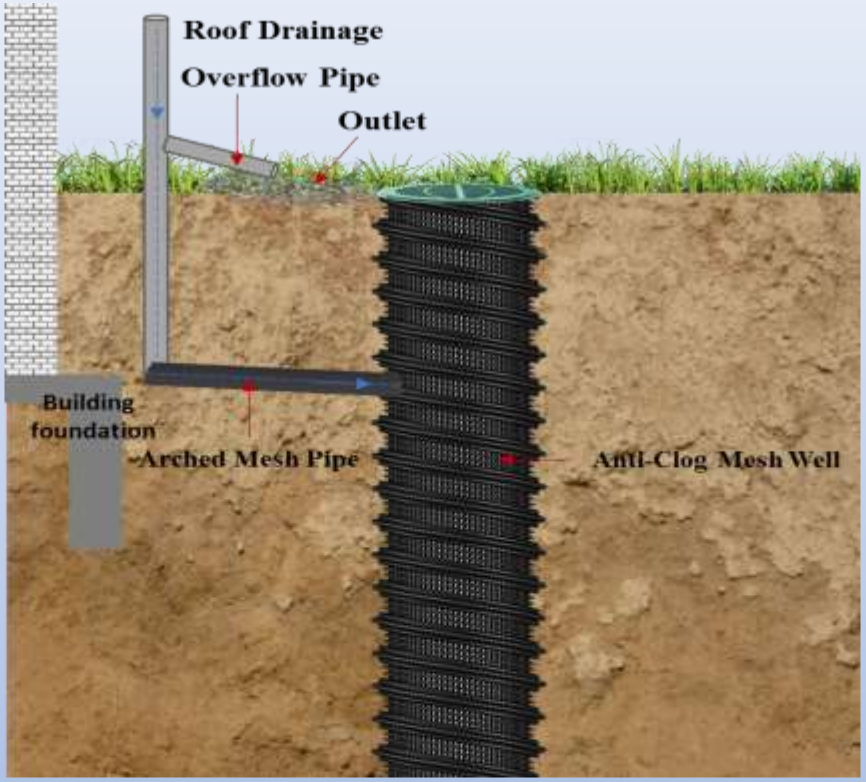
Aquifer Recharge Aquifer Storage and Recovery

DMWS-Drainage Mesh Wells System to replace the cement drain can save costs

DMWS is the best drainage system for preventing dengue fever

Recharge Aquifer

DMWS-Drainage Mesh Wells System-Roof Drainage Design



Roof Area: 20m*20m=400M²

Expected Rainwater : 50mm/hr

Q_f=C x I x A

Q_f ： expected Rainwater （m^3/hr）

C ：runoff coefficient

I ： Rainwater intensity 〈50mm/hr〉

A ： Roof area 〈$400m^2$〉

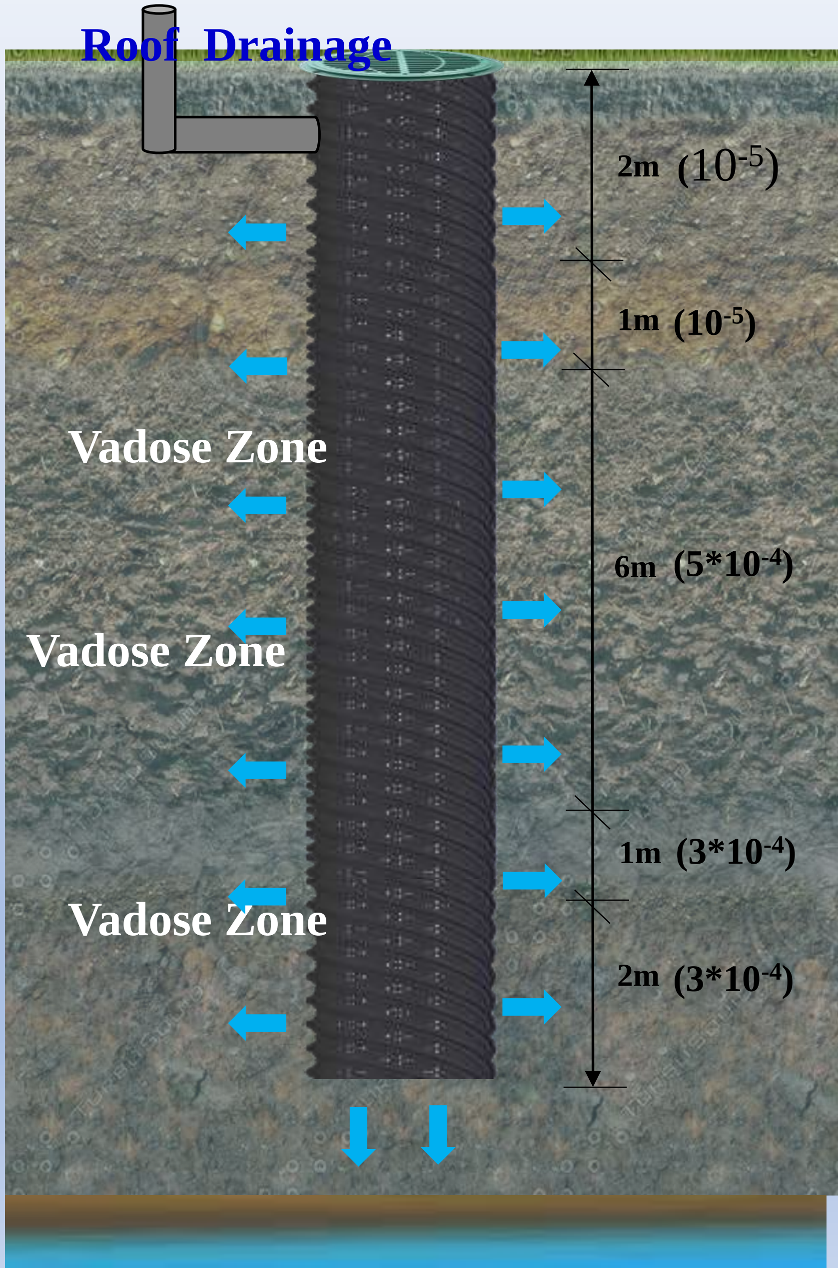
Q_f=0.9*(50/1000)*400=18.0M^3/hr

Q_w Penetration of permeable wells (Soil permeability coefficient K：10^{-4}m/s)

Code	Diameters	ID m	Q_0 : A_o x k x t (Penetration of permeable wells M^3/hr)							
			L=1m M^3/hr	L=5m M^3/hr	L=10m M^3/hr	L=15m M^3/hr	L=20m M^3/hr	L=25m M^3/hr	L=30m M^3/hr	L=35m M^3/hr
NSO-150	6”	0.148	0.173	0.843	1.679	2.516	3.352	4.189	5.025	5.862
NSO-200	8"	0.193	0.229	1.101	2.192	3.283	4.374	5.465	6.556	7.646
NSO-250	10"	0.239	0.286	1.367	2.718	4.069	5.419	6.770	8.121	9.472
NSO-300	12"	0.290	0.352	1.663	3.302	4.941	6.580	8.219	9.858	11.497
NSO-400	16"	0.390	0.484	2.247	4.452	6.656	8.860	11.064	13.269	15.473

DMWS-Drainage Mesh Wells System

Roof Drainage



Infiltration wells permeable area(A_w)

Pipe area+ Bottom area =Water permeable surface area (m^2)

$2\pi R$ x (Well Length) $+\pi R^2$=Water permeable surface area (m^2)

Q_w Penetration of permeable wells

(Soil permeability coefficient K : 10^{-4} m/s)

$Q_w : A_w$ x k x t/hr

$Q_w : A_w x\, k\, x\, t$

Q_w : DMWS Water permeability (m^3/hr)

A_w : DMWS Water permeability area（m^2）

k : Soil permeability coefficient or final infiltration rate (m/s)

t : Rainwater delay reference value(s)。

Code	Φ	ID/m	L/m	Bottom Area
NSO-150	6"	0.148	0.4647	0.0172
NSO-200	8"	0.193	0.6060	0.0292
NSO-250	10"	0.239	0.7505	0.0448
NSO-300	12"	0.290	0.9106	0.0660
NSO-400	16"	0.390	1.2246	0.1194

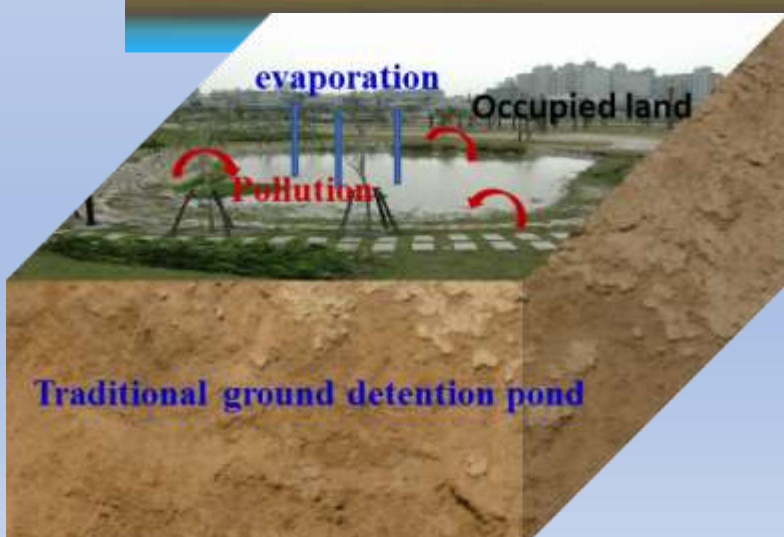
		L*3m	L*6m	L*3m	Bottom Area	M^3
Code	Φ	10^{-5}m/s	$5*10^{-4}$m/s	$3*10^{-4}$m/s	10^{-4}m/s	permeability /HR
NSO-150	6"	0.0502	8.030	1.506	0.006	9.592
NSO-200	8"	0.0655	10.472	1.964	0.011	12.512
NSO-250	10"	0.0810	12.968	2.431	0.016	15.497
NSO-300	12"	0.0983	15.735	2.950	0.024	**18.808**
NSO-400	16"	0.1323	21.161	3.968	0.043	25.304

$$Q_f=0.9*(50/1000)*400=18.0M^3/hr$$

ECO-MESH

DMWS-Drainage Mesh Wells System

Underground Flood Pond



DMWS-Drainage Mesh Wells System

Underground Flood Pond

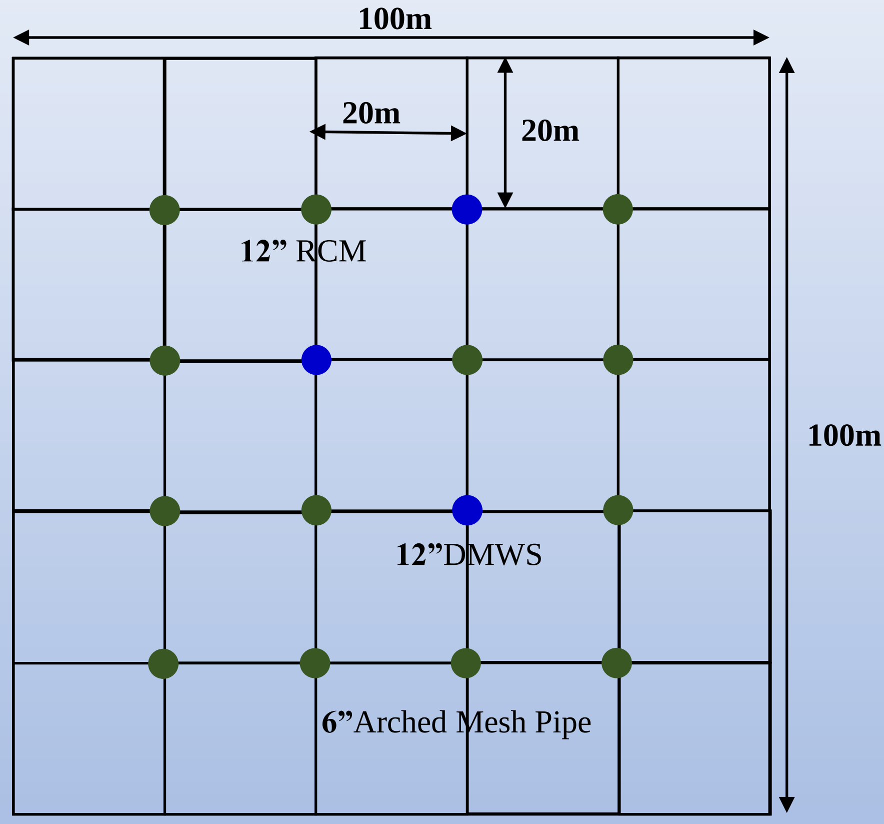
Discussion on planning of underground detention pond

The detention pond is the most commonly used method to reduce stormwater runoff, but it is more suitable for a wide range of development zones. For small-scale development bases or building plots in urban planning areas, there is currently no runoff regulation. It is recommended to revise the building regulations, set the specifications for building rainwater storage facilities, and share the responsibility for flood control.

The setting of the land for the flood detention pond will increase the development cost. In order to reduce the land cost and the underground of the flood detention pond, the parks, depressions and parking lots in the development zone should be matched with the location of the flood detention pond.

The underground aquifer is used as the water storage space, and the groundwater surface is usually several meters to several hundred meters deep underground, and the space is unlimited.

DMWS Drainage Design - 100m*100m



DMWS Drainage Design
Park 、Green Space
Area **: 100公尺* 100公尺**
Rainwater ***Q = C x I x A***
C=0.5
I=50mm/hr
A=10000M²

Rainwater ***Q = 0.5*50/1000*10000=250M³/hr***

DMWS - Materials

6” Arched Mesh Pipe slope **1/250**

Flow Rate **: 0.481 m/sec**

Flow Volume **: 6.54 L/sec=23.54M³/hr*4** inlets **= 94.17M³/hr**

12” DMWS *** 3 set = 94.17M³/hr* 3=282.48 M³/hr**

12” RCM*** 13** set **+6”**Arched Mesh Pipe *** 800m** Infiltration=**16M³/hr**

282.51M³/hr+ 18.5M³/hr=301M³/hr>250M³/hr

DMWS - Materials

6”Arched Mesh Pipe=1600m

12” DMWS= **3 sets**

12” RCM=13 **Sets**

DMWS-Drainage Mesh Wells System
Aquifer Recharge Aquifer Storage and Recovery

INTRODUCTION

Aquifer storage and recovery (ASR) is defined as "the storage of water in a suitable aquifer through a well during times when water is available, and recovery of the water from the same well during times when it is needed". Essentially, excess fresh water is infiltrated and stored in aquifers through wells or infiltration ponds, and recovered from the same wells when needed. Increasingly applied worldwide, it is often considered the technology of choice because :

1. Water can be stored for extended periods of time and recovered as needed;
2. There is insufficient aboveground storage space;
3. Water is well preserved, e.g. no algae growth;
4. The stored water is protected from external influences, such as temperature fluctuations, evaporation, contamination;
5. It eliminates the need for (expensive) water treatment and prevents the build-up of waste streams;
6. It helps create aboveground space for collection of peak precipitation and prevents the loss of precious fresh water.

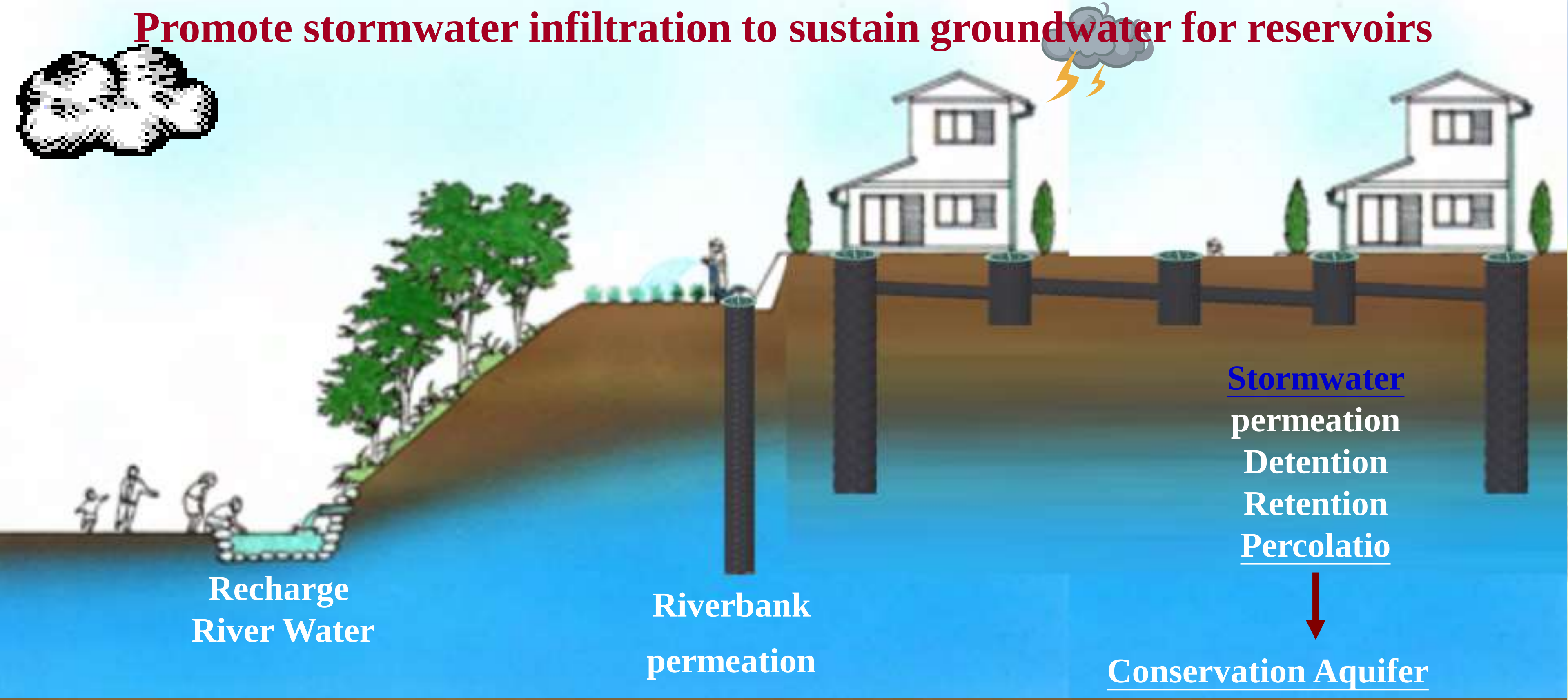
The technology is used in areas where the original groundwater quality is poor due to high salinity levels, or where the quality is suitable, but net extraction can cause damage as a result of dehydration. In the Netherlands, this technology is applied primarily at drinking water companies and increasingly in the greenhouse sector, where large quantities of rainwater are captured on the greenhouse roof and used as an ideal and low-cost source of tap water for irrigation.

DMWS-Drainage Mesh Wells System

Aquifer Recharge Aquifer Storage and Recovery

DMWS-Drainage Mesh Wells System

Promote stormwater infiltration to sustain groundwater for reservoirs



10 km^2 stores up to 200 million M^3 of groundwater

DMWS-Economical & Simple Solution

Reference

Quick facts

Dry wells have been used around the world for decades. They are used in Australia, Europe (e.g. UK and France), Asia (e.g. Japan and India), and the US.

Dry wells are also known as soakaways, soakwells, and soak pits.

The majority of U.S. states oversee their own dry well programs; the rest are regulated directly by the EPA.

States with large dry well programs (number of dry wells in state):

Washington: 100,000

Arizona: 52,000

Oregon: 46,000

California: 35,000

Aquifer Storage: A Promising Part of Texas Water Solutions

Among the state's water supplies, aquifers are a critical source of water for Texas. According to the Texas Water Development Board, Texas has nine major aquifers that produce large amounts of water over large areas, and 21 minor aquifers.

Beyond supplying water, aquifers may also play a key role in future water management for the state through aquifer storage and recovery (ASR).

With ASR excess water is injected into sand aquifers, and stored there until it's needed in a time of drought.

"ASR is desirable because the storage is underground, and there's no evaporation. Environmentally, it doesn't change the surface of the land. With a surface reservoir, those are big issues — evaporation and environmental challenges," Dr. Calvin Finch, director of the Water Conservation and Technology Center, said in a Texas Water Resources Institute article.

For Texas, ASR is a relatively new technology, but one that holds great promise. According to a 2011 Texas Water Development Board report, Texas will need almost 9 million acre-feet of new water per year by 2060. "It will be difficult for conservation and other traditional strategies, especially expensive, controversial surface reservoirs, to meet all of that demand," the report's executive summary notes. "The capture and storage of water when it is available is critical to sustainable water management. The escalating costs and environmental challenges associated with surface water reservoirs have encouraged water professionals to explore ASR."

Evaporation is a huge hurdle when it comes to surface water storage. During the 2011 drought and heat wave, Lake Travis lost 206,000 acre-feet to evaporation, significantly more than the 166,000 acre-feet the city of Austin drew from the lake. That same drought has spurred 13 study areas around Dallas that could become ASR sites.

Although Texas has not widely adopted ASR, there are two cities that are using it currently: San Antonio and Kerrville. The San Antonio Water System (SAWS) takes extra, permitted water from the Edwards Aquifer when water levels are high, and pumps it into the sandy Carrizo Aquifer. The Carrizo is a more stable place to hold the water – water in a sand aquifer tends to stay put, or move very slowly. SAWS currently has about 90,000 acre-feet of water stored, and can store up to 120,000 acre-feet. (One acre-foot equals 326,700 gallons).

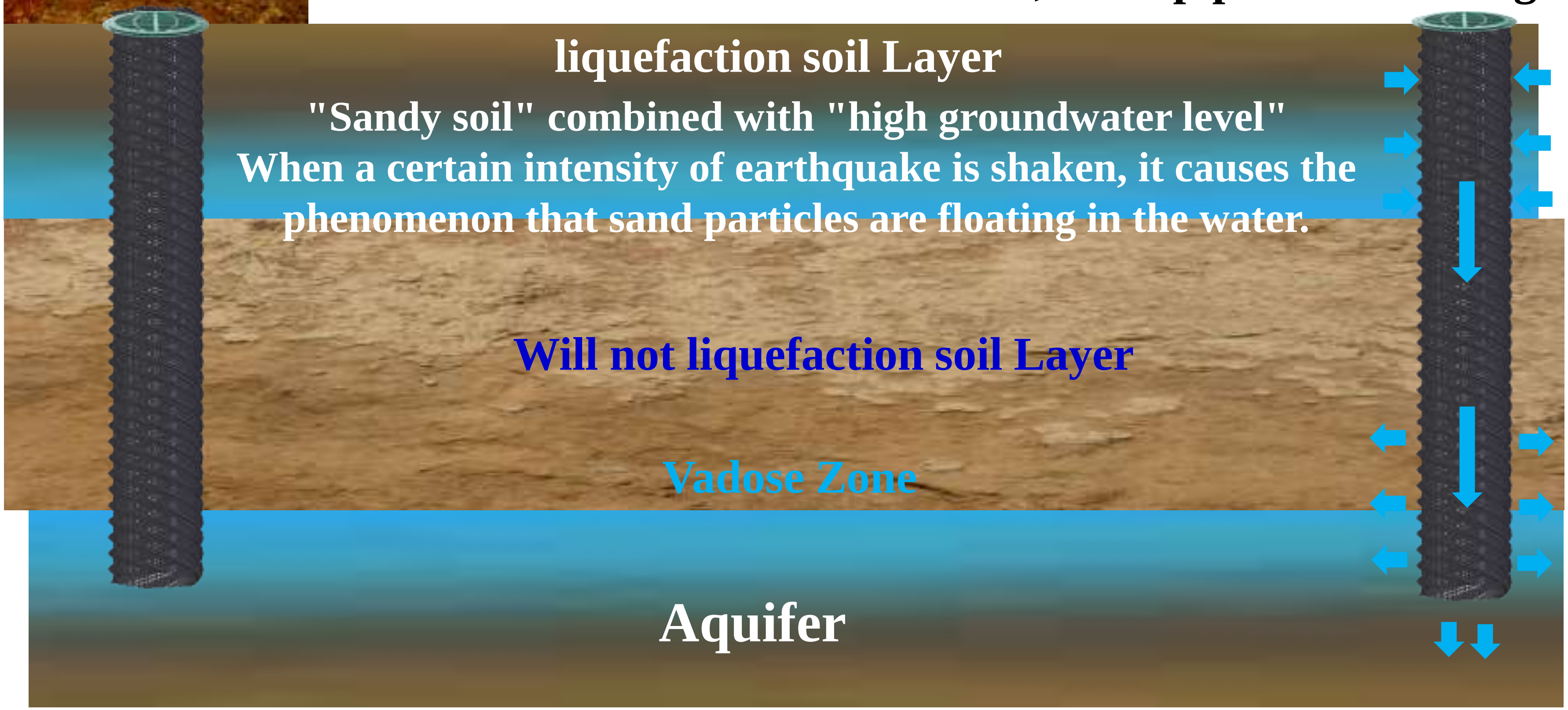
The city of Kerrville has been storing excess Guadalupe River water in its Lower Trinity Aquifer ASR system since 1990, and the city has two wells. Kerrville's target storage is 4,600 acre-feet.

DMWS-Drainage Mesh Wells System

Liquefaction Soil Improvement Wells System

Installation of vertical drains to allow the rapid dissipation of excess pore pressures generated during earthquakes to prevent liquefaction development, or desaturating potentially liquefiable soil, by permanently lowering groundwater or gas entrainment. Generally Earthquake Drains can be installed up to depths of about 25 m.

Drainage Mesh Well sidewall special design, without gravel, and other non-woven filter material, mesh pipe anti-blocking.



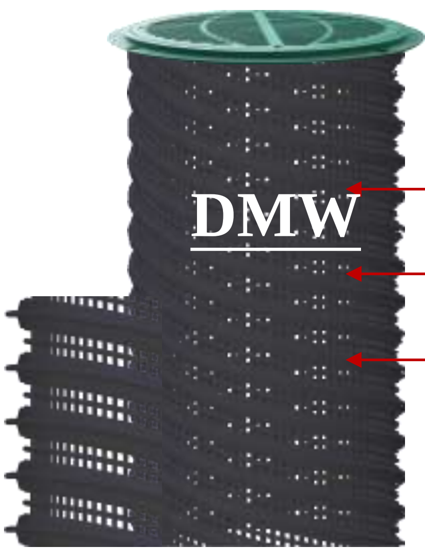
DMWS-Drainage Mesh Wells System
DMW-Drainage Mesh Wells (WSO)-Specifications

DMW-Drainage Mesh Wells (WSO)-Specifications

Mesh Wells straight connector specifications

Mesh Well		ID*OD	Pitch	Length
Size	Code	±3.0%mm	±3.0%mm	m
6"	WSO-150A	148*165	14.0mm	5m
8"	WSO-200A	195*216	14.5mm	5m
10"	WSO-250A	239*267	14.5mm	5m
12"	WSO-300A	290*318	15.0mm	5m
16"	WSO-400A	390*420	15.5mm	5m

Connector		ID*OD	Pitch	Length
Size	Code	±3.0%mm	±3.0%mm	cm
6"F	WSF-150A	166.0x183.0	14.5mm	35cm
8"F	WSF-200A	217.0*240.0	14.5mm	40cm
10"F	WSF-250A	268.0*290.0	14.5mm	45cm
12"F	WSF-300A	320.0*342.0	15.0mm	50cm
16"F	WSF-400A	422.0*452.0	15.5mm	55cm



The sidewall openings are fine mesh design

The sidewall has T-type thread design and high compressive resistance

Mesh Well sidewall is Anti-Clog and minimizes soil entry without extra filter material, such as non-woven fabric, gravel.