RAINWATER HARVESTING SYSTEM DESIGN GUIDE

A COMPLETE GUIDE TO DESIGNING AND IMPLEMENTING EFFICIENT RAINWATER HARVESTING SYSTEMS

RMS

RAINWATER MANAGEMENT SOLUTIONS™

About Us

RMS is a renowned industry leader specializing in comprehensive, turn-key solutions for advanced rainwater and stormwater management.

100+ YEARS

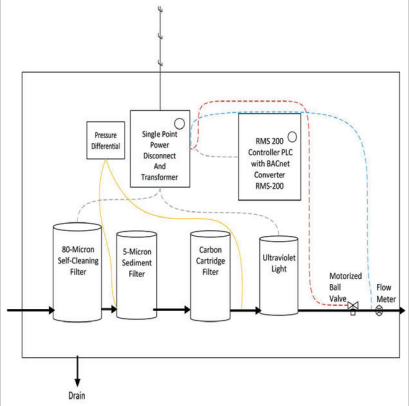
RMS has more than 100 years of combined experience in the rainwater & stormwater reuse industry

RMS provides comprehensive rainwater harvesting systems and solutions for residential, commercial, industrial, and agricultural projects. Also offered are expert design and consulting services, collaborating with development, engineering, and architectural firms that require specialized rainwater and stormwater management system design expertise.

ARCSA, ASPE, ASSE, IAPMO, & USGBC affiliated

- Feasibility studies including ROIs, tank sizing, and more
- Selecting treatment equipment, pump, and other integral equipment
- System integration
- 2D and 3D AutoCAD drawings
- Written specifications for standard, custom, and system-specific designs
- Retrofitting to existing buildings
- Start-up, commissioning, and training services support

RMS designs and builds custom treatment skids, pump skids, and controls



from inception...

to design...

to production

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Application Design

RMS has extensive experience in designing rainwater harvesting systems for a variety of water re-use applications such as:

- Toilet flushing
- Cooling tower make-up
- Vehicle washing
- Irrigation
- Fire suppression
- Laundry
- Process water
- Pool/pond filling

Climate Pledge Arena, Seattle, WA

- 740,000 square foot event arena
- Hosts NHL Seattle Kraken, WNBA Seattle Storm, and live music/events
- "Rain to Rink" system designed to use rainwater for the ice rink, toilet flushing, and building washing.
- Pre-filtered by one WISY WFF300 vortex filter
- 15,000-gallon custom order fiberglass tank
- 25-gpm water filtration skid
- Capable of providing approximately 855,000 gallons of water annually

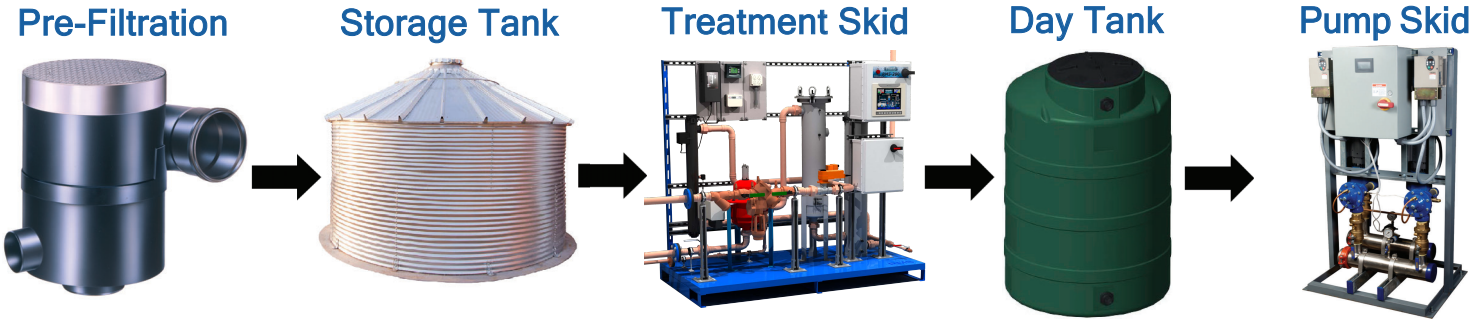
Fralin Biomedical Research Center at Virginia Tech Carillion, Roanoke, VA

- 145,000 square foot LEED Silver certified medical research facility owned by Virginia Tech
- Harvested rainwater is used for toilet flushing and outdoor irrigation
- Pre-filtered by two WISY WFF300 vortex filters
- 25,000-gallon concrete storage tank
- RMS three-stage water filtration skid

System Overview

The equipment for the filtration packages has been selected based on flow-rate capacity. As such, each package is named by the maximum flow rate capacity. Standard filtration packages range from 25 gallons per minute to 200 gallons per minute, available in 25 GPM increments. Maximum operating pressure is to be 125 PSI, with minimal operating pressure to be 30 PSI.

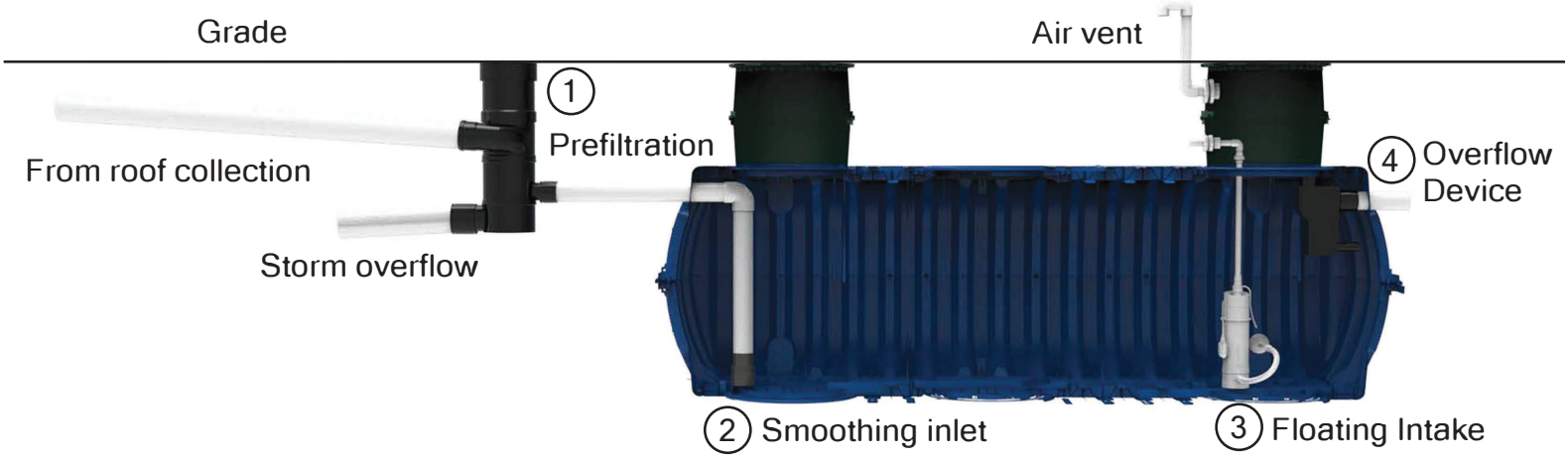
In applications which require higher flow rates and/or higher pressures at the end use, it is recommended to use a "Day Tank'" system. A transfer pump will pump water from the primary cistern, through the filtration skid, for storage in a smaller day tank. A booster pump can then draw water from the day tank and send it to the end use at the required flow rate and/or pressure. Filtration skids *should not* be placed on the suction side of booster pumps.



4-Step System

RMS has identified the WISY 4-Step System as the ideal method for rainwater harvesting.

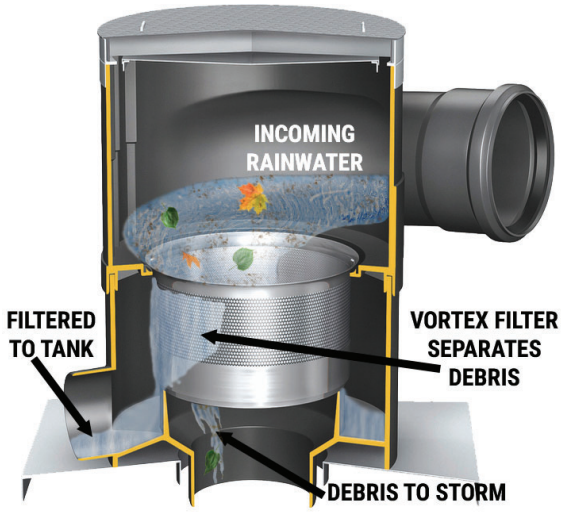
1. Pre-filtration reduces the amount of debris in the tank, promotes a healthy tank environment, and reduces system maintenance.
2. A smoothing inlet gently guides water into the tank to avoid disturbing settled particles.
3. Floating intakes draw water from just below the surface, where the water is cleanest. This reduces wear and tear on the pump and treatment system.
4. The overflow protection device skims the water's surface to remove floating particles.



Pre-Tank Filtration

Pre-tank filtration is the first step of the 4-step system. A pre-tank water harvesting filter has one inlet, a filtered water outlet and a debris/overflow outlet. These low maintenance filters prevent unfiltered water from entering the storage system. Pre-filtration devices reduce the amount of debris entering the tank, promote a healthy tank environment, and reduced system maintenance.

The polyethylene construction allows for direct burial. Load rated lids are available. Above grade installation is possible with available mounting brackets. Pressure rated stainless steel units are also available.



WISY Vortex Filter Sizes

4" WFF 100
280-micron filtration from up to 2,100 ft^2

6" WFF 150
280-micron filtration from up to 5,500 ft^2

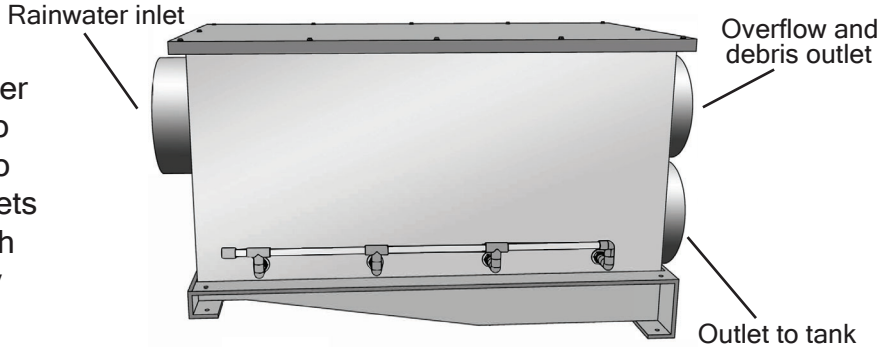
12" WFF 300
380-micron filtration from up to 32,000 ft^2

Stainless Steel Variants
For pressurized applications

Pre-tank filters do not allow debris larger than 400 microns to enter the tank under any circumstances. Pre-tank filters are highly efficient when sized correctly, generally with approximately 95% of water being sent to storage. The pre-tank filters are sized based on the catchment area and rainfall data for the specific location.

High Volume (HV) Filters

RMS HV pre-tank filters are designed to filter high volumes of water from roof areas up to 200,000 square feet. Sizes range from 6" to 24" with bottom and side filtered water outlets available. These products are available with slip fittings or flange fittings. Optional spray nozzles clean the filter element. Multiple levels of sediment removal are offered. Direct burial options are available.



Storage Options

RMS works with leading tank providers across the country to ensure that the tank will meet the project's requirements. RMS can manufacture tanks for custom applications where dimensions and atypical fittings may be a factor. A variety of storage tanks are available in above and below-ground applications with materials of construction including:

- Corrugated and Smooth Wall Metal
- Fiberglass
- Polyethylene
- HDPE Pipe
- Concrete
- Modular Tanks

Tank Sizing

RMS utilizes proprietary tank sizing software to identify the appropriately sized tank to ensure the proper amount of storage, allow for system overflow to promote water quality, and reduce costs when possible.

Tank Accessories

RMS provides tank accessories that help to optimize water quality, monitor tank conditions, and regulate pump activity.

Smoothing Inlet (Step 2 of the 4-step system):

- Minimizes turbulence from incoming rainwater
- Oxygenates the water to optimize water quality
- Available in 4" and 8" inlet sizes

Floating Intake (Step 3 of the 4-step system):

- Draws water from just below the surface, where the water is cleanest
- Available in 1", 1-1/4", and 2" intake with 1,200-micron or 300-micron filtration

Overflow Device (Step 4 of the 4-step system):

- Skims and removes floating particles from the water's surface
- Designed to prevent vermin, backflows, and storm drain odors from entering the tank
- Available in 4" and 8" inlet

Additional Accessories:

- Level sensors monitor and report the volume of available water in the tank
- Float trees anchor multiple float switches at different depths within the tank to activate pump/domestic backup functions

Pumping Systems

RMS has pumps to meet a wide variety of horsepower, flow, pressure/TDH, and voltage demands for your project requirements. RMS also builds custom, manufacturer- approved cooling jackets to house large pumps and motors.

- ☑ Above Ground/Booster
- ☑ Submersible
- ☑ Recirculation

Variable Frequency Drive (VFD)

RMS has partnered with industry leaders to develop a variable frequency drive (VFD) specifically for water harvesting. A variable frequency drive reduces energy spikes by powering the motor at an adjustable rate. A VFD reduces wear and tear on your pump motor and provides more consistency on pressure/flow output from the pump. A custom macro in the VFD reduces on-site start-up to merely setting desired pressure.

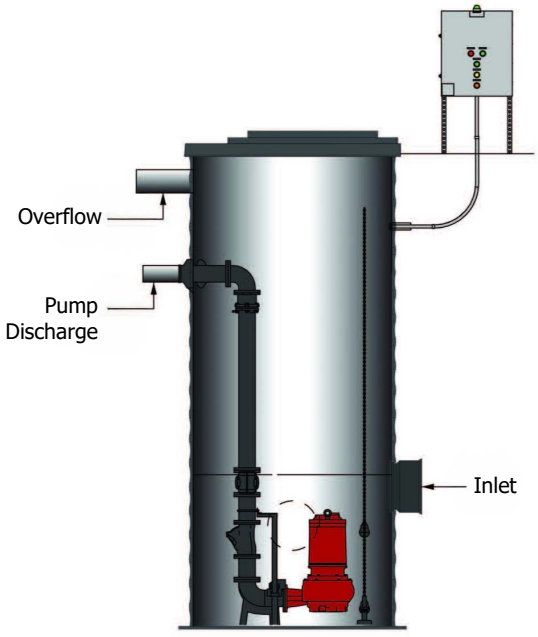
Booster Pump Skids

In addition to standard transfer pumps, which deliver water to a day tank or to end use, RMS offers booster pump skids designed to increase flow or pressure when desired. These powerful booster pumps are ideal for applications where higher pressure or flow rates are essential. Booster pump skids are also the perfect solution for flooded-suction applications, ensuring optimal performance and reliable water distribution even in challenging conditions.

Additional Pump Solutions

RMS offers several additional pump solutions to meet necessary design requirements. These include:

- Sump pumps
- Dry pit pumps
- Injection pumps
- Aeration pumps
- Complete pump basin packages



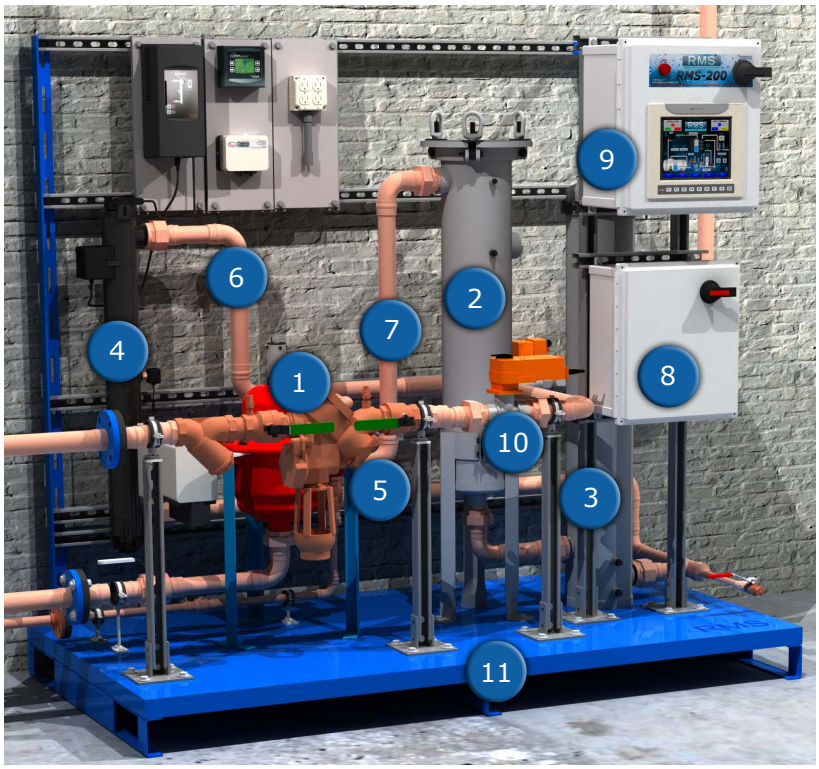
ADP Pump Basin

Standard Filtration Packages

After 25 years in the rainwater harvesting industry, RMS has identified the key components and the most effective methodology for filtering and disinfecting water for re-use. Potable, NSF compliant systems are available.

Basis of Design

1. Automatic Self-Cleaning Filtration for large particulates
2. Fine sediment filtration
3. Carbon Filtration to reduce discoloration and odor
4. Ultraviolet Light as disinfection method
5. Domestic Backup Connection for continuous water supply if rainwater is depleted
6. Flow Meter to monitor flow rate and totalized flow
7. Pressure Differential Transmitters for filtration maintenance alarm
8. Single Point Power Disconnect Panel for emergency discontinuation of power
9. RMS Controller UL Listed PLC with graphical interface suitable for BAS communication
10. Actuated Valve for backup water supply control
11. RMS Skid is powder coated carbon steel; various piping materials available upon request



Standard Skid Specs

Note: All standard skids have 80-micron automatic self-cleaning sediment filtration, 5-micron sediment filtration, max pressure of 110 psi, and a height of 72". Typical pressure loss across standard skids is 10 to 15 psi depending on the model.

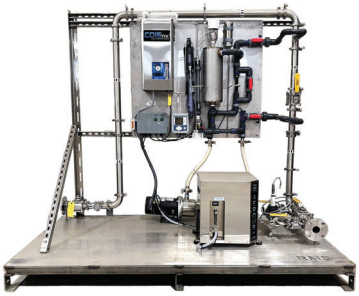
Model	Flow Rate (gpm)	Rainwater Inlet/Domestic Inlet/System Outlet	Length	Width
RWF 15	15	1"	42"	32"
RWF 25	25	1 ½"	60"	42"
RWF 50	50	2"	78"	42"
RWF 75	75	2"	78"	42"
RWF 100	100	3"	96"	52"
RWF 125	125	3"	104"	52"
RWF 150	150	3"	104"	52"
RWF 175	175	3"	104"	52"
RWF 200	200	3"	104"	52"
RWF 300	300	4"	128"	72"

Note: RWF 300 is not UL certified

Optional Treatment Equipment

Ozone

Ozone water treatment injects ozone (O_3) directly into the water to breakdown bacteria, viruses, and organic materials. This is a chemical-free method with no harmful residues that can handle a wide range of contaminants.

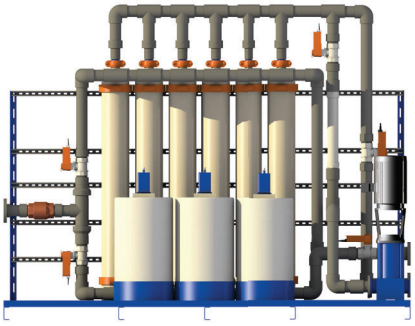


Chemical Injection

Chemical injection is used for applications such as disinfection, pH adjustment, oxidation, and coagulation. An injection pump introduces the selected chemical at the required rate (GPH/GPM) and pressure to ensure the desired concentration. Typical disinfecting chemicals used for water treatment are chlorine, chloramine, and chlorine dioxide.

Ultrafiltration

Ultrafiltration uses semi-permeable membranes to filter the water under pressure and remove contaminants 0.02 to 0.1 microns. This method of treatment is recommended when a particularly high concentration of organic material is present in the water, e.g. when collecting from a green roof.



Reverse Osmosis

Reverse osmosis (RO) uses a semi-permeable membrane under high pressure to remove contaminants. This method can reduce salts, bacteria, and other contaminants from the water. RO systems require pretreatment such as water softeners (where applicable) and carbon filters to reduce fouling of the membranes. This method produces reject water with a high concentration of contaminants that must be properly managed. RO is recommended when salt must be removed, e.g. when reusing rainwater from parking lots that are treated during winter months.

Special Media Filtration

Media filtration entails a wide variety of treatments such as sediment filtration via mechanical removal and ion exchange on a molecular level. Treatment strategies will depend on the targeted contaminants. Some examples of common media filtration for rainwater, stormwater, and greywater reuse are activated carbon, sand filtration, and Zeolite media filters. Reducing particulates along with odors is typically a target for a well-functioning system. Other media filtration examples are water softeners, green sand media filters, and Birm filters.

System Monitors

RMS has established relationships with leading manufacturers to ensure complete yet flexible product integration in our rainwater harvesting systems. RMS offers full-system integration through in-house design and manufacturing capabilities.

Components offered include (but are not limited to):

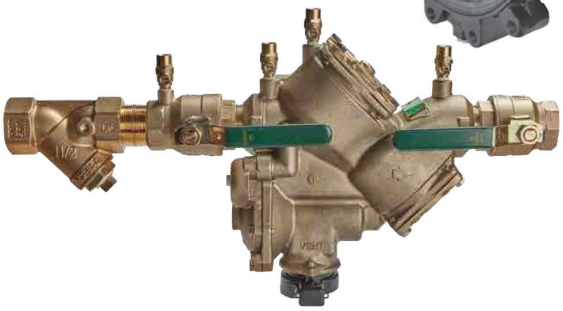
- Flow meters: ultrasonic and paddlewheel
- Level sensors: ultrasonic and pneumatic
- Pressure differential transmitters
- pH and chlorine sensors
- Oxidation reduction potential sensors
- Oxygen sensors
- Turbidity meters

These sensors relay accurate and timely information on system status, water quality and quantity, and more. RMS can integrate these components for control and monitoring through the RMS 200 controller, RMS 200 Mini controller, and other controls platforms.

Flow Control

RMS provides a variety of flow control equipment to meet needs for system operation. System controls can be programmed to automatically open or close motorized valves for features like low water level pump shutoff and backup water. Manual valves can be used for isolation or shutoff. Check valves and reduced pressure zones integrate additional water sources while preventing back flow. A wide variety of flow control equipment is available, including the following:

- Actuated/motorized control valves
- Butterfly valves
- Solenoid valves
- Manual ball valves
- Check valves
- Pressure reducing valves
- Reduced pressure zone (RPZ)



System Control

RMS offers custom rainwater harvesting controllers that are constructed, programmed, and tested in its UL 508A Panel Shop:

- RMS 200 Controller: 10.4" screen
- RMS 200 Mini Controller: 7" screen
- Run light boxes also available

These UL/CA listed PLCs are the "brains" behind our more advanced rainwater harvesting systems, monitoring digital and analog inputs to control outputs or display information pertaining to the system. Standard controllers can be outfitted with up to 64 digital inputs and outputs, with many additional customization options. Analogue inputs and outputs are also available. Controllers can integrate with building automation systems, allowing for remote monitoring of the rainwater system. Options for communication protocols include MODBUS RS485, MODBUS TCP, BACnet MS/TP, and BACnet IP. In addition, RMS has developed several basic controllers to operate and monitor systems.

RMS 200 Controller

The controls engineering and design team will provide a custom solution needed for any rainwater harvesting system, providing guidance throughout design, construction, operation, and maintenance. RMS can directly assist with any controller operation needs, no third party is necessary. Examples of typical monitoring points include:

Flow

- Flow Rate
- Pressure in Real Time
- Differential Pressure
- Totalized Flow

Water Quality

- pH
- Oxidation Reduction Potential (ORP)
- Chlorine Concentration
- Turbidity

Status

- Water Level
- Pump, Motor, and VFD Activity
- System Faults
- Valve Operation

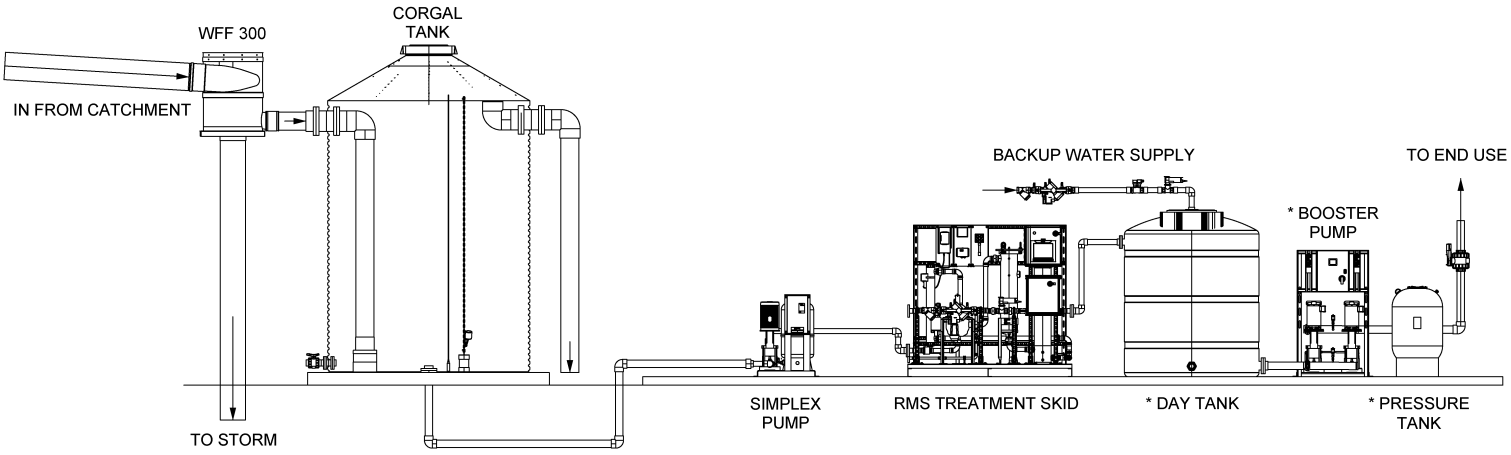
Single Point Power Disconnect

RMS provides UL listed power distribution panels. The Single-Point Power Disconnect Panel connects to building power at available voltage and phase. It provides a single point to emergency disconnect and includes step-down transformer to power 120V secondary and low voltage control wiring, thus minimizing the amount of on-site high-voltage wiring that must be completed at the job site. Typical designs will have all circuit protection located on-skid. The single high voltage line adds convenience that facilitates system maintenance.

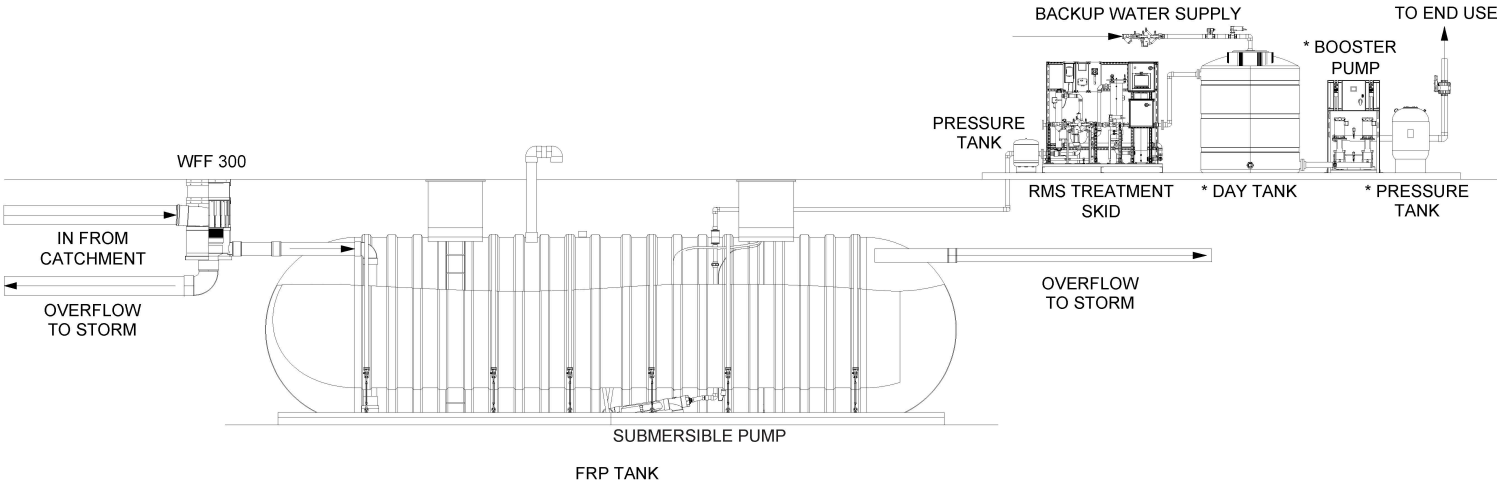
System Schematics

All system designs shown can be used in above and below ground applications. Schematics below are customizable to meet project needs and specifications.

Booster Pump with Treatment Skid to End Use



Submersible Pump with Treatment Skid to End Use



* Optional equipment based upon project requirements.

Submersible Pump with Treatment Skid to End Use

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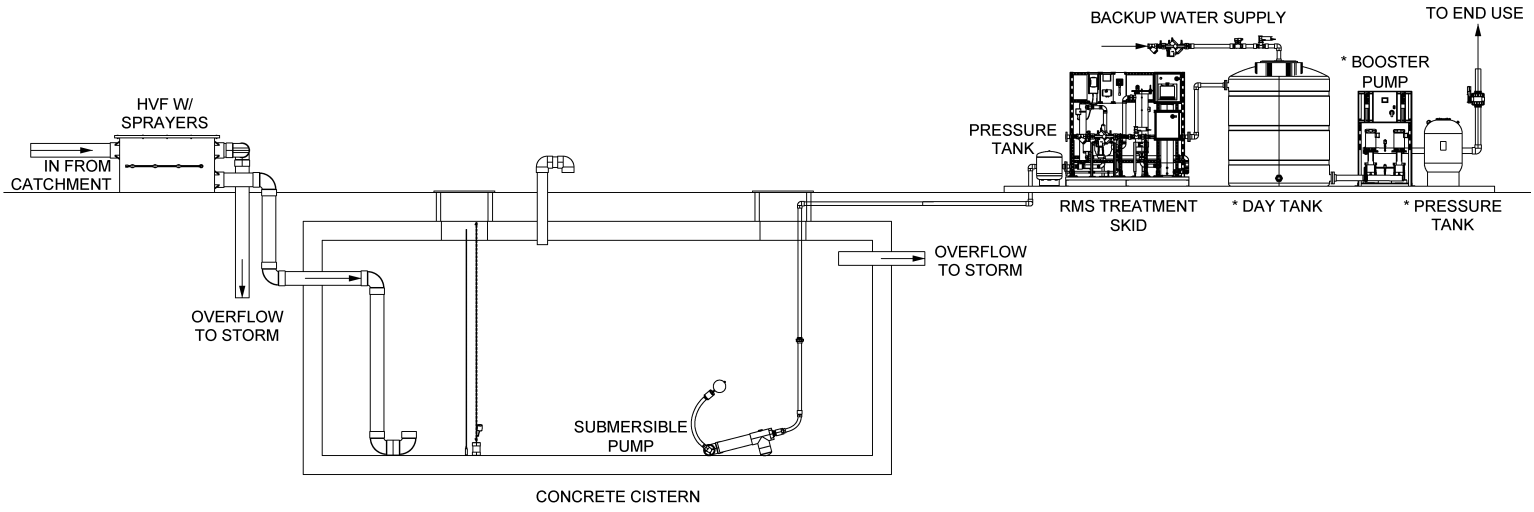

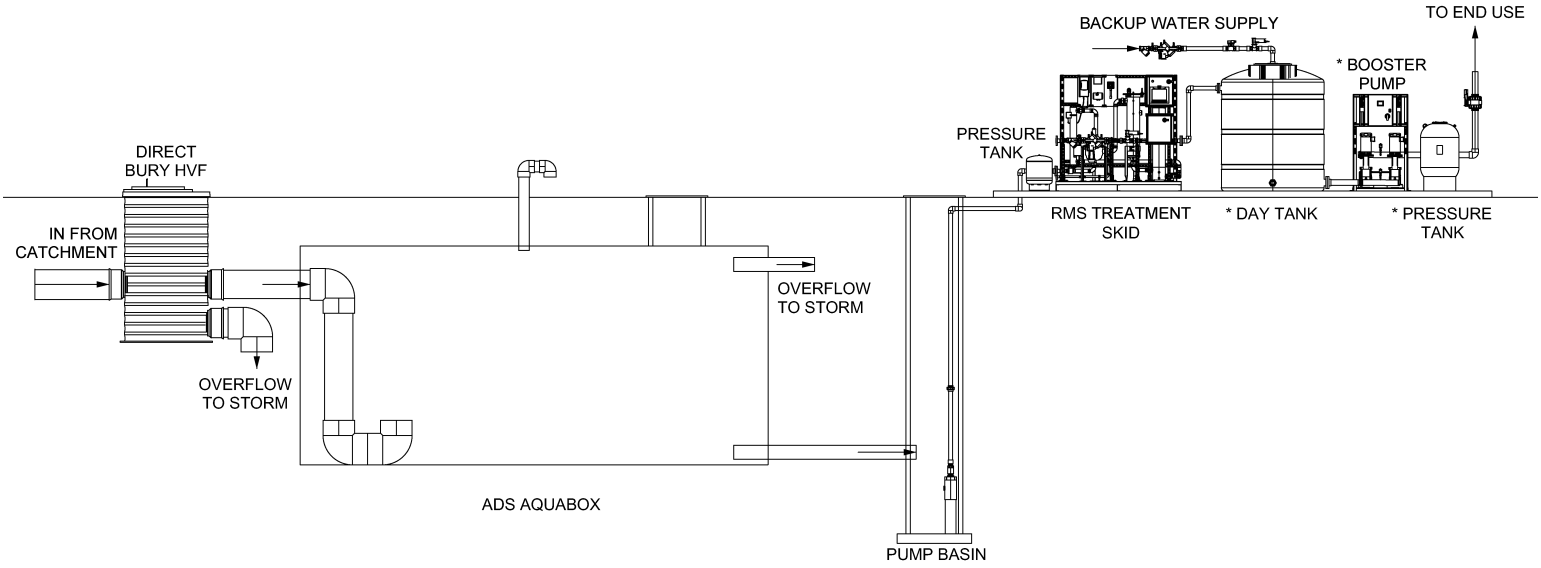

* Optional equipment based upon project requirements.

Design Notes

The schematics on pages 11 and 12 are fully customizable to meet specific project requirements. All systems shown are suitable for both above- and below-ground applications.

Pre-Filtration: A pre-filter in a rainwater harvesting system is a self-cleaning, in-line filtration device installed upstream of the storage tank to remove leaves, moss, sediment, and other particulates before water enters the cistern. Its purpose is to protect downstream components such as pumps, valves, and treatment systems by ensuring only clean rainwater reaches the storage tank, thereby improving system reliability and extending equipment life. Pre-filter selection is based on available roof square footage for collection, calculated flow and velocity of runoff, installation location, and source water.

Cistern Tank: Selecting the proper cistern tank volume requires considerations of collection roof area, location, precipitation events, and demand. A smoothing inlet should be installed on the incoming line of the cistern to direct water in an upward and controlled manner, preventing disturbance. Allowing periodic overflow facilitates natural cleansing by flushing out floating particulates. A cistern's overflow capacity must always match or exceed the inlet capacity to prevent hydraulic bottlenecks. A submersible level sensor allows for real-time display of water level. The cistern tank shall be equipped with float switches on a float tree assembly, including a low-water cut-off float that also signals the backup water supply to supply end use demand and a top float indicating a full tank and overflow condition.

Cistern Tank Pump(s) and Controls: A submersible well-type cistern transfer pump shall be selected to operate and deliver designed output. The cistern tank pump shall be installed in a manufacturer-approved cooling jacket and each cooling-jacket shall be supplied by one or multiple coarse floating filter intakes, depending on size and designed flow rate. A variable frequency drive with pressure sensor for the cistern transfer pump shall control the cistern tank pump and provides constant pressure to system to fulfill demand.

Water Treatment: The rainwater treatment skid shall consist of a powder-coated steel frame plumbed in Type L copper with compression fittings, with optional construction in Schedule 80 PVC, stainless steel, or PEX up to 1 inch. The treatment skid consists of an automatic self-flushing sediment strainer with an 80-micron screen operating solely on water pressure, a 304 stainless-steel bag filter housing with 5-micron replaceable filter bags, a 304 stainless-steel carbon filter housing with replaceable cartridges and an ultraviolet (UV) light disinfection unit equipped with a UV transmittance monitor. A pressure differential monitoring across filter housings, flow indicator tracking current flow rate and totalized flow, and an end-of-skid control valve.

Controller: U.L. Listed RMS Controller PLC with color touchscreen displaying a likeness of entire system, providing monitoring points of system parameters including but not limited to PSI system reading(s), UV light fault, pump faults, cistern tank level, day tank level, and alarms.

Single Point Power Distribution Panel (Electrical Disconnect): To be located within visual sight of the pump system in compliance with local codes. Includes a UL listed assembly consisting of a polycarbonate enclosure, primary and secondary transformer, branch circuit protection, and main disconnect.

Backup Water Equipment: Includes an actuated valve controlled by the water harvesting system to supply backup water when collection cistern levels are inadequate. A reduced-pressure zone (RPZ) assembly with backflow prevention, approved and inspected by the authority having jurisdiction and installable on the skid or near the Day Tank. Flow indicators for harvested and backup water supply(ies) that track and monitor current flow rates and totalized flow.

Day Tank: Utilized when varying demand usage and/or high pressure requirements such as what's needed for high-rise buildings is being required. Also known as a break tank, it allows treated rainwater and backup water supply(ies) to fill a single vessel and be on stand-by for when water is demanded. The day tank will often include multiple non-mercury float switches controlling the rainwater and backup water supply(ies) fill valves in addition to protecting the booster pump system from dry running. Utilizing a level sensor allows real-time display of day tank level.

Booster Pump System: A flooded-suction booster pump skid with each pump delivering designed output and is supplied with a variable frequency drive to supply the system with constant pressure. A dedicated touchscreen controller shall be supplied with each pump system and is powered by the local Single Point Power Disconnect Panel. The booster pump system will come equipped with an ASME-rated pressure tank installed off skid.

Notes:

Ready to get Started?
You can call us at +1 866-653-8337 or 540-375-6750, email us at info@rainwatermanagement.com, or visit us at www.rainwatermanagement.com. Can't wait? Get started design today by scanning the QR code below. There you will find system schematics and forms for design assistance that you can submit today.

Get Started Today

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