Santa Fe Opera:
Water Harvesting and Drainage Project

The planter on the opera terrace was leaking into the offices below. We excavated to find a Styrofoam base with drainage pipe above it. Three to four inches of water would accumulate with no where to go but into the building. (photo at left) Other pipes in the planter were connected to a roof water harvesting system. We had to excavate the entire planter and store all materials on the terrace in a way that protected all surfaces. We were asked to do this at the beginning of a rainy season, two weeks before the opening of the opera. With material lead times we had 4 days to complete the job before opening day. Afternoon work was restricted by orchestra rehearsals.

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Our solution was to install a layer of gravel to provide a slope at the planter bottom. On top of this we added a plastic membrane to create a trough for the water to run in. This had to be glued to the planter wall and sealed with silicone. On the membrane, a drainage tile was installed to create a flow space for the water. On this, a filter fabric was placed to separate the drainage structure from the soil. (All in photo to left). Piping from the roof drainage above had to be connected to our system and run through the floor of the planter to the main drain. (Center photo) This drainage was harvested into storage tanks for reuse. Finally the soil, plants, and mulch were replaced (Photo upper right.) This was all accomplished in time for opening day. Installation was done by Earth & Water, Inc.

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Low Profile Polyethylene Tanks

This installation had several buildings in a compound. The area available for storage was in a corner of the property that borders another property (#1). The tightness of the sight made digging for a buried tank impractical. The topography divided the land into two watersheds. Each was drained to a sump for pumping across the property (#2 & 3). The Tanks were required to fit in the space vertically as well as horizontally due to historic neighborhood restrictions, and the space was too tight to excavate for buried tanks. Six horizontal nurse tanks were selected for a total capacity of 9,000 gallons. The tanks are connected in parallel by a manifold for isolation in case of the need to clean or repair one of them.


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Polyethylene "Tuna Can" Tanks

Collaborative project with Ecoscapes, LLC

This home had the majority of the drainage directed to the rear of the home as sheet flow from the patio or as pipe flow which exited from the rear wall. (#1). The runoff from the home and hardscape had created erosion and subsidence as deep as 2 feet (.6 meters). (#2). The owner had a site with good fall to a viable tank location. The collection and conveyance was done with grates and pipes at the exits of sheet flow from the patio. (#3) The piped exits were connected to down pipes at the wall. (#4) A driveway in the front of the house was also harvested with a grate and channel system. All of the conveyances enter the system via an in ground foul flush system using square plastic sumps. The conveyance system was painted to match the walls.

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Polyethylene "Tuna Can" Tanks

Collaborative project with Ecoscapes, LLC

These tanks were named because of their shape which is wide and low. Each tank has a 5000 gallon (18,925 liter) capacity. The low profile creates opportunities to install tanks where a taller tank would be a visual problem, or where the lower profile can create a gravity versus a pumped conveyance. This system used "Tuna Cans" in an arroyo at the rear of the property. The head of the arroyo was on the property so stormflows could be controlled with a series of check dams. The harvesting of rainwater from the site also directed most of the flows from the arroyo into the tanks. The arroyo sidewalls were modified by collapsing them to fill around the tanks. This created a more stable slope, and it provided the backfill to adequately cover the outlets and valves for freeze protection.

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Hybrid Pumped and Gravity Conveyance with Underground Tank

Santa Fe, New Mexico

This site is at the top of a hill. The addition of roof and hardscape accelerated the existing erosion problems (3). The owners wanted a responsible landscape and a solution to the erosion problems. An important element was converting storm water runoff to rain water harvesting. Rainwater is harvested from the roof and all of the hardscape via a system of drains (2 & 4). The drain pipes are visible in (1) as three vertical white lines. When painted, the drains will blend into the wall. In this same photo, the terrain can be seen to slope to a low point below the arrow. The tank is on the other side of the site, so a sump and pump were installed at the low point for conveyance. The other side of the home (5) allowed for two gravity conveyance systems.

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Hybrid Pumped and Gravity Conveyance with Underground Tank

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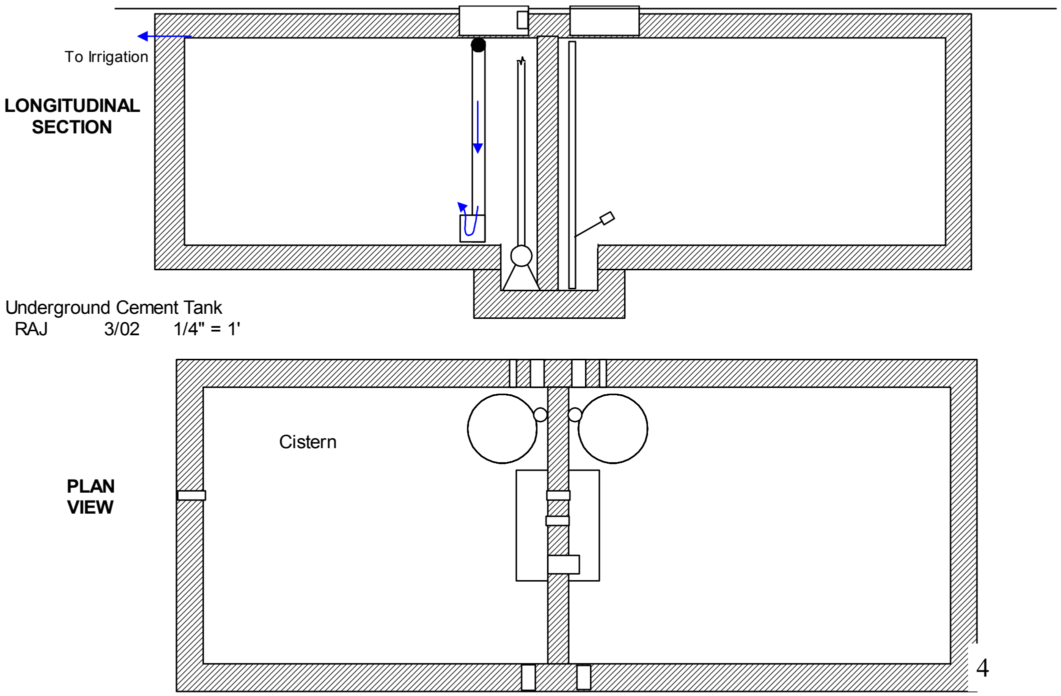
Both pumped and gravity fed conveyance pass through foul flush/ filter tanks. (1) These are sized to remove the first flush off of the surfaces and to filter out any large particle that follow.   The tank is excavated and formed with steel rebar. (2&3) It is then formed with pumped concrete.   The design is shown in (4).   The tank has two chambers each having the capacity for 10,000 gallons (37, 850 liters).   A central dividing wall with pass through valve allows either side to be isolated for cleaning or repair while the other side holds water. All pipes are unioned and sized so that they can be switched to the other side of the tank . The incoming rainwater enters via an inlet stiller so that sediment is not disturbed. A submersible pump is used for year round operation



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Rainwater Harvesting System

Sheet flow collection, filter bed, pumped sump

This property collected sheet flow from the driveway, roofs, and hardscape. It delivered all of the water through a rock lined channel to a sculptural dry pond. A primary filter was designed to sit in the pond and deliver the water to a secondary filter and to a sump pump. It was necessary to move and store all of the harvested water to the high end of the property 50 meters away so that the dry fire hydrant could be accessed by a fire engine.

Counter Clockwise from Top (Arrows show direction of Flow; Picture sequence is in the order of flow)

1. Sheetflow from driveway
2. Water Harvesting channel in patio
3. Outlet to filter
4. Primary and Secondary filters, Surge tank lid and Pump box

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Rainwater Harvesting System

Sheet flow collection, filter bed, pumped sump

Additional rainwater was harvested from the flagstone patio at the right. Drain core was installed at the base of the patio and this flow was connected to the filter pond. The detail for the main filter is shown at the lower right. Rainwater collected from the filter passes to a sump and then is pumped across the property to the tank. Stored rainwater is available for landscape irrigation and for fire protection. A dry fire hydrant is standard to all designs.

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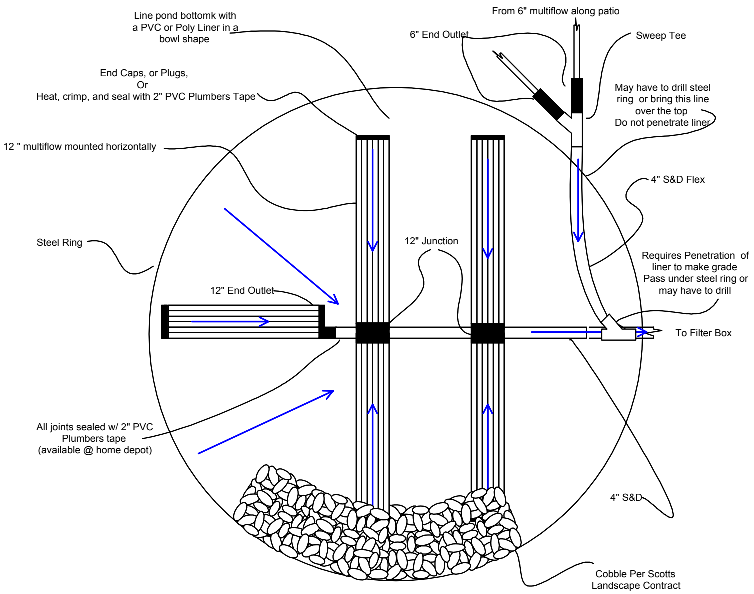

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Tar and Gravel Roof System

Santa Fe, New Mexico

Tar and gravel roofs are found throughout the Southwestern USA because, they are less expensive to build than other styles. Many of these roofs use “canales” to eject stormwater from the roof and allow it to fall to the ground. These canales must be modified so that flows are directed to downspouts, gravel is kept out of the pipes, and freezing water does not back up and pool on roofs in the winter. (3 & 4) The installed downspouts are painted to match the stucco. (5) All of the downspouts connect to lateral conveyance pipes. These are run to a sump and pump system (2). The rainwater is pumped to the two polyethylene tanks (1). A typical system uses 6000 gallons of tankage (22,710 liters) for a roof of 2000-2500 square feet (185-232 square meters). The system is used to irrigate landscape plantings. The annual average precipitation is 14 inches (355 mm). At an average efficiency of 70% this system will collect 15,300 gallons (58,000 liters)

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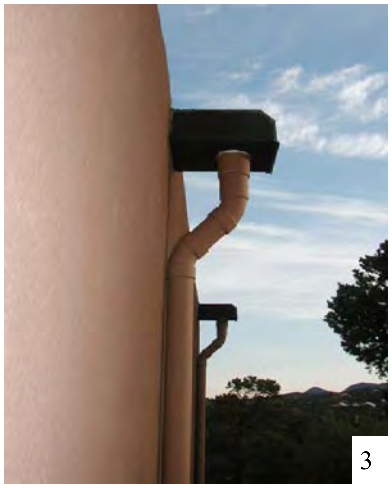

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This series of photos shows the components of an underground tank system for water harvesting. The tank in the photos is 10,000 gallons (37,850 liters).

These systems can use rain-water harvested from the roof. The tanks were originally made for gasoline stations but they can be ordered with a potable lining if required. In this case a used and refurbished tank was acquired. The pump and controls shown in the lower lefthand corner supply the harvested water for landscape irrigation. The system is controlled by an electronic “brain” shown in the photo below. The brain shows the level of water in the tank, and it automatically makes logical decisions about water useage. An important feature for a system in temperate, semi arid areas is to provide irrigation water during dry winters without freeze damage to components. These systems have that capability.

WATER HARVESTING SYSTEMS WITH UNDERGROUND FIBERGLASS TANKS

Santa Fe, New Mexico, USA

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Rainwater Harvest System

Trujillo, New Mexico USA

This home site is on a mesa where a well would not likely be successful. A rainwater harvesting system was chosen to provide water for construction and for the future residents. A pole barn was constructed to house the high density polyethylene tanks. This created a harvesting surface to begin filling the tanks. These tanks were the best choice for this site from the perspective of cost and delivery. While the tanks are not made to be completely buried, they can be partially buried. Our general burial specification is 2 feet (60 cm). This puts the outlets of the tank below the local frost line. All tanks are individually valved for cleaning and repairs. The structure on the right is the pump house. This will contain inlet filtration from the roof of the pole barn and from the roof of the house. The water will be pumped using photovoltaic power to the residence. A composting toilet is planned so that greywater will be the only effluent produced. This effluent will be gravity fed to mulch basins for watering native landscape plants.

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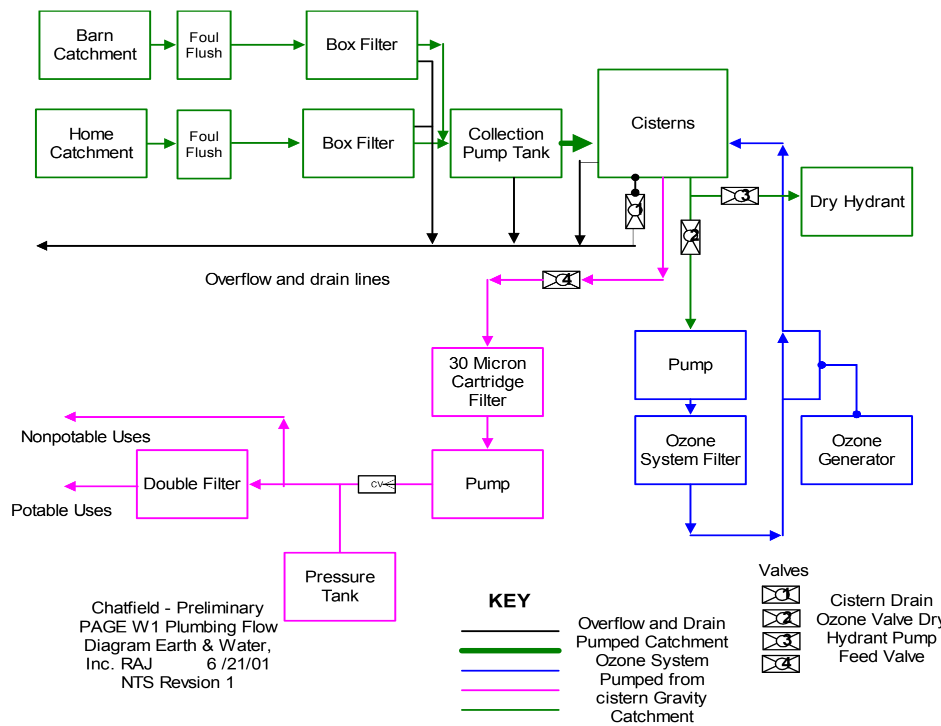

Rainwater Harvesting System

Horse Arena in Cañada de Los Alamos, New Mexico

We were asked to create a drainage system for this facility, thus treating the stormwater as a problem to be disposed of into a local arroyo. At the same time, the owner had a 1/2 gpm well in an area of fractured granite. Our solution was to treat the stormwater as an asset. We installed a 10,000 gallon (37580 liter) catchment system from 3000 square feet (278 square meter) of metal roofs. Includes fast flow filter box, ozonization, and UV treatment. Pumps powered by photovoltaic system. Dry hydrant installed for fire protection. The entire system was less expensive than a risky new well, solving two problems at once. It provides drinking water for people and horses.

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Counter Clockwise from left:

1. Booming tank into the cut slope
2. Complete installation with box filter, well house, dry hydrant, Photovoltaic system
3. Self-Draining foul flush at each downspout

Rainwater Harvesting System

Cerrillos, New Mexico

This residence is in an area where the wells are failing. The water budget calculations showed the potential for using rainwater for all of their potable needs. Water is harvested from 3855 square feet (358 square meters) of metal roof . At 90% efficiency the yield will be 30,300 gallons (114,685 liters) per year. This will provide 41 gallons (155 liters) per day to each of the two residents. The tank is made of galvanized steel and it holds 10,000 gallons (37,850 liters) when full. This is a 120 day supply.

The rainwater is flushed and filtered (60 micron) before the tank inlet. It is filtered again at the outlet (30 micron) and is treated with UV before pumping to the house. A sub-micron filter is installed in the kitchen for drinking water.

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