Alternate On-Site Water Sources

Many large commercial and industrial facilities can use water that is less than-potable quality for processes. There are a number of opportunities for various sizes and types of businesses to develop alternate on-site water sources. Some processes, however, require very high quality source water, so some types of reuse water require additional treatment to remove contaminants or constituents. Even typical disinfection by-products found in potable water must often be removed by specialized filtration, so such sophisticated processes can as readily begin with non-potable source water.

Potable water from a municipal water supply is often not necessary for commercial and industrial facilities. Either they require water of lesser quality or their processes require water that must be of much higher quality.

Alternative sources of water, which can be found on-site and used in these processes, may include:

- rainwater and stormwater
- air-conditioner condensate
- filter and membrane reject water
- foundation drain water
- cooling-tower blowdown
- on-site treated gray water and wastewater

Potential uses of alternate on-site sources of water include:

- irrigation
- cooling-tower makeup
- toilet and urinal flushing
- makeup for ornamental ponds, pools, or fountains
- swimming pools
- laundries
- processes
- any other use not requiring potable water

The use of treated effluent or reuse water provided by a publicly-owned water-treatment facility is not addressed in this section.

The initial step in determining the potential for alternate water sources is to identify the requirements — including water quality — that non-potable water can satisfy. After verifying that some demands can be met by non-potable water, determine the volume and quality requirements for the potential use. Each section below provides criteria for evaluating a potential water supply and includes basic considerations for system design, although, due to the site-specific nature of both non-potable water demand and potential supply, these are necessarily broad. The final section discusses the potential and design considerations for conjunctive use.

Source design and evaluation considerations include:

- determining volume and quality of the available on-site source
- identifying possible uses
- matching water quality to type of use
- deciding the type of treatment, if needed
- considering other basic factors for system design

Due to the unique circumstances of site size and orientation, air-conditioning loads, impervious cover, and water-quality constraints of the proposed end use *versus* the source water, cost-effectiveness evaluations are unique to each proposed business or industrial process. As a result, a number of techniques require a feasibility study at the proposed site to determine cost implications and payback period.

Rainwater Harvesting

Rainwater falls on large and small facilities alike. However, facilities with large areas of impervious cover can capture runoff and use the water for various non-potable purposes with little treatment. This section deals with methods available to facilities that capture water from their roofs. Those that capture water from paved surfaces are dealt with in the "Stormwater" section. Harvested rainwater can also be combined with air-conditioner condensate, the next option.

The type of roof surface impacts the quality of the rainwater runoff. For the highest quality rain water, especially if the water is to be used for drinking purposes or in-building uses such as flushing toilets and urinals, harvesting should employ smooth metal roofs and non-toxic, non-leaching surface finishes. Gutter design should employ at least a 1 percent slope and route water to a central collection point for transfer to a cistern or storage tank. The system will need a "roofwasher" or "first-flush diverter" to minimize the debris and detritus from the roof surface that enters the cistern.

For rainwater destined for landscape watering, consideration should be given to diverting water directly into landscaped areas, with swales and berms to capture and direct the flow. Care must be taken in designing such landscape rainwater harvesting to avoid long-term pooling of water and creation of potential insect vectors. Costs are considerably lower for systems which do not include tanks or cisterns, and slowing the water down to allow it to percolate into the landscape has stormwater runoff reduction benefits as well.

Approximately 0.62 gallons of water can be collected per square foot of collection surface per inch of rainfall. In practice, however, most installers assume an efficiency of 80 percent. Some rainwater is lost to first flush, evaporation from the roof surface, or splash-out from the gutters. Rough collection surfaces are less efficient at conveying water, and water captured in pore spaces is lost to evaporation.

The inability of the system to capture all water during heavy storms also affects practicable efficiency. For instance, spillage may occur if the flow-through capacity of a filter-type roofwasher is exceeded, and overflow rainwater will be lost after storage tanks are full.

The use of rainwater collection systems, also referred to as cisterns, is most practical in regions with periodic precipitation throughout a plant's growing season. For example, in California, since most regions don't receive precipitation during the summer, early fall, and late spring, cisterns are far less practical than in other parts of the country, because very large storage capacities are needed to capture enough water to use at any length into the irrigation season. Stated another way, the more frequent the precipitation, the smaller the needed storage facility and the less the capital costs.

Calculations

Annual production potential:

gallons = roof area (sq. ft.) x annual precipitation (in.) × (0.62 x 0.8)

Required annual storage capacity for the planned landscape should be determined as follows:

- Calculate the monthly water budget for the planned landscape using the water budget calculations in the section, “Landscape Irrigation Efficiency.”
- Estimate the monthly average rainfall quantities that could be harvested, based upon roof area and rainfall for the location.
- Estimate the amount of rainwater storage that would be cost-effective to construct, based upon monthly inflows from rainfall and outflows based upon the landscape water budget.

Recommendations

Proven Practices for Superior Performance

- Plumb gutter systems to facilitate rainwater catchment at commercial facilities.

Additional Practices That Achieve Significant Savings

- Have new commercial developments with more than 20,000 square feet of roof area to provide a preliminary feasibility study, including cost analysis, to determine whether rainwater harvesting is viable at the site.

Stormwater

Stormwater capture and reuse offers many unique opportunities and should be examined when stormwater systems are being designed. All new properties are now required to integrate stormwater management for water-quality purposes into the design (USEPA). The section, “Landscape Irrigation Efficiency,” discusses this topic in detail. Stormwater can be a valuable source for landscape irrigation, but only if it can be captured and held. The overall concept is to keep the rain on the site where it falls to the maximum extent possible. The water captured and held can displace part or all of the potable water otherwise used for irrigation and can optimize groundwater infiltration, water quality, and slow-release augmentation of local streams.

There are three ways this can occur:

- storage in the soil profile
- capture in on-site features, such as berms, swales, rain gardens, or terraces
- capture in a detention structure, such as a pond, from which it can be pumped back to the landscape

The first two rainwater-harvesting methods offer capture and reuse in relationship with stormwater control systems. Therefore, these often least-costly methods of harvesting rainwater also maximize the potential for stormwater to infiltrate groundwater resources. The section on “Landscape Irrigation Efficiency” includes design considerations. The newer Best Management Practices (BMPs) for stormwater control also enhance the ability to use stormwater as a resource for the landscape, even in more arid climates.

Recommendations

Proven Practices for Superior Performance

- Include capture in on-site features, such as berms, swales, rain gardens, or terraces, and the use of soil as a water-storage medium jointly in the design of landscape and stormwater facilities.

- Require stormwater ponds to be established or enlarged to accommodate long-term storage for landscape irrigation and other uses.

Additional Practices That Achieve Significant Savings

- Examine the potential of captured and stored stormwater along with other on-site water sources.

Air-conditioner Condensate

Require plumbing of heating, ventilation, and air-conditioning (HVAC) systems such that commercial and other types of facilities can collect air-conditioner condensate. Clarify in local ordinances the specific plumbing uses of alternative sources of water and their relationships to the potable-water system. This can be combined with previously described options for rainwater harvesting.

Condensate-recovery water can be used as make-up water for cooling towers. Due to its high water quality, it increases the cycles of concentration achievable in cooling towers. Condensate can also be used for irrigation and other non-potable uses. In the past, regulations have required that condensate be plumbed to the sanitary sewer. If it is used for landscape irrigation, provisions may have to be made to divert water collected during coil cleaning to the sewer, if copper concentrations would be of concern.

Since air-conditioning condensate production depends upon cooling load, relative humidity, and make-up-air volumes, someone familiar with psychometric relationships and air-conditioner system design must carefully calculate the amount of condensate produced.

Examples combining harvested rainwater and air-conditioner condensate include:

- The University of Texas, where combined sources provide an estimated average of 110,000 gallons of water a day, of which air-conditioner condensate makes up as much as half
- The Austin Resource Center for the Homeless (ARCH), where toilet flushing and landscape irrigation use rainwater and air-conditioner condensate.

Recommendations

Proven Practices for Superior Performance

- Change regulations that require condensate to be discharged into a sewer to allow for other alternative uses.
- Commercial sites with more than 100-tons of air-conditioning must examine the feasibility of diverting all condensate drain water to a common point where it could easily be captured.

Filter and Membrane Reject-Water Recovery

Require plumbing of large and very-large filter and membrane systems to recover water that can then be used for landscape irrigation and other purposes. The product stream of membrane filters is water destined for the filtered end use and a reject stream traditionally routed to the sanitary-sewer system. However, other than elevated TDS, this water is often usable for other on-site purposes. When used in landscape irrigation, proper selection of landscape materials with high salinity tolerance is necessary. In specific circumstances, filter reject water may be used in other processes within a plant. Refer to sections on “Pools, Spas, and Fountains” and “Landscape Irrigation Efficiency” for additional information.

Examples of the use of filter-backwash and membrane reject water include:

- Swimming-pool backwash water at several City pools in Austin, Texas, is used to irrigate parkland.

- RO reject water, combined with water from a stormwater pond, is used for landscape irrigation at a major microelectronics manufacturing plant in Austin, Texas.
- Many industries use RO-reject water for cooling-tower make-up.

Recommendations

Proven Practices for Superior Performance

- New projects that employ filtration and membrane processes must provide a feasibility summary study of how these sources might be employed.

Foundation Drain Water

Foundation drain water, another source on large commercial campuses, is captured to preserve foundation integrity. It is typically routed through French drains to a common sump, where it can be gathered and pumped to replace potable water for uses such as landscape irrigation.

The purpose of a foundation drain is to remove water that could potentially harm the foundation and funnel it, by gravity flow, away from the building to a low spot in the landscape. A traditional foundation-drain system does not concern itself with the water after it leaves the drain outlet. Depending upon the location, this can involve very large quantities of water. Proper use of filter cloth or drain tile is necessary to prevent clogging of the drain lines. If designed in connection with a subsurface pipe system similar to a leach field, foundation drain water can be distributed over a larger area. Combined with appropriate landscaping, this can reduce or eliminate the need to use potable water for irrigation.

Recommendations

Proven Practices for Superior Performance

- New projects that employ filtration and membrane processes should provide a feasibility summary study of how these sources might be used.

Cooling-tower Blowdown

Evaluate the feasibility of reusing cooling-tower blowdown water for another purpose, such as diversion for compressors, vacuum pumps, and other equipment with water-cooled air-condenser units. A detailed analysis is beyond the scope of this section, but any such project should be closely coordinated with local stormwater and water-quality officials, since the type of cooling-tower water treatment will determine the quality of the blowdown water. Using blowdown water may offer a classic example of tradeoffs. In the section, “Thermodynamic Processes,” achieving the maximum numbers of cycles of concentration was a goal. This was based on a stand-alone cooling-tower operation. In this case though, if the need for irrigation water exceeds blowdown volumes at the site, the designer may wish to consider reducing the cycles of concentration and, instead, choose treatment that will produce blowdown suited for irrigation purposes. This also avoids water-quality problems for streams receiving runoff from the property. The net benefits of using blowdown are that it makes use of all the water entering the tower, displaces potable water use for irrigation, and eliminates wastewater discharge from the tower.

Another option is to use nanofiltration or RO to treat tower make-up water so that extremely high cycles of concentration can be achieved. Reject water can then be used for irrigation.

Recommendations

Proven Practices for Superior Performance

- New projects that employ filtration and membrane processes should provide a feasibility summary study of how these sources might be used.

On-site Treatment of Gray Water and Wastewater

Gray water is defined in California law as "untreated waste water which has not come into contact with toilet waste. Gray water includes waste water from bathtubs, showers, bathroom wash basins, clothes-washing machines, and laundry tubs, or an equivalent discharge as approved by the Administrative Authority. It also does not include waste water from kitchen sinks, photo-lab sinks, dishwashers, or laundry water from soiled diapers," in Title 24 section 5 of the Code. The use of gray water or on-site treatment of wastewater for on-site reuse requires a project-by-project analysis and is beyond the scope of this document. However, many commercial projects have employed technologies ranging from simply using septic tanks and near-surface dosing of the effluent for subsurface irrigation to the installation of full-capacity wastewater-treatment plants, followed by conventional landscape irrigation. Another example is treating effluent to a quality sufficient for toilet and urinal flushing.

As an example, the 250-unit Solaire Apartments in Battery Park was a private-public partnership and is the first "green" residential high-rise building that incorporates advanced materials, energy conservation, and water reuse in an urban setting. The Solaire Apartments selected the ZENON Membrane Solutions proprietary ZeeWeed MBR (membrane bioreactor) process to treat, store, and reuse wastewater for toilet flushing, irrigation, and cooling towers. This approach reduces the fresh water taken from the city's water supply by more than 75 percent and significantly decreases energy costs, since less drinking water is pumped from the city's treatment plant and wastewater is not transferred to the city's wastewater treatment system. The system is the first on-site water-recycling system in the U.S. built inside a multi-family, residential building.

Gray water from wash basins, bathing and showers, and laundry operations has also been considered.

A primary concern is to involve health-department, code-enforcement, and stormwater-quality officials in the design and development of any project to ensure that all applicable environmental concerns are taken into account, that appropriate technologies are employed, and that regulations are met.

Recommendations

Proven Practices for Superior Performance

- New projects that employ filtration and membrane processes should provide a feasibility summary study of how these sources might be used.

Multiple Sources

Plumbing of rainwater, gray water, drain water, and blowdown from various sources to common end uses, like landscape irrigation, or non-potable indoor uses, such as toilet flushing, is not common, but is recommended. Cost effectiveness of such "hybrid" systems is improved by diversifying the sources of water and improving the consistency of water availability, since rainfall episodes, often the largest and most significant single source of water, are sometimes separated by long dry periods.

Gray water generally does not contain fecal matter and, thus, can more easily be treated and reused on-site. Gray water requires simple filtration to remove suspended particles and, when stored, requires only treatments such as chlorination for odor or aeration for nutrients in the water.

Recommendations

Proven Practices for Superior Performance

- Clarify in local ordinances the specific plumbing uses of alternative sources of water and their relationships to the potable-water system