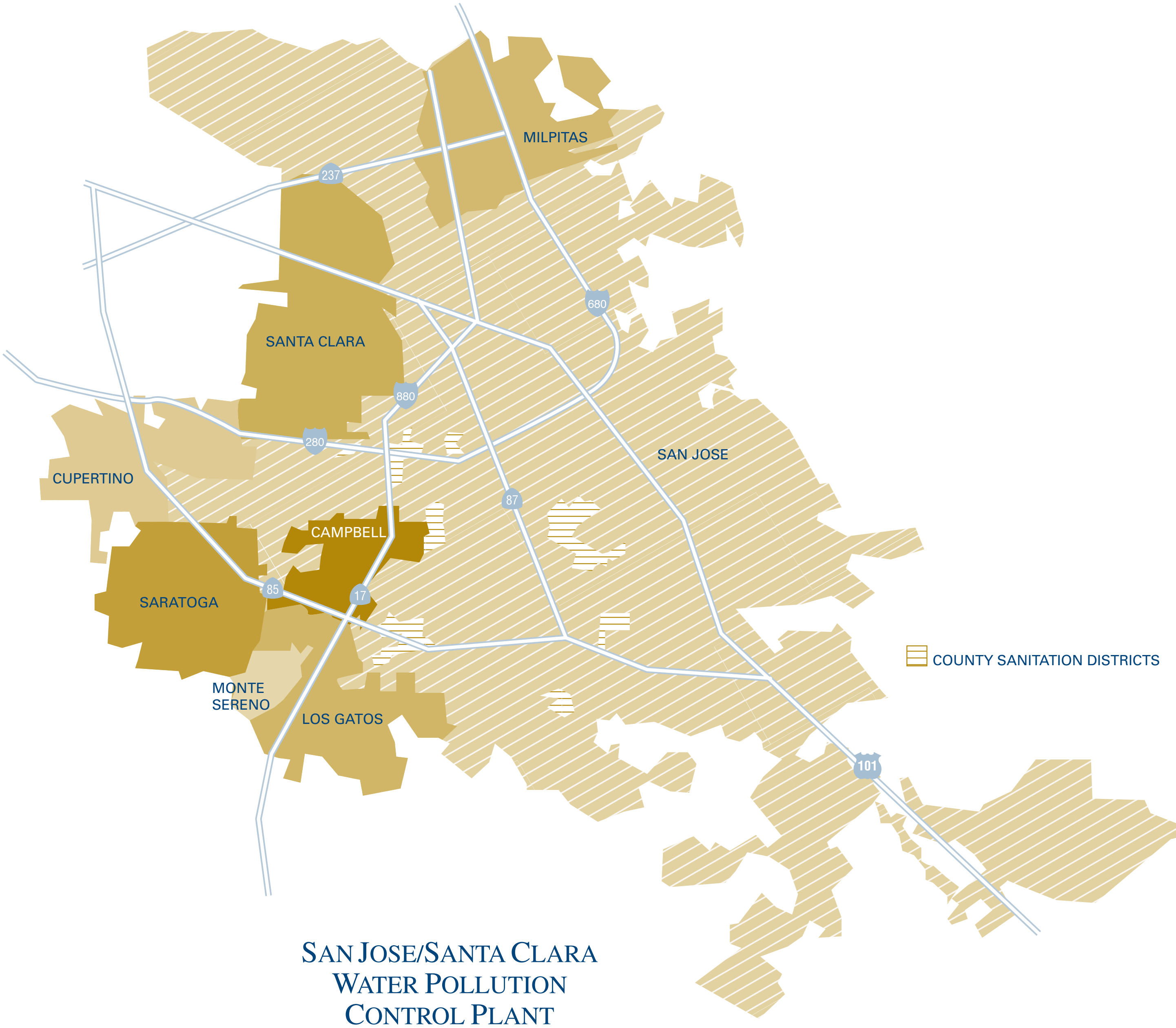
Guidelines for Efficient Water Use

Implementing Water and Wastewater Reduction Projects

For facility owners, operators
and environmental managers



San Jose/Santa Clara Water Pollution Control Plant

The Plant is owned by the Cities of San José and Santa Clara, and is operated by the City of San José Environmental Services Department on behalf of the tributary agencies.

Tributary Agencies

Burbank Sanitary District
Cupertino Sanitary District
City of Milpitas
Santa Clara County Sanitation Districts No. 2 – 3
Sunol Sanitary District
West Valley Sanitation District
- Serving:
  - City of Campbell
  - Town of Los Gatos
  - City of Monte Sereno
  - City of Saratoga

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CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY

Environmental Services
A Certified Green Business

It should be noted that the ideas presented in these Guidelines are not intended as an endorsement by the City of San José or San Jose/Santa Clara Water Pollution Control Plant of any particular method, process or product. They are suggestions for your consideration.

Contents

Figures

Abbreviations

AWNS
Acid Waste Neutralization System

CFR
Code of Federal Regulations

City
City of San José

DHS
California Department of Health Services

Definitions

Baseline Flow Rates — The current average daily influent and effluent flow rates established for a facility prior to installation of any new water efficiency measure.

Boiler Blowdown — The water that periodically must be removed from a boiler to control buildup of particulates, sludge, and treatment chemical concentration.

Domestic Sewage — The liquid and water born-wastes derived from the ordinary living processes, free from industrial wastes. (Uniform Plumbing Code (UPC) Section 206.0. 1997 edition)

Effluent — Any water, reused water, recycled water or water exiting a process.

Electrodeionization (EDI) — A high purity water treatment system combining ion exchange with selective membrane filtration to filter positive and negative ions.

Facility Total Flow Rate — The sum of all effluent flow streams leaving a facility including wastewater discharged into the sanitary or storm sewer, system losses, water included with product, and wastewater hauled off-site.

Facility Flow Balance — A detailed diagram showing all processes and activities using water, along with their associated flow rates.

Filtration — A water treatment process using sand, charcoal and other media that can selectively filter out certain contaminants, particularly particulates.

Flow Balance Closure — (Total Influent Liquid Flow Rate - Facility Total Flow Rate)/ Total Influent Liquid Flow Rate X 100%.

Groundwater Reclamation — Water pumped from an aquifer.

Hauled Waste — Any waste removed outside of the sanitary sewer from the location where the waste was produced.

Industrial Wastes — Wastes generated from producing, manufacturing, and processing operations of every kind and nature.

Abbreviations (cont'd)

DI
Deionized (as in Deionized water)

EDI
Electrodeionization

ESD
Environmental Services Department

HMMP
Hazardous Material Management Plan

HVAC
Heating Ventilation and Air Conditioning

IX
Ion Exchange

Plant
San Jose/Santa Clara Water Pollution Control Plant

POTW
Publicly Owned Treatment Works

RO
Reverse Osmosis

SBWR
South Bay Water Recycling

UPC
Uniform Plumbing Code

WET
Water Efficient Technologies

Units of Measure

gpd
gallons per day

gpf
gallons per flush

khz
kilohertz

mgd
million gallons per day

mg/l
milligrams per liter

Influent — Any water, reused water, or recycled water entering a process.

Internal Process Water Reuse — The use of any wastewater or previously used water, including domestic wastewater, as an influent for use as source water for the same process or redirected for use as source water for another process.

Mass Audit — Investigation of pollution prevention and source reduction measures performed by or for a facility.

Potable Water — Water suitable for drinking.

Process — Production, manufacturing or processing operation, including industrial and commercial operations.

Pretreatment — The reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a Publicly Owned Treatment Works (POTW). The reduction or alteration may be obtained by physical, chemical or biological processes or process changes or by other means, except as prohibited by 40 CFR 403.6(d). Appropriate pretreatment technology includes control equipment, such as equalization tanks, or facilities, for protection against surges or slug loadings that might interfere with or otherwise be incompatible with the POTW. However, where wastewater from a regulated process is mixed in an equalization facility with unregulated wastewater or with wastewater from another regulated process, the effluent from the equalization facility must meet adjusted pretreatment limit calculated in accordance with 40 CFR 403.6(d).

Process Water — Water entering, re-circulating, or exiting any process before disposal to the sanitary sewer.

Recycled Water — The beneficial use of municipal wastewater after treatment at a central POTW (for the San Jose/Santa Clara Water Pollution Control Plant treated water is called South Bay Recycled Water).

Reverse Osmosis — A water treatment process that produces high purity water by using pressure to push water through a membrane with very small pores.

Reverse Osmosis Reject — Water and materials filtered out by a reverse osmosis treatment process.

Sanitary Sewage — Liquid waste containing some solids from residences, business buildings, institutions, and industrial establishments, excluding ground surface and storm waters, subsurface drainage, and certain industrial wastes.

Sanitary Sewer System — All sewers, treatment plants and other facilities owned or operated by the City for carrying, collecting, pumping, treating and disposing of sanitary sewage.

Total Influent Liquid Flow Rate — Average daily flow entering facility from all water sources including liquid chemicals used in manufacturing, treatment, etc.

Water-Reliant Processes — Any process requiring water in any form.

Investing in the Future Together

A Handbook for Business and Industry

Public-private partnerships between government and industry are needed to explore new technology and new processes – and to jointly confront new climatic and other global challenges.

The goal of this guidance document is to assist companies, primarily industrial users in the Plant's service area, to reduce the amount of potable water used and wastewater discharged by:

- Offering technical assistance and exploring water saving opportunities in tandem with the Santa Clara Valley Water District, the wholesale water retailer in this area.
- Encouraging industries to investigate onsite industrial wastewater reduction/reuse opportunities.
- Providing recycled water for irrigation and industrial uses to companies located along pipelines operated by South Bay Water Recycling, also administered by the City of San José.

These guidelines should be helpful to any business or industry located in the Valley and interested in reducing flows, but they will be particularly beneficial to metal finishing, electronics, and high tech companies.

Conservation Benefits

Reduction of water use and wastewater discharge has numerous benefits:

- Deferred expansion costs of onsite waste treatment system(s)
- Reduced utility cost, including water purchased, wastewater discharged, and possibly energy and chemicals used
- Deferred or reduced sewer capacity and discharge connection fees
- Reduced potable water consumption, thereby insuring a safe and reliable water supply for the future
- Enhanced protection of the health of the South San Francisco Bay habitats

How to Use These Guidelines

This handbook's sections are organized to follow the steps necessary for evaluating water efficiency projects. These steps include:

- Establishing a baseline flow rate
- Identifying high water use areas
- Completing a water balance
- Reviewing and identifying potential flow reduction projects
- Evaluating the cost feasibility and practicality of identified projects

Icons

Note or Tip

Caution

Money-saving idea

1 Components of a Flow Reduction Project

☞ The beginning of a flow audit project is a good time to calibrate all flow meters.

Important components of a facility's water balance include identifying all water-reliant processes and activities, and collecting, measuring and recording water use data on existing facility operations. When completed, a facility water or flow balance will identify the baseline flow, show various water use areas within the facility and allow for the prioritization of potential flow reduction projects.

Establishing a Baseline Flow

☞ Facility information can be collected from a variety of sources, such as:

- Plumbing plans
- Original and as-built construction drawings
- Industrial wastewater discharge permit application
- Process operation/facility records
- Mass audits and control measure plans, flow audits, Hazardous Materials Management Plan (HMMP), SB-14 Source Reduction Plan

A facility's baseline flow is essential for identifying:

- Water use within the facility
- Reductions in water use resulting from control measures
- Payback periods for determining project cost effectiveness

To account for variations in flows and to give a representative average of the facility's water use, use flow data that is most current and spanning an adequate period of time, e.g., one year. Measure all influent and effluent flows over this period and calculate the average daily flow, which constitutes the baseline flow.

Flow Balance Diagram

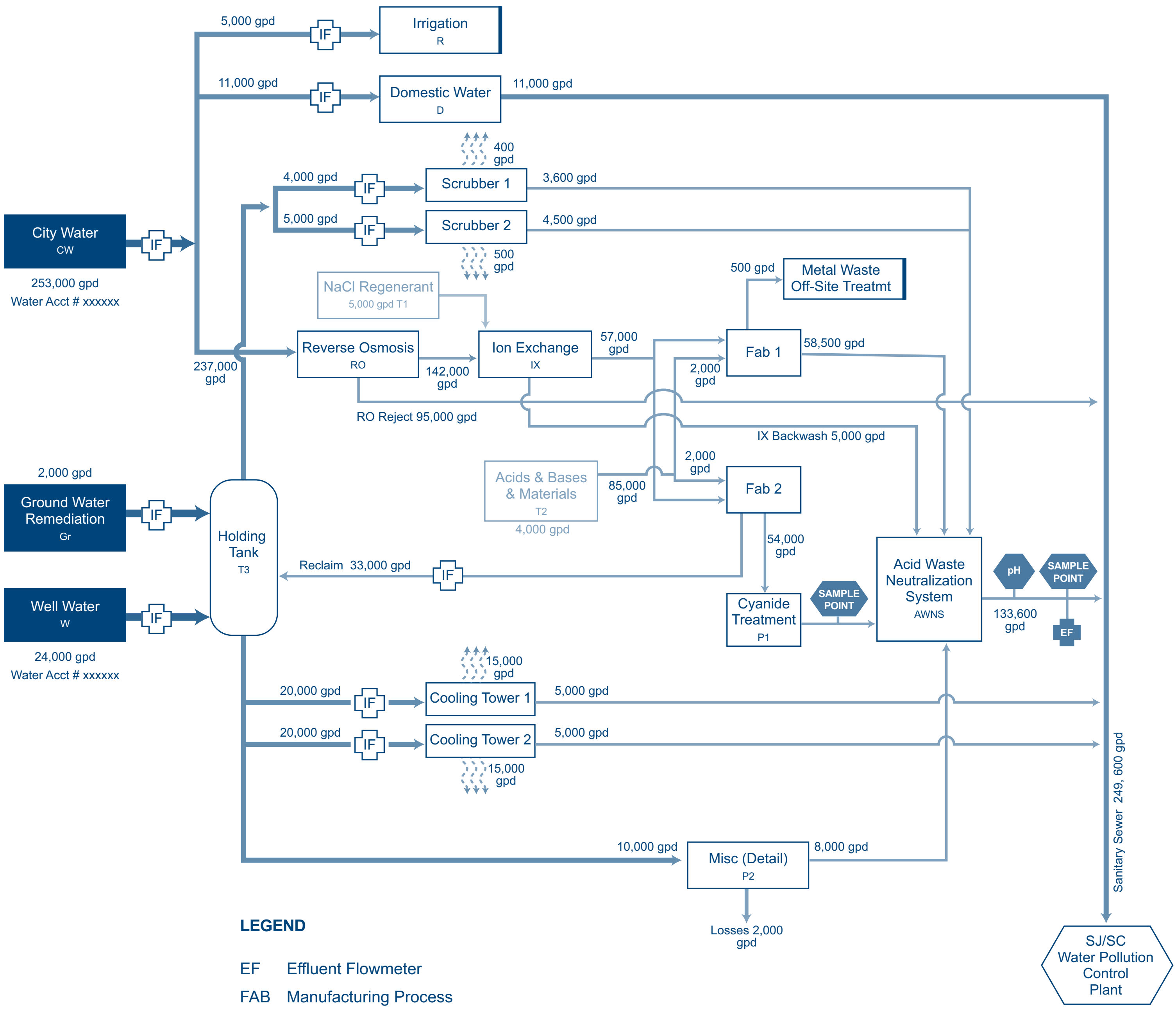
Prepare a detailed facility flow balance diagram by showing all processes and activities using water, along with their associated flows. For large facilities or complex operations, it may help to break down the facility into the major structures or processes first. The detailed flow diagram should address manufacturing, cooling towers, scrubbers, water treatment systems, and wastewater treatment systems.

The diagram should include:

- Sources of all incoming water. If available include corresponding Water Account and/or Meter Numbers.
- Quantities of all chemicals received and used in aqueous form greater than or equal to 1,000 gallons per day (gpd) should be accounted for in the flow balance diagram.
- Gross flow balance of water throughout the facility. This includes irrigation, domestic (toilets, showers, cafeteria, etc.), manufacturing processes, HVAC, scrubbers, evaporation, storm drains, product, sanitary sewer, etc.
- The path and direction of all water usage. (Example: Either to reuse in another process, treatment, directly to sample box, or the sanitary sewer, etc.)
- Specify on the diagram the number of the units that are alike. For example, represent each cooling tower as a separate block, show the number of reverse osmosis (RO) train units in parallel or sequence, etc.
- Show on the diagram the RO system, water deionization (DI) system, treatment systems, all flowmeters, and wastewater sampling point(s). Flowmeters should be identified as influent, influent dedicated to process, or effluent, and all sample points should also be identified.

An example of a completed Facility Flow Balance Diagram is shown in Figure 1.

Figure 1: Example Facility Flow Balance Diagram



LEGEND

EF	Effluent Flowmeter
FAB	Manufacturing Process
gpd	Gallons Per Day
IF	Influent Flowmeter
P	Auxiliary Process (non-manufacturing) treatment bottle washing, etc.
pH	pH Monitor
T	Tank
(evaporation symbol)	Evaporation

Water Use — Domestic Sewer Applications

All water uses that result in *domestic sewage* should also be identified in the facility flow balance. Domestic sewage is defined as the individual employee usage of water in the workplace. This flow includes water used in showers, bathroom usage (toilets, urinals, and sinks) and at food facilities if available on site (e.g. cafeteria).

A general rule of thumb for domestic water uses in a facility is 10 to 15 gallons per person. Flow may be adjusted downward if the facility does not have a cafeteria or if low-flow fixtures have been installed.

Identifying High Water Use Areas

Collect the flow rates for all influent, effluent, chemical usage entering and exiting water using processes. All flow rates should be recorded as a workday average in gallons per day (gpd). Add together all influent flow streams into the facility to determine the Total Influent Liquid Flow Rate. The Total Influent Liquid Flow Rate should include flow from all sources, plus the flow rate of any liquid chemicals used in manufacturing, treatment, etc, greater than or equal to 1,000 gpd.

Influent flows may include the following, but take care to count an influent flow only once:

- Water used for irrigation, and domestic applications
- Process waters including manufacturing and treatment processes
- Water supplied to equipment such as cooling towers, scrubbers, reverse osmosis, ion exchange, boilers etc.

The water supply could be potable water supply, well water, recycled water from South Bay Water Recycling (SBWR), or groundwater reclamation. Reverse osmosis and ion exchange could also be the source of water supply for processes using pretreated water. Also, be aware that a previous process in the manufacturing flow diagram could be the water supply source for the next process in the flow diagram.

Completing a Water Balance

Similarly, determine the *Facility Total Flow Rate* by adding together all effluent flow streams leaving the facility. The total effluent flow rate should include all flows that are directed to a final destination (as opposed to that which will continue/recycle to the next or other blocks in the flow diagram). Effluent flows may include the following; once again, take care to count an effluent flow only once:

- Discharge flows to the sanitary sewer,
- Flows attributed to system losses (i.e. evaporation, leaks, etc.),
- Water that ends up in the product, and/or
- Water that is shipped off-site for treatment and/or disposal.

Add together all effluent flows leaving the facility site to determine the Facility Total Flow Rate.

Compare Facility Total Flow Rate and the Total Influent Liquid Flow Rate of the facility. The flow balance should be within 90% closure. If it is not within 90%, look over the flow data to identify missing or incorrectly counted flows.

2 Flow Reduction Measures

Not only does water conservation lower water and sewer bills, it makes environmental sense.

The various water conservation methods, practices and technologies described in this section generally follow the water efficiency model of the 3Rs – Reduce, Reuse and Recycle. For easier reference, these water conservation measures are divided under the following headings.

- General Facility Conservation Measures
- Water Reuse Opportunities
- Metal Finishing and Electronics Industries Water Conservation Technologies

General Facility Water Conservation Measures

!$ INCENTIVES!

Periodically check with your environmental inspector or water conservation coordinator for the latest programs and incentives.

Incentives on the Web

Also regularly visit the Environmental Services website for updated water conservation incentives at

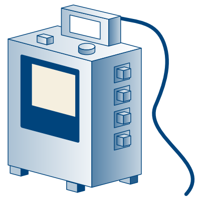
http://www.slowtheflow.com/business.html

The Santa Clara Valley Water District also offers technical assistance and incentives for certain water conservation measures. Visit **www.valleywater.org** for more information.

A full-time, ongoing commitment to flow reduction efforts must be made by owners, managers, and operators of a business. Some facility water conservation measures applicable for many facilities are included in this section.

Idle Flow Rate Reduction:

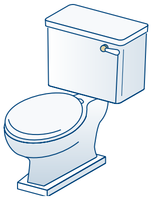
Reducing flow rates during idle periods achieves significant water reduction. Water quality monitoring sensors are required to ensure optimal water rinse quality. Eliminate the opportunity for process operators to adjust flow rate set points.



Flow meter

High Efficiency RO System on water supply to minimize reject:

High efficiency reverse osmosis (RO) systems are systems that contain more than one unit, arranged in various design configurations. The brine from the first stage RO unit is further treated in the subsequent steps, producing more high quality permeate and less water wasted as reject.



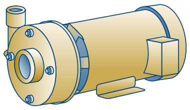
Money-saving low flow toilet

Replace Toilets and Urinals with Low Flow Units:

Replace traditional toilets (3.5 gpf) and urinals with ultra-low flush (1.6 gpf) or high efficiency (1 gpf) units – can save over 2.5 gallons per flush.

Retrofit and Replace Faucets and Shower Heads with Low Flow Units:

Low flow showers and faucets can also save energy by reducing hot water consumption.



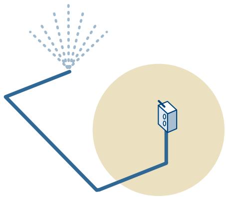
Pump with mechanical seals

Replace Pump and Packing Seals with Mechanical Seals:

Consider replacing pump and packing water seals with mechanical seals, especially for plants with a large number of pumps.

Install Irrigation Flow Controls:

Weather-based irrigation controllers, rain sensors, rotor spray heads and dedicated landscape meters can help improve water efficiency for landscaping.



Weather-based irrigation controller

DISCHARGERS are responsible for the successful implementation of any flow reduction technology, including ensuring worker health and safety and compliance with all local, state, and federal regulations.

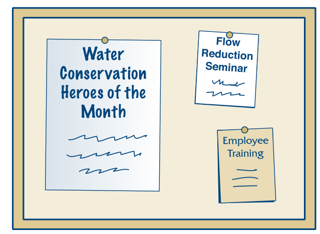
While these water conservation measures have been shown to reduce water consumption, the San Jose/ Santa Clara Water Pollution Control Plant and its tributaries do not endorse any flow reduction technology, product or vendor listed in this document.

Inspection/Maintenance of Facility:

Facility maintenance is a good place for employees to be involved in water reduction efforts. The facility's maintenance protocol should include regular inspections coordinated with preventative maintenance of the facility's production, storage, and waste treatment facilities to identify leaks and improperly functioning equipment that can lead to wastewater generation and water losses. Inspect all piping systems, storage tanks, automated flow controls, floor drain primers and equipment operators' techniques. Verify that the flow rate settings have been adjusted to the minimum level required to properly operate the equipment.

Employee Training:

- Develop ongoing training plans to educate employees on source reduction and flow reduction concepts, and to encourage employees to offer innovative flow reduction ideas specific to your facility. This could reduce overall water costs and minimize liability. Retrain personnel periodically to ensure that employees follow flow reduction procedures and understand why it is beneficial to do so.

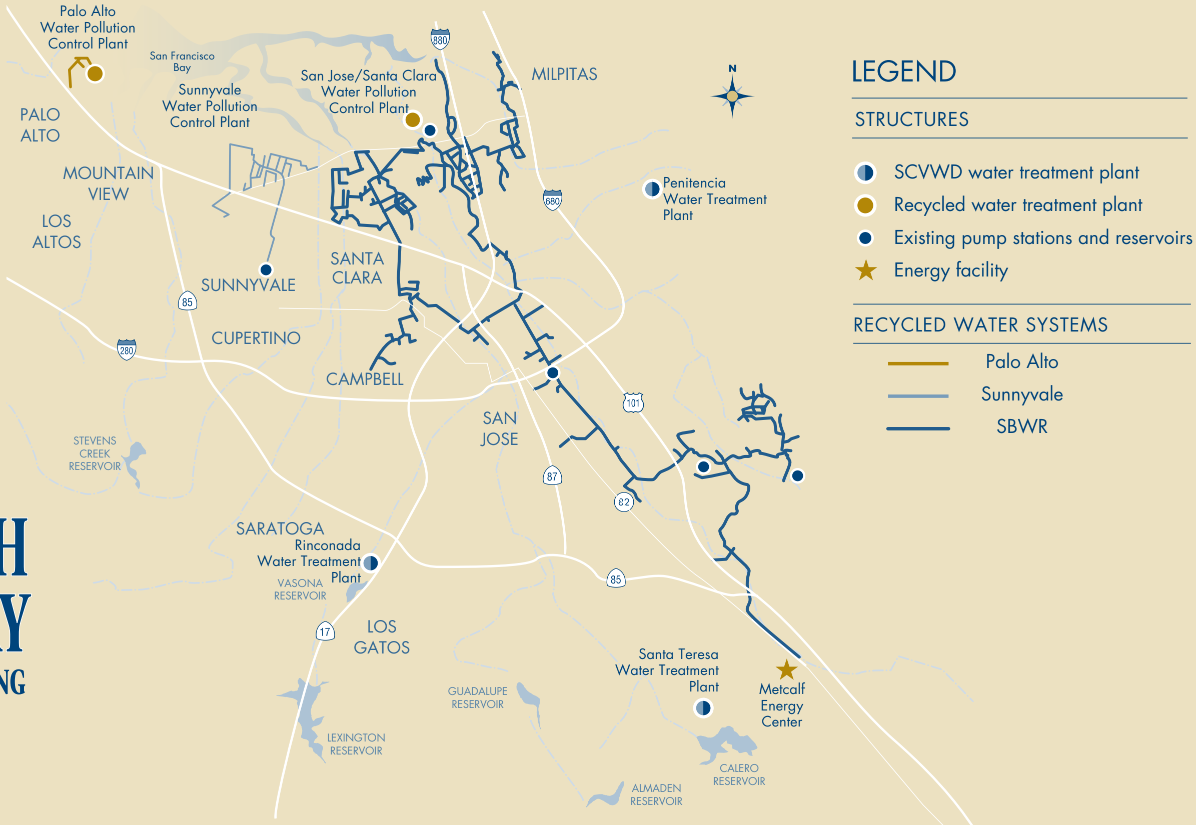


- Advertise success or results of efforts as positive reinforcement. As new developments occur in water conservation, keep employees informed so they can perform their duties more efficiently.
- Periodically review employee manuals to include up-to-date information. Organize employee training seminars through trade associations and/or consulting firms that offer training in water conservation as part of their package of services.
- Train all employees to recognize malfunctioning equipment in their work area and institute a mechanism for reporting problems observed to the proper maintenance personnel.

Facility Maintenance Water Conservation Ideas:

- Check water supply system for leaks.
- Wash autos, buses, and trucks less often.
- Discontinue using water to clean sidewalks, driveways, loading docks, and parking lots. Consider using brooms or motorized sweepers.
- Make sure irrigation equipment applies water uniformly.
- Water landscape only when needed; two-to-three times a week early in the morning or late in the evening is usually sufficient. Do not water landscape every day.
- Investigate the advantages of installing drip irrigation systems.
- Remove excessive lawn thatch and aerate turf, encouraging movement of water to the root zone.

Can I Use Recycled Water?



SOUTH BAY WATER RECYCLING

Protect the environment and your bottom line!

Recycled water is a clean, reliable, economical alternative to potable (drinking) water. It is water from the Plant that is highly treated to make it suitable for non-potable uses.

Recycled water is regulated by the California Department of Health Services (DHS). Beneficial uses of recycled water include landscape irrigation of schools, golf courses, parks, or median strips, as well as water for fountains and other water features.
It can also be used for cooling and other industrial processes.

Businesses that use recycled water not only protect the environment they also experience significant savings on their water bills. Locally recycled water is available from South Bay Water Recycling (SBWR), a network of more than 100 miles of pipeline. SBWR delivers recycled water to over 540 facilities in the cities of San José, Milpitas, and Santa Clara. If your business is within the SBWR service area (see map) consider recycled water for both landscape irrigation and industrial uses. Local businesses that currently benefit from these savings include:

1 California Paperboard uses recycled water for 50% of their industrial supply.

2 San Jose State University has used recycled water in their cooling towers since 2000.

3 Metcalf Energy Center uses as much as 3 million gallons per day of recycled water for cooling during the summer.

4 San José City Hall uses recycled water for toilet flushing and water features.

Since 1997 local businesses have used more than 17 billion gallons of clean, reliable, recycled water supplied by SBWR. To find out if your business can use recycled water contact the SBWR program office at (408) 277-3671 or talk to your environmental inspector.

☞ To learn more about recycled water, check out the SBWR website at **http://www.sanjoseca.gov/sbwr/**

Water Reuse Opportunities

Any water can be reused once or more if the water quality is such that it does not impact production capabilities or harm the working environment. Reusing water saves you money on the cost of water, but more importantly, it saves this valuable resource. When reviewing your facility flow balance, look for ways in which process water can be used internally to that process or other processes.

Chemical monitoring and chemical feed control are key to protecting cooling tower and heat exchanger interior walls from corrosion, pitting, and other problems.

!$ Semiconductor manufacturers and other high purity water users are excellent candidates for reusing process water in other uses or as a replacement for potable water. Doing so can lower water and sewer bills and save money.

When installing new equipment, consider installing wet benches equipped with built in water recirculating units.

Cooling Towers

Maximize Cycles of Concentration to at Least Five:

Cooling towers can increase the cycles of concentrations to at least five. Many cooling towers operate between seven and eight cycles depending on the initial source of water.

Side Stream Filtration:

Side stream filtration can facilitate maximizing cycles of concentration by removing particles and suspended solids in the recirculating water. Side stream filtration is applied to cooling towers where the turbidity of the supply water is high and/or airborne contaminants such as dust or oil are common.

Reusing various process wastewaters in cooling towers is one of the more popular options for water reuse. *Process waters* for some industries, such as semiconductor manufacturers are cleaner than potable water. *Reverse osmosis reject*, *scrubber water*, and *boiler blowdown*, which are usually discharged to the sewer system, can also be considered viable options for reuse in cooling towers. Depending on the metallurgy, cooling tower chemical water treatment programs can be designed to use a wider variety of makeup water qualities compared to other higher quality water processes.

Note: The City of San José has published Guidelines for Managing Water in Cooling Systems with more detailed information on water-use optimization in cooling towers. A copy is available by request or can be downloaded at the following website: http://www.sanjoseca.gov/esd/PDFs/cooling.pdf

Scrubbers

Facilities that have on-site scrubbers should evaluate the use of process water as make-up water for the scrubbers. Reverse osmosis reject and boiler blowdown are other potential sources of scrubber make-up water.

Internal Process Water Reuse

Process Water in General

The different processes in various industries are too numerous to present in this document. However, you can find new ways to reuse process waters more than once by:

- Examining your facility's flow diagrams and the source water quality needs of each process
- Stream flow segregations scenarios
- Cost analysis of different treatment methods (See following section on Water Treatment Technologies)

Stream Segregation:

Keeping cleaner process water from mixing with more contaminated process water may increase the practicability of reuse. For instance, final rinses are often much cleaner than first or second rinses and may be reused as source water for the first rinse or in other processes such as cooling tower or scrubber makeup.

Rinsewater

Many industrial users in the Plant's tributary area have rinsing steps in their industrial process. After rinse solutions become too contaminated for their original rinse process, they may be useful for other rinse processes. Process lines and rinsewater requirements should be evaluated so rinse system arrangements can be developed to take full advantage of reuse opportunities.

Options to consider include:

- Effluent from a rinse system that follows an acid cleaning bath can be reused as influent water to a rinse system following an alkaline cleaning bath. This configuration can actually improve rinse efficiency. The neutralization reaction reduces the viscosity of the alkaline drag-out film. In some instances, unwanted precipitation of metal hydroxides onto the cleaned workpieces can occur.
- Alkaline cleaning rinsewater effluent can be used as rinsewater for workpieces that have gone through a mild acid etch process.
- Effluent from a final rinse operation, which is usually less contaminated than other rinsewaters, can be used as influent for rinse operations that do not require high rinsewater quality.

Dilution is No Solution

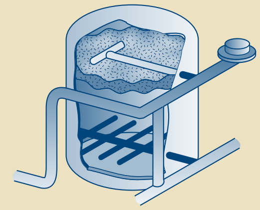
Any reuse of wastewater from one process to another may require additional monitoring locations. Discuss any additional monitoring locations with your environmental inspector.

Water Reuse Treatment Technologies

Some process waters need to be treated before reusing. A cost-benefit analysis may indicate that treating the water is more cost effective than simply discharging down the drain, especially if the treatment can be combined with treatment of existing source waters such as mixing process water with potable water prior to an existing reverse osmosis (RO) membrane process.

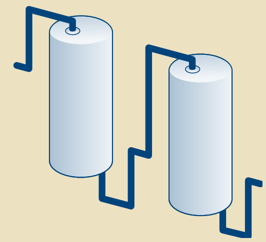
Filtration

Uses sand, charcoal and other media to selectively filter out certain contaminants, especially particulates. Cooling towers often include rapid sand filters or high efficiency cartridge filters for side-stream filtration.



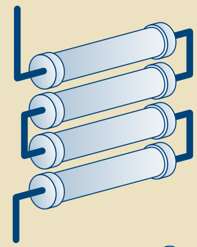
Ion exchange

Can be used to remove metals from dilute rinse solutions. The rinse water is passed through a series of resin beds that selectively remove cations and/or anions. A common use of ion exchange for process bath recovery is for the treatment of rinse water from a chromic acid process bath.



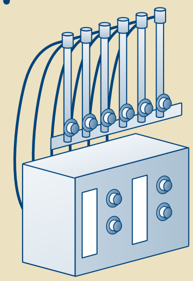
Microfiltration/Reverse Osmosis (RO)

Uses pressure to permit passage of purified water through a semi-permeable membrane, while not allowing dissolved salts to pass through. RO membranes are not suitable for solutions that have high oxidation potential such as chromic acid.



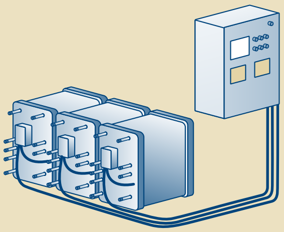
Electrodialysis

Employs cation or anion-permeable selective membranes and electric potential. Cation exchange membranes allow cations such as copper or nickel to pass; while anion exchange membranes pass anions such as sulfate, chloride, or cyanide. Electrodialysis treatment of dilute rinsewaters can be very effective in rinsewater reuse applications.



Electrodeionization (EDI)

Is similar to electrodialysis but includes ion exchange resins between the membranes. The self-cleaning action of the ion exchange resins eliminates the need for regeneration through the use of electro potential and selected ion permeable membranes. Using an EDI to treat first pass RO Reject will produce less reject than a second pass through an RO unit.



Note: The City of San José has published Guidelines for Industrial Wastewater Reuse to guide water reuse projects through the City's various planning and permit approval processes from construction to operation. These guidelines are available either by request or can be downloaded at:
http://www.sanjoseca.gov/esd/PDFs/IndustrialWastewaterReuse.pdf

Metal Finishing and Electronic Industries Water Conservation Technologies

Using Hot Ultra-pure Water for Rinsing: Elevating the ultra-pure water temperature provides better rinsing for certain processes, and reduces the amount of water volume required.

Flow Restrictors

Flow restrictors limit the volume of rinse water flowing through a running rinse system. Once the optimal flow rate has been determined, these devices are used to maintain constant flow of makeup water to the system.

Manual Flow Controls

Industries often use batch process product lines in which rinse lines are manually turned on and off throughout the day. Pressure-activated control devices such as hand, knee, or foot-pedal activated valves ensure that makeup water is not left on longer than is necessary to maintain rinse water quality after the rinse operation is completed.

Sensor Activated Rinses

Where appropriate, a contact switch can be placed on the tank so that when racks of parts are rested in a rinse tank, the feed line water valve is opened and the rinse cycle is activated. Time and conductivity flow controls are two of the most common flow controls. Table 1 is a comparison of the two types of flow control devices.

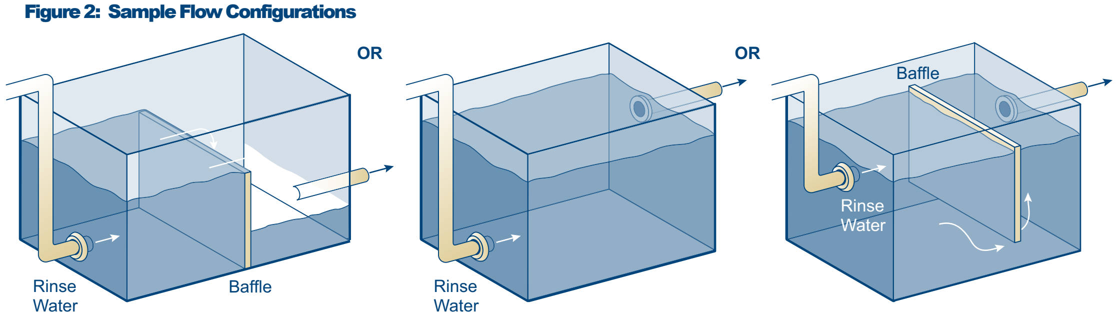
Table 1: Choosing Timer or Conductivity Flow Controls

FLOW CONTROL TYPE	HOW IT WORKS	BEST UTILIZATION
Timer Flow Controls	Timers are used with spray, continuous, and sensor-activated flow rinses to shut the spray off after a predetermined period and allow only the amount of water flow necessary to rinse the parts.	Timer flow controls work best for rinsing operations with uniform work piece batch rinsing.
Conductivity Flow Controls Use of these controllers can reduce product reject rates by improving water quality.	A conductivity or pH meter can be used to control makeup water flow through a rinse system. A conductivity probe or pH cell is used to measure the level of dissolved solids or hydrogen ions in the rinsewater. When this level reaches preset minimum and maximum concentrations, the controller opens or closes a valve that controls the flow of water into the rinse system.	Since most metal finishers process variable work piece batches, conductivity control equipment is usually the best choice for these operations.

Tank Arrangement

Tank size, shape and internal configuration should be arranged to encourage circulation, to promote improved settling of solids, and prevent back siphoning. Figure 2 illustrates placement of baffles and inlet and outlet pipe arrangements that slow down flow rate velocities to achieve these goals. Be sure to arrange all piping in a fashion that would eliminate a back siphon potential. Use gravity flow where possible.

Figure 2: Sample Flow Configurations



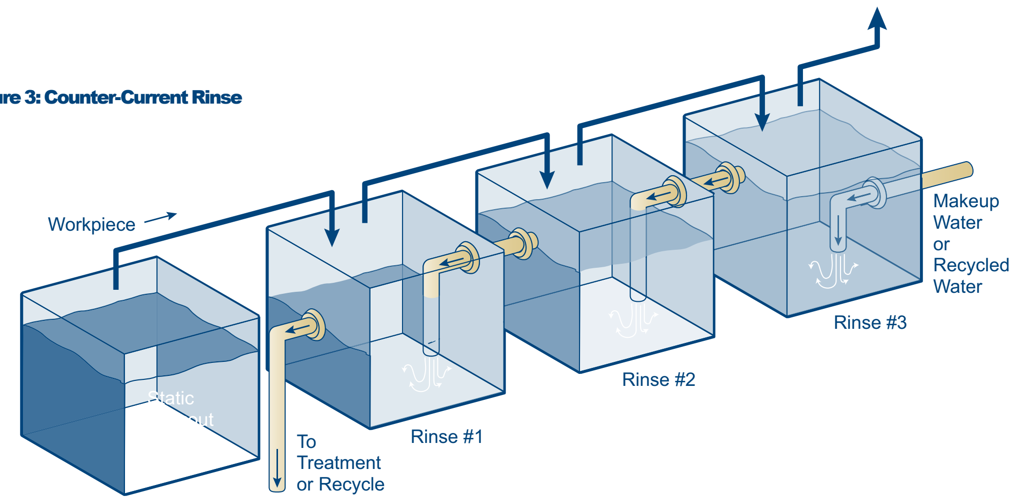
> **!$** Rinse tank water conservation measures such as flow restrictors, tank arrangement, spray rinse systems, and rinse agitations are easy to implement and cost effective, especially if included in the design phase of a new process line.

Counter-Current Rinse Systems

A multi-stage counter-current rinse system uses up to 90% less rinse water than a conventional single-stage rinse system. In a multi-stage counter-current rinse system, the workpiece moves in the opposite direction of the rinse water flow as it is immersed in successively cleaner rinse tanks. Actual water savings will vary depending on the number and configuration of tanks used. Counter-current rinsing should be operated with automatic or restricted water flow controls to allow minimal wastewater flow.

Counter current rinsing does require more tanks. However, facilities with floor space limitations can reduce the size of the rinse tanks or segregate existing tanks into multiple compartments (if workpiece size allows).

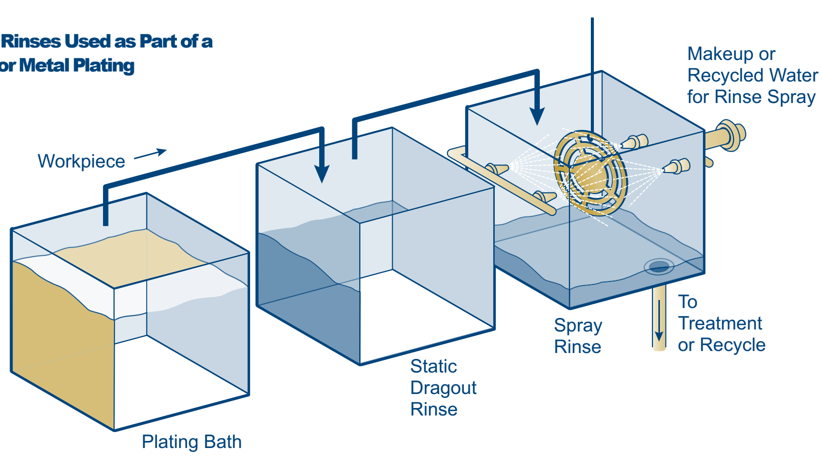
Figure 3: Counter-Current Rinse



Spray Rinse Systems

Use of spray type rinsing is a more effective water reduction technique than typical overflow and quick dump types. Short duration spray rinsing uses between one-eighth and one-fourth of the water volume a continuous flow rinse uses. Spray rinsing is highly effective for simple workpieces such as sheets, but may not reach inner cavities of more complex workpieces. In this case, it can be combined with immersion rinsing. The application of spray rinsing as a first step in a rinse cycle is effective in reducing wastewater production. Spray rinses may be triggered manually or automatically, and may remain in operation for a short duration for workpiece rinsing. Two uses of spray rinsing are shown in Figure 4 and 5.

Figure 4: Spray Rinses Used as Part of a Rinse System for Metal Plating



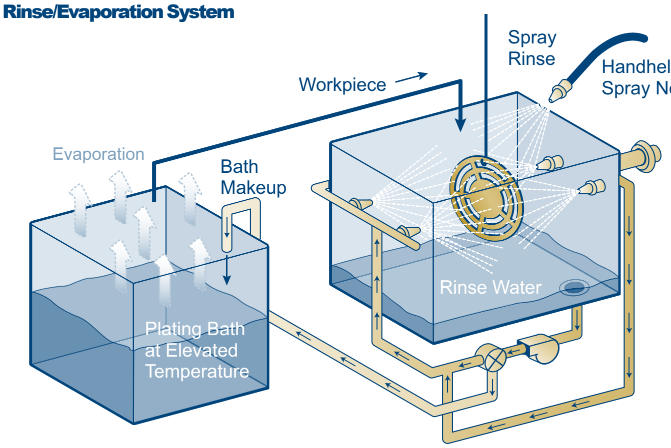
Spray Rinses with Evaporation Makeup Systems

Use of a spray rinsing system with evaporative makeup is an effective water minimization technique that can result in zero discharge for process tanks that provide elevated temperatures and resulting evaporation losses. To maintain product quality, this system may need to be combined with treatment processes, or an occasional bath decant to reduce accumulation of impurities. Covering heated tanks overnight and on weekends can reduce evaporative losses significantly.

Oversprays/Foggers

Oversprays and foggers are variations of a spray nozzle system for spray rinse systems. Oversprays use high-pressure water and fog nozzles use high-pressure air for atomization to produce a fine mist capable of greater workpiece penetration for rinsing and lower water use than for a conventional spray nozzle. Using an overspray or fogger (rather than a spray nozzle) directly over a heated plating bath to rinse the workpiece allows for longer hang time and better rinsing action for the workpiece.

Figure 5: Spray Rinse/Evaporation System



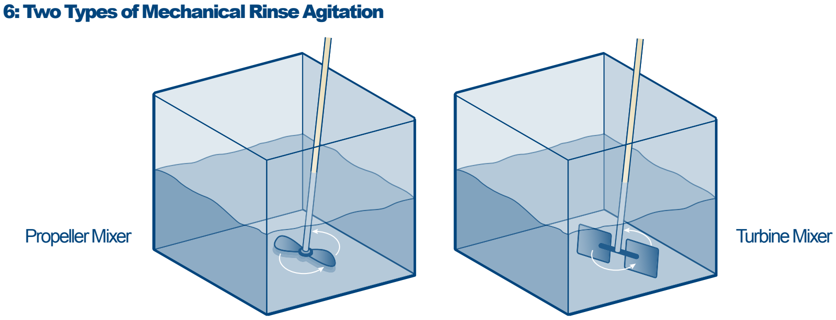
Rinse Agitation Measures

The purpose of rinse agitation is to maintain the contents of the tank in a completely mixed state. Three rinse agitation measures include:

Mechanical Mixing

Turbulence is induced by means of rotating impellers, such as propellers, turbines, and paddles.

Figure 6: Two Types of Mechanical Rinse Agitation



Air Agitation Rinsing

Forced air or water is the most efficient method for creating complete mixing during rinse operations. This can be achieved by pumping either air or water into the immersion rinse tank. Air agitation can provide the best rinsing because the air bubbles create improved turbulence to remove the chemical process solution from the workpiece surface.

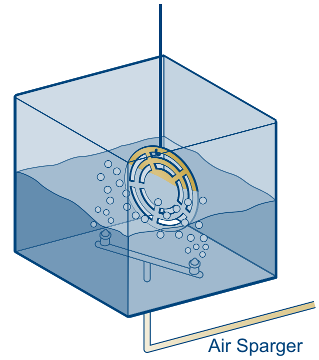


Figure 7: Air Agitation Rinsing

Ultrasonic/Megasonic Agitation Rinsing

Ultra/Mega-Sonic rinsing uses high frequency acoustic waves to generate pressure waves in water. Ultrasonic has a frequency of approximately 65 kHz and megasonic has frequencies of 860 kHz.

Ultrasonic waves create small vacuum bubbles in liquid tank contents. When these bubbles collapse, they cause a strong cleaning action on nearby parts. Ultrasonic cleaning is particularly useful for parts with hard to reach surfaces, and may allow operation at a lower temperature. Caution is advised on the use of this measure in acidic rinses. Megasonics offers selective cleaning, where only the side facing the transducers is cleaned, thus reducing the volume of excess rinse water. Megasonic rinsing also provides better results for surfaces that are sensitive to other sonic frequencies and their consequent cavitation effects.

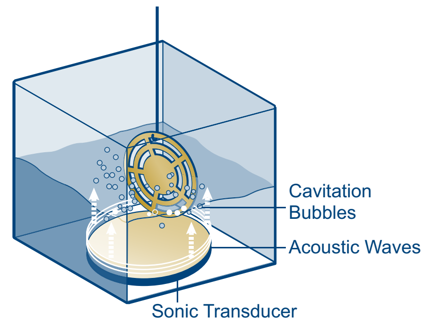


Figure 8: Ultrasonic/Megasonic Agitation

For Semiconductors Only: Spin Rinsing

Through sequential wafer rinsing and drying steps, the spin rinsing is an alternative wafer rinsing technique that can achieve significant water reduction.

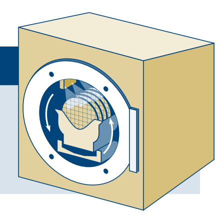


Figure 9: Spin Rinser/Dryer System for Semiconductors

Workpiece Dragout Water Reduction Techniques

Workpiece Dragout Agitation

If the configuration of the workpiece permits, agitation between the workpiece and rinsewater can be performed by moving the workpiece rack in the water or creating turbulence in the feed water. Since many metal finishing plants operate hand rack lines, operators could easily move workpieces manually by agitating the hand rack. Rinsing is more effective if the pieces are raised and lowered in and out of the rinse tank rather than agitating the pieces while they are submerged. This technique is effective for use with workpieces with large surface areas and interior surfaces that will not effectively drain.

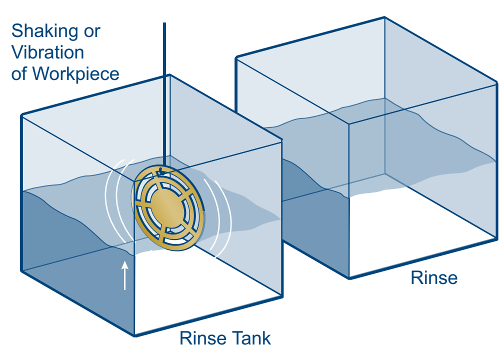


Figure 10: Workpiece Dragout Agitation

3 Evaluating Available Water Reduction Methods

Once projects have been identified for potential water savings, determine the payback period for the selected projects by comparing the operational savings from implementing each project to the design, capital, and installation costs of the projects.

Calculating the payback period requires calculating the total project costs, the pre-project annual operating costs and the post-project annual operating costs. Figures 8 and 9 are blank worksheets facility managers can use to calculate these costs.

The total project cost is calculated by adding the equipment, material, and labor costs of implementation together with the ongoing operating expenses. To determine the payback period, compare the project cost with the projected savings after implementation.

Total Project Costs

The costs associated with the equipment purchase and installation should take into account the cost of financing, and could include the following:

- Labor (design and installation)
- New equipment
- Spare parts
- New material costs
- Supplies and tools
- Permits and fees associated with the building
- Lost production and production time
- Operator training

Pre-Project Annual Operating Costs

The costs associated with the ongoing operations should take into account the cost of equipment depreciation, and could include the following:

- Operations
- Maintenance
- Waste treatment
- Laboratory support
- Utilities such as
  - electricity
  - water
  - sewer

In certain circumstances you may want to include other costs such as administration, parts, increase in chemical used, fees and taxes, permits and insurance costs.

The annual operating costs should be calculated for the current operation, and estimated for the projected operation.

Estimated Post-Project Annual Operating Cost

Estimate the annual operating project costs after implementing the project using estimated project savings such as reduced water savings, chemical costs, wastewater treatment costs.

!$ Don't forget to calculate the costs of water and sewer (wastewater) discharge. These costs can be substantial. Utility costs vary throughout the tributary area. However, the average water purchase cost is approximately $3 per 1,000 gallons, while the discharge cost is $2-4 per 1,000 gallons discharged. For a flow reduction project reducing 5,000 gallons of water per day, the water and wastewater savings can be over $10,000 per year!

Project Payback Period

Compute the simple payback period for each project or group of projects, by using the formula below. Complete a separate analysis for each project to determine the payback period. Implement any projects found to have a cost effective payback period for your facility.

$$\text{Project Payback Period} = \frac{\text{Total Project Costs}}{\text{(Pre-Project Annual Operating Costs)} - \text{(Estimated Post-Project Annual Operating Costs)}}$$

!$ The Water Efficient Technologies program is a financial incentive program for companies exploring ways to reduce their wastewater discharge. The one-time rebate is $4 per hundred cubic feet of water saved per year (748 gallons), up to 50% of project costs to a maximum of $50,000 per project. To find out more about how your company can participate in this or other programs, contact the WET coordinator at **(408) 945-3000** or visit **www.slowtheflow.com**

Figure 11: Blank Estimated Total Projects Costs Worksheet

	Estimated Total Project Costs			
COSTS:	**Item(s)**	**Quantity**	**Unit Cost**	**Total Cost**
Design Labor				
In-house				
Consultants				
Installation Labor				
New Equipment				
Purchased Materials				
Spare Parts				
Shipping				
Sales Tax				
Permits				
Planning and Building				
Occupancy				
Hazardous Materials				
Hazardous Wastes				
Utility Connection Fees				
Electricity				
Water (potable)				
Recycled Water				
Sewage Collection and Treatment				
Lost Production Time				
Maintenance Training				
Other				
			Costs, Subtotal	
CREDITS				
Financial Incentives				
Equipment Salvage/Resale				
Other				
			Credits, Subtotal	
			Estimated Total Project Cost (TPC)	

Figure 12: Blank Pre-Project and Estimated Post-Project Annual Operating Cost Worksheet

	Annual Operating Costs (AOC)	
ANNUAL COSTS:	**Pre-Project AOC**	**Estimated Post-Project**
Labor		
Operations		
Maintenance		
Administrative		
Waste Treatment		
Laboratory Support		
Parts		
Utilities		
Electricity		
Potable Water		
Recycled Water		
Sewer Service and Use		
Chemicals		
Treatment Chemicals		
Waste Treatment		
Conditioning Chemicals		
Permits		
Insurance		
Training		
Other		
Costs, Subtotal		
ANNUAL CREDITS		
Reclaimed Chemicals		
Tax Savings from Depreciation		
Other		
Credits, Subtotal		
Totals		
	Payback Period =	

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Notes

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