

Reclaiming Water for Cooling at SCE's Mountainview Power Plant

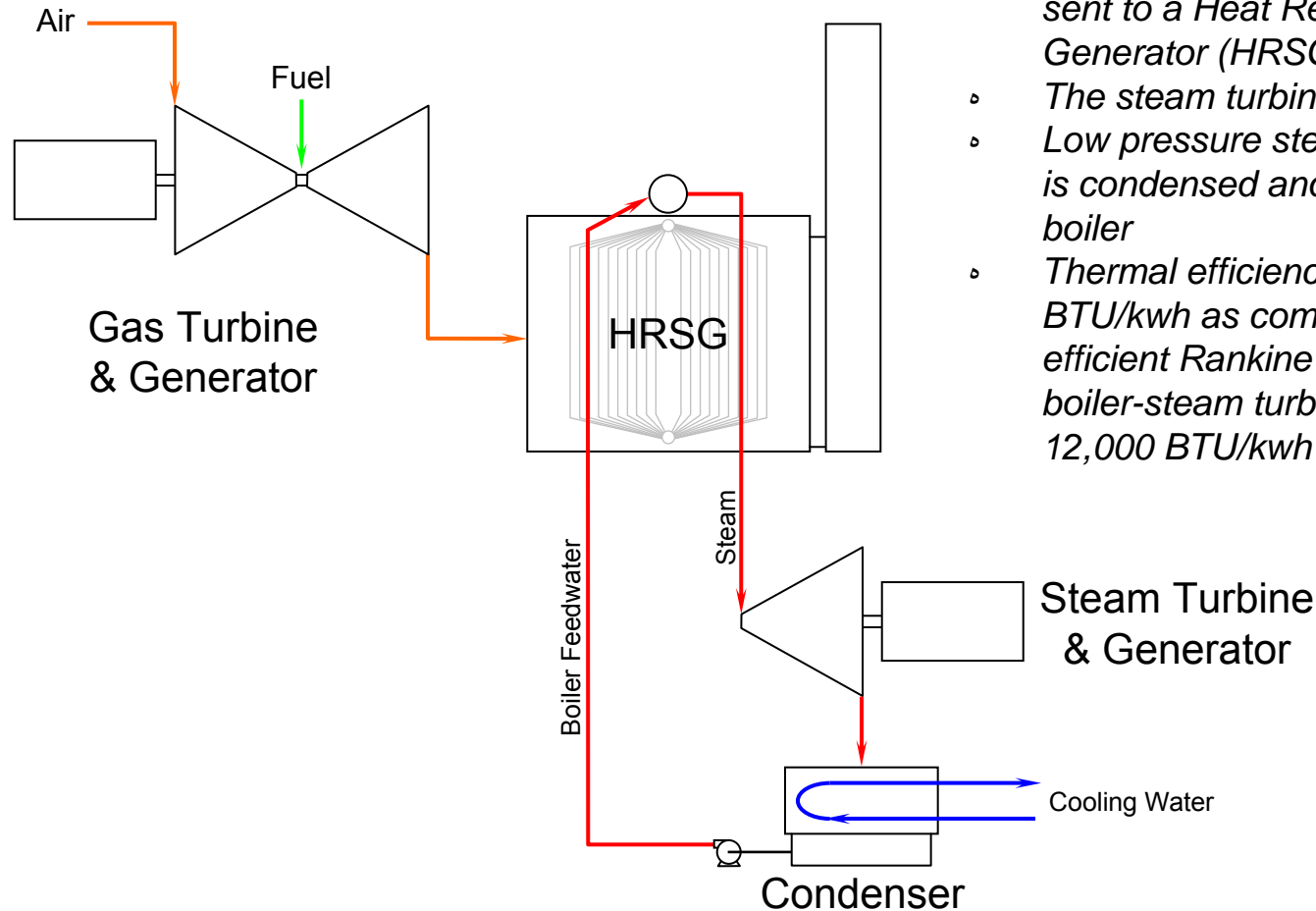
*Advanced Cooling Technologies
EPRI Workshop*

Presented by
Michael N DiFilippo, Consultant

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Combined Cycle



- Fuel is burned to drive a gas turbine
- The gas turbine drives a generator
- Hot exhaust from the gas turbine is sent to a Heat Recovery Steam Generator (HRSG)
- The steam turbine drives a generator
- Low pressure steam from the turbine is condensed and sent back to the boiler
- Thermal efficiency is 6,000 to 7,000 BTU/kwh as compared to less-efficient Rankine Cycle plants (typical boiler-steam turbine) at 10,000 to 12,000 BTU/kwh

Plant Output
MVPP

MVPP is a 2 x 1 combined cycle power plant.....

	<u>Gas</u> <u>Turbine A</u>	<u>Gas</u> <u>Turbine B</u>	<u>Steam</u> <u>Turbine</u>	<u>Total</u>
Unit 3	170 MW	170 MW	185 MW	525 MW
Unit 4	170 MW	170 MW	185 MW	<u>525 MW</u>
Total Plant				1,050 MW

(Units 1 & 2 are retired)



What makes MVPP a unique power plant?

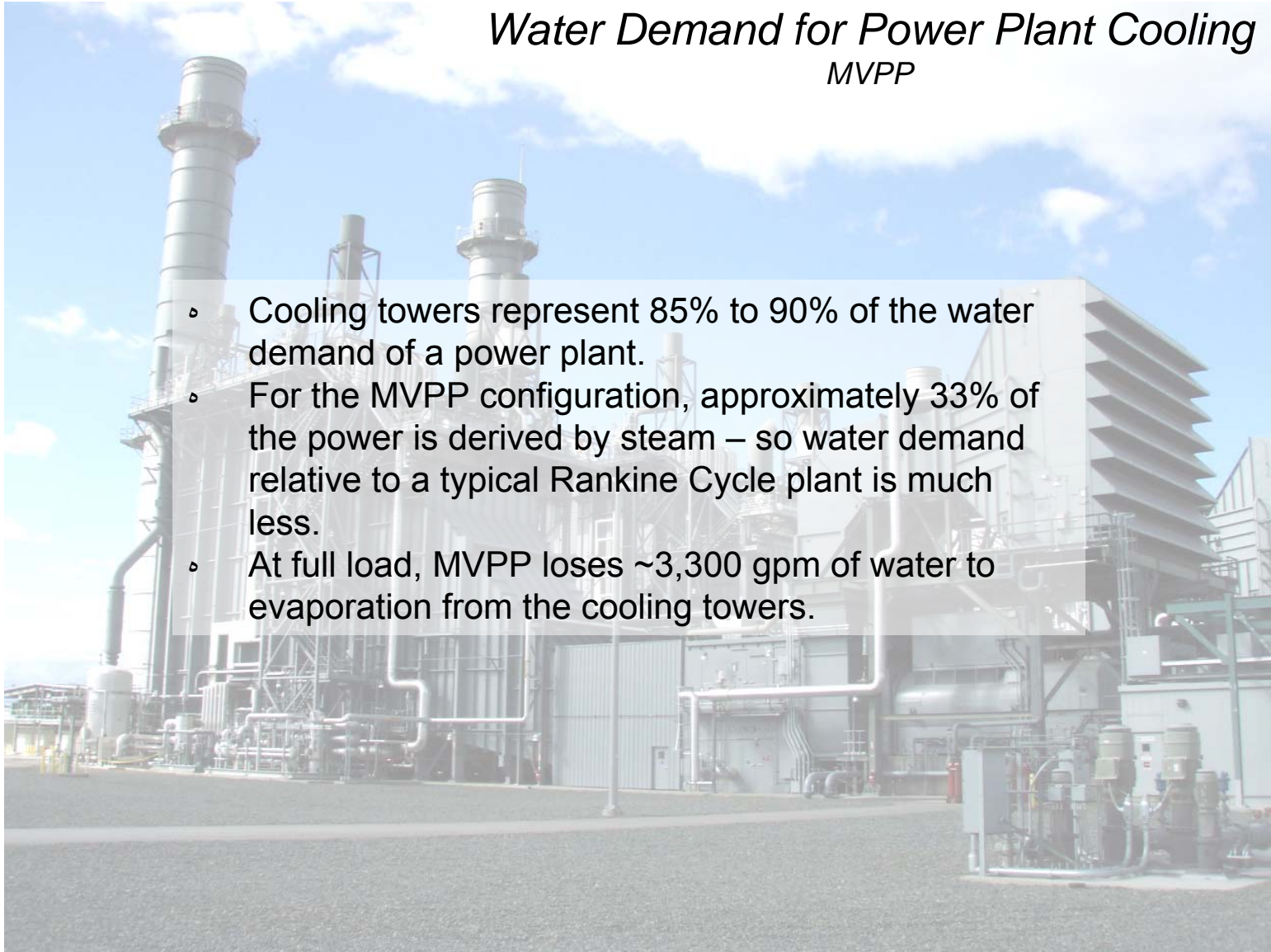
Cooling water comprised of.....

- *Treated municipal effluent*
- *Contaminated groundwater*

Water Demand for Power Plant Cooling

MVPP

- Cooling towers represent 85% to 90% of the water demand of a power plant.
- For the MVPP configuration, approximately 33% of the power is derived by steam – so water demand relative to a typical Rankine Cycle plant is much less.
- At full load, MVPP loses ~3,300 gpm of water to evaporation from the cooling towers.





Treated Municipal Effluent for Power Plant Cooling

- About 40 years ago, the City of Burbank started using municipal effluent for cooling tower make-up.
- 10 years ago, there were a handful of power plants in the US using treated municipal effluent – mostly in the Southwest, Texas and Florida.
- Today, there are hundreds of power plants using treated effluent for cooling tower make-up.
- There are a few plants that completely utilize treated effluent, e.g. Palo Verde Nuclear Generating Station (Arizona), Magnolia Power Plant (Burbank) and MVPP.

Water Sources

MVPP

Reclaimed Water.....

- City of Redlands Title 22 treated municipal effluent
- Reclaimed water is not without significant operating issues – mineral scale & corrosion potential
- ~50% of plant water in 2006 @ MVPP
- Usage to increase in future years

Groundwater.....

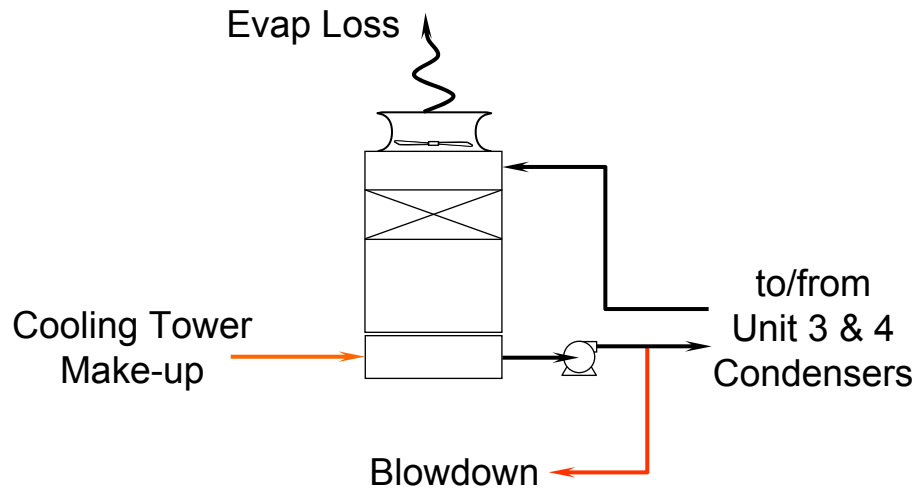
- Perchlorate-contaminated groundwater (plant wells in the mid aquifer)
- Perchlorate is a very stable molecule

Fresh Groundwater.....

- Heat Recovery Steam Generator feedwater (deep aquifer)

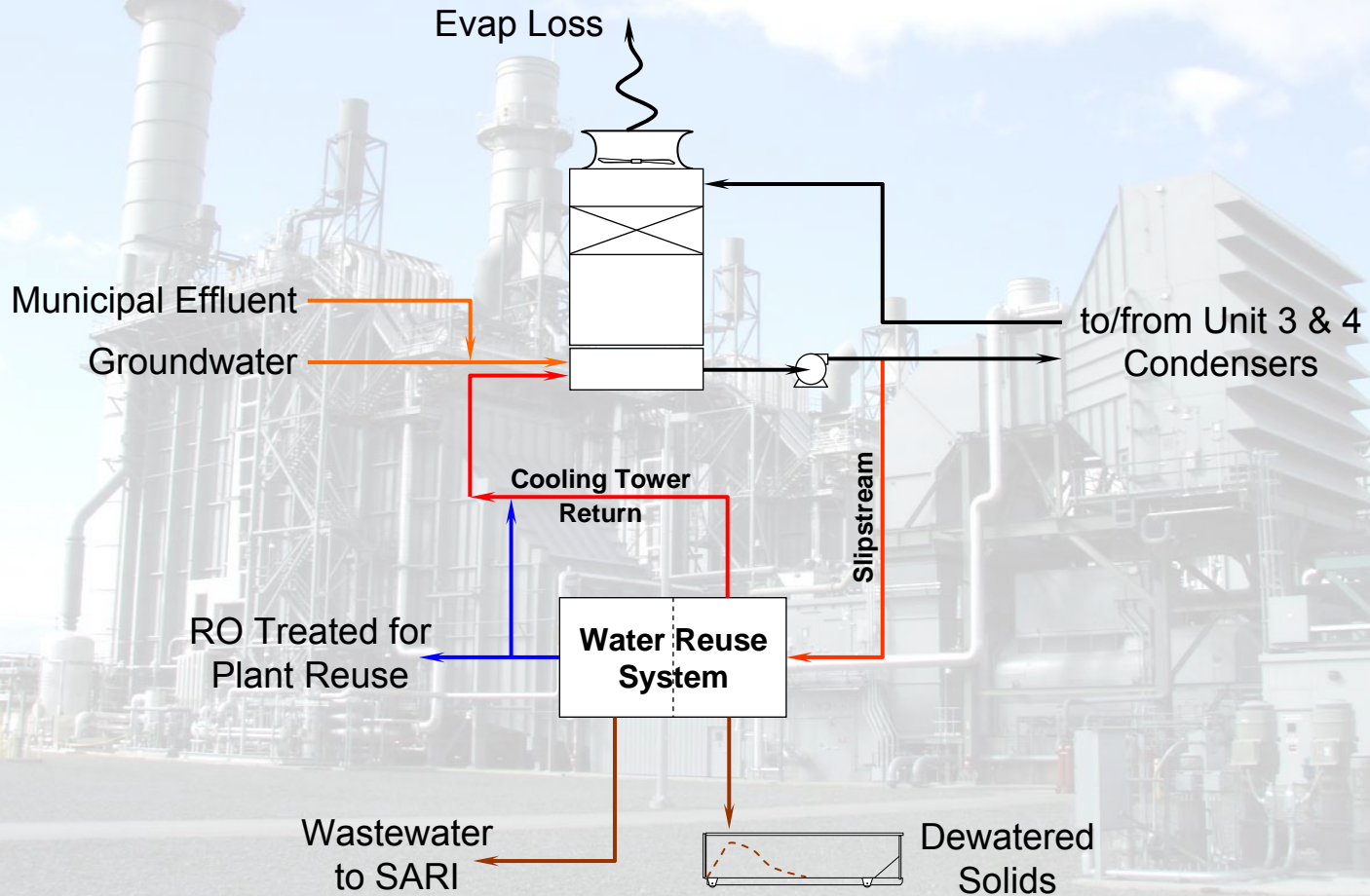
- This water is used for cooling tower make-up.
- MVPP is located in one of the few areas in California where groundwater is plentiful
- Cooling tower blowdown is treated for cooling re-use and general plant use.
- Plant wastewater (20% -25% of water demand) is discharged to the Santa Ana Regional Interceptor (SARI)

Cooling Tower Function MVPP



- The cooling tower extracts heat from circulating cooling water to/from the main steam condenser.
- Circulating water extracts heat and thereby condenses steam (from the steam turbine).
- In the cooling tower, water falls through “fill” which provides surface area to allow water to be exposed to air. Air is drawn into the tower by fans.
- A small portion of water evaporates in this process. For every pound of water evaporated, ~1,000 BTUs of heat are extracted.
- As evaporation occurs, the salts in the circulating cooling water concentrate.
- If not controlled, salts will form mineral scale and corrosion and will impair operation of the plant.....so blowdown is utilized to control the salt content of the cooling water.
- Mineral scale and corrosion are exacerbated with the use of reclaimed municipal effluent.

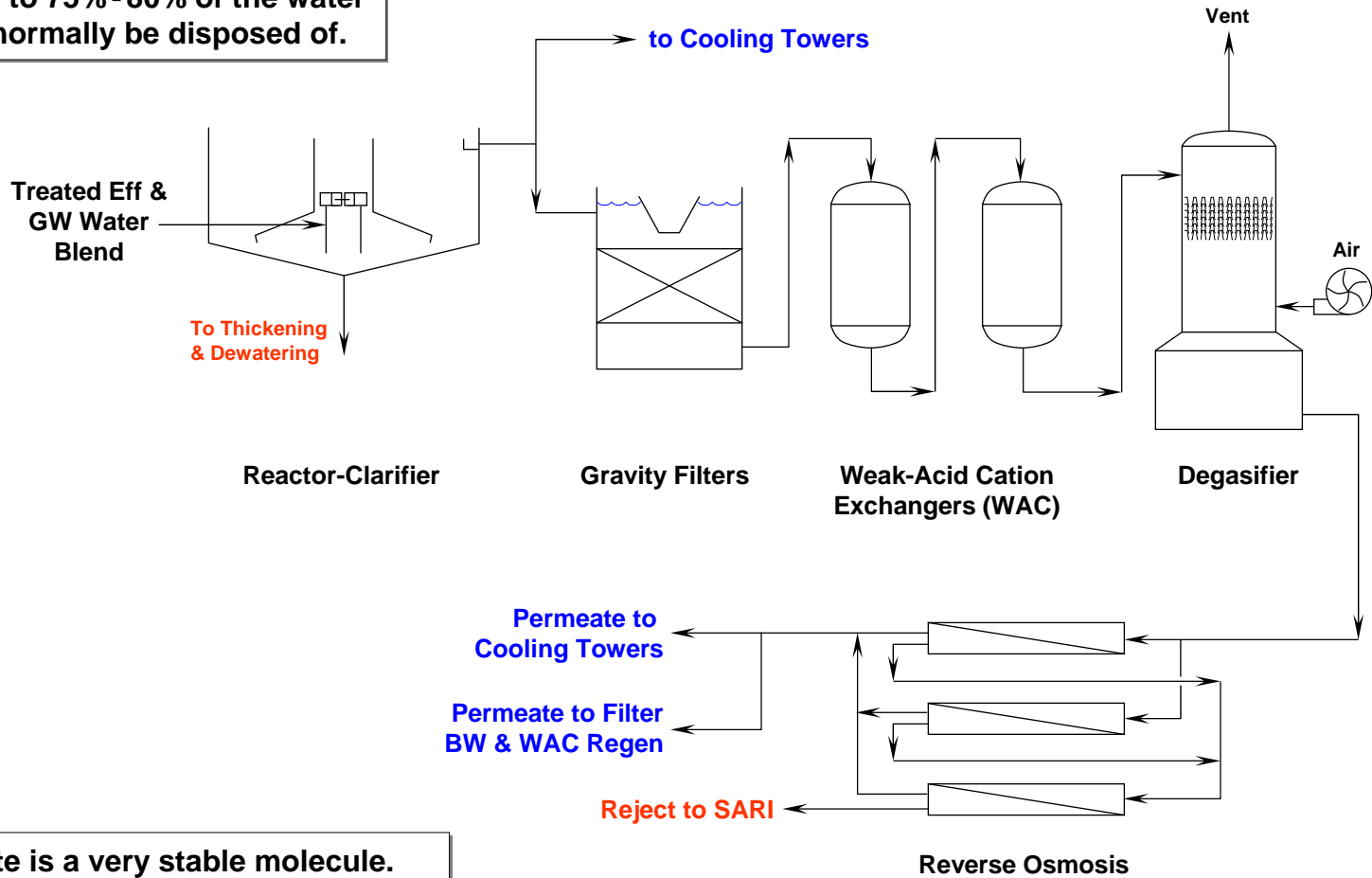
Water Treatment & Recovery MVPP



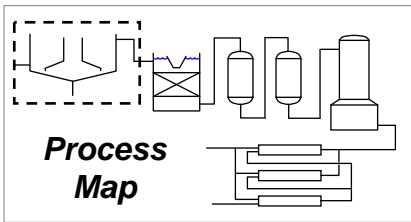
Water Treatment & Recovery System Process

MVPP

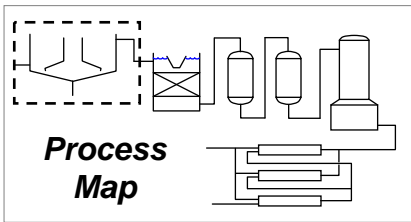
The water treatment plant at MVPP recovers up to 75% - 80% of the water that would normally be disposed of.



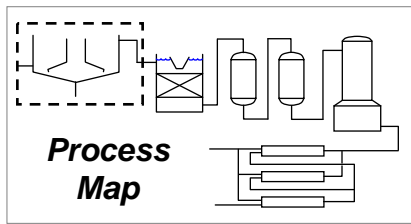
Perchlorate is a very stable molecule. As such, it is concentrated by the water treatment in the RO reject to SARI.



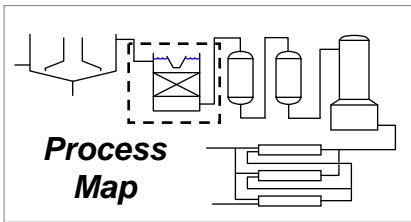
*Reactor Clarifier (foreground)
Thickener (background)*



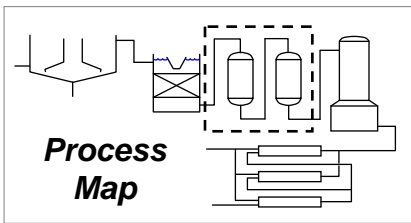
*Reactor Clarifier
Effluent Launder*



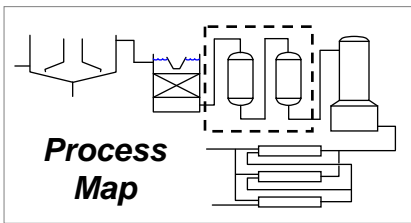
Filter Press



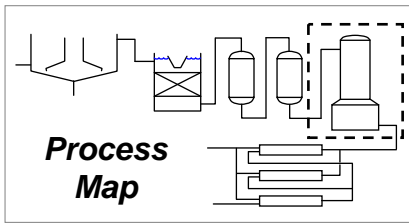
Gravity Filters



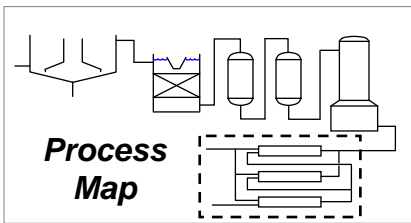
*Weak Acid
Cation Exchangers*



Neutralization System



Degasifier



Reverse Osmosis System

Water for Power in the Future

With increasing pressure for scarcer water resources, expect.....

- Widespread use of “other” degraded waters, i.e. brackish groundwater, oil-field produced water, etc.
- Desalination plants (for domestic use) that are integrated into power plants – several are in the study & design phase in California
- More power plants using air cooled condensers (ACC), i.e. dry cooling
- Once-through cooling on the California coast may be converted to cooling towers and ACCs.

Mountainview Power Plant

Redlands, CA

