

**SIEMENS**

Bob Wenta

**Applications Using  
Membrane Filtration as RO  
Pretreatment**



### Drivers

### Reliable

### Established

### Simple

### Compact

### Flexible

- Drivers for Continuous Membrane Filtration (CMF)
- Membrane Filtration is:
  - ◆ Reliable
  - ◆ Established
  - ◆ Simple
  - ◆ Compact
  - ◆ Flexible
- Many successful applications of Membrane Filtration
  - ◆ Potable water from surface and ground waters
  - ◆ Filtration of secondary and tertiary wastewater
  - ◆ Separation of biomass in activated sludge process
  - ◆ RO pretreatment from surface and waste waters

# Conventional Filter Effluent Quality...

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Drivers

Reliable

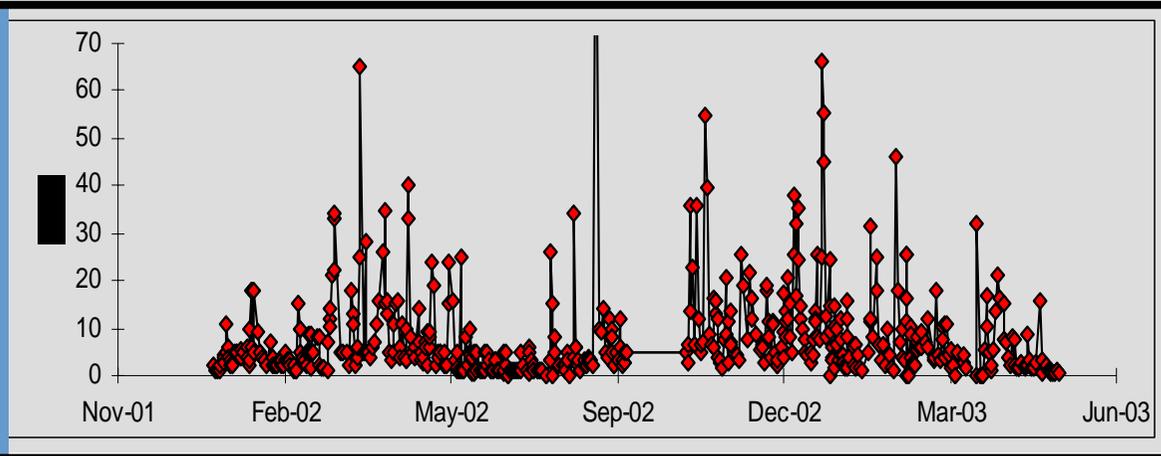
Established

Simple

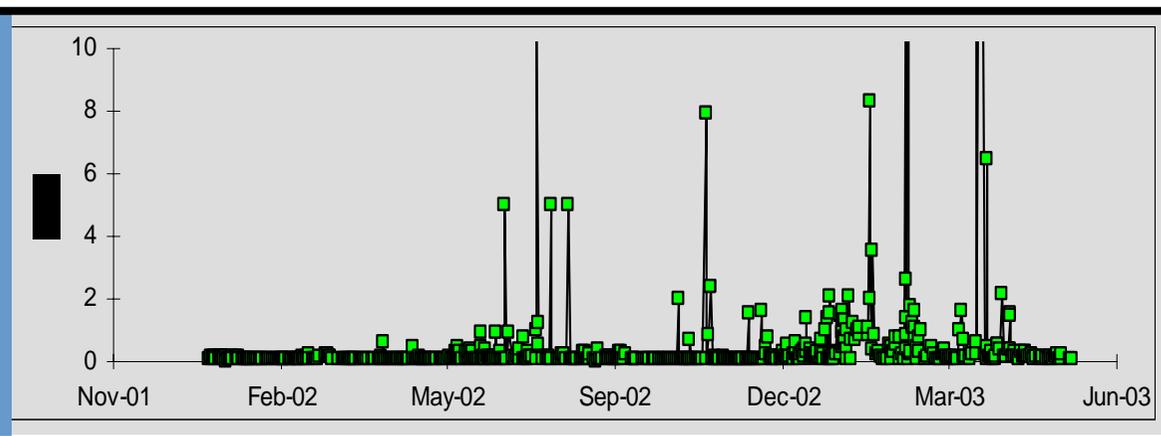
Compact

Flexible

Variable  
Feedwater  
Turbidity



Variable  
Sand  
Filter  
Effluent  
Turbidity



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...Affects RO Performance

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Drivers

Reliable

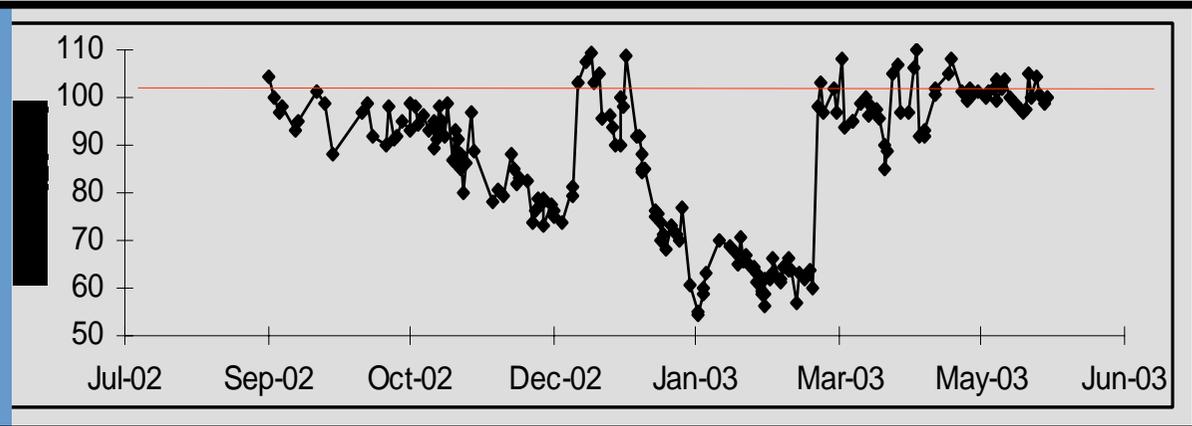
Established

Simple

Compact

Flexible

**Declining  
RO Flow  
Rates**



Frequent cleanings

Declining flow

Unreliable capacity

Costly down-time

Improve reliability

Reduce operating costs

Reduce wastewater

Reduce chemicals

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**Reverse Osmosis requires better pretreatment → CMF**

# CMF : Predictable Performance

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Drivers

Reliable

Established

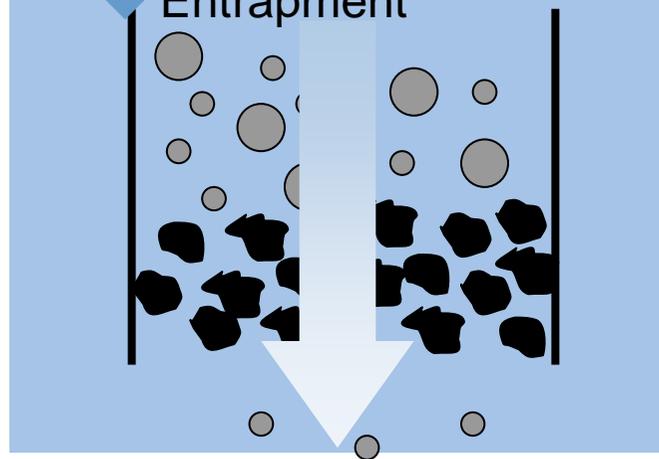
Simple

Compact

Flexible

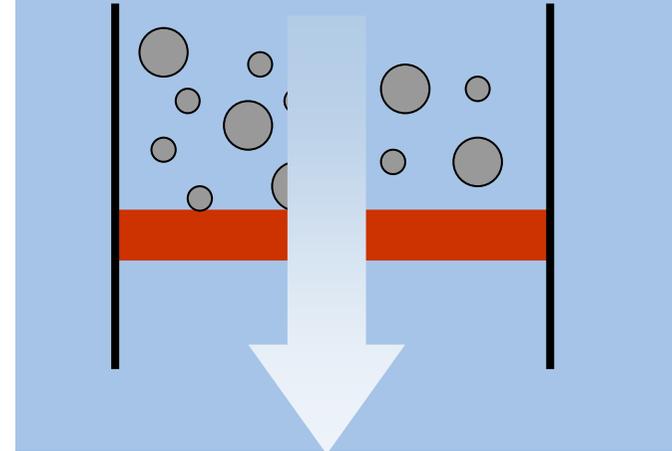
## Granular Filters

- Relies on random:
  - ◆ Collisions
  - ◆ Sieving
  - ◆ Entrapment



## Membrane Filters

- Relies on pore size of membrane
  - ◆ < 0.1 NTU typical
  - ◆ < 2.0 SDI typical



Drivers

Reliable

Established

Simple

Compact

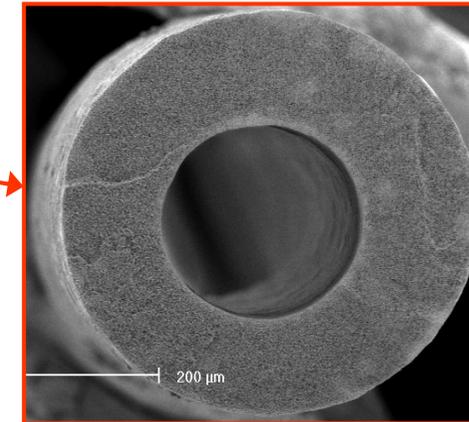
Flexible

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CMF Physical Data



Material	PVDF
Pore Size	0.04 - 0.1 micron



- Outside-in flow path prevents plugging of fibers
- Monolithic membrane structure will not delaminate
- Secure bonding of fibers will not detach from potting
- High test pressure assures membrane integrity

# CMF Replaces Multiple Steps

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Drivers

Parameter

Conventional Process

Membrane Filtration

Reliable

Process Steps

Multiple

1

Established

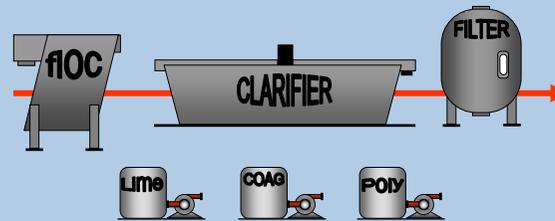
Waste Steps

Multiple

1

Simple

Schematic



■ Same flow rate, more reliable and easier to operate

Compact

Flexible

# CMF Replaces Multiple Steps

# SIEMENS

Drivers

Parameter

Conventional

Membrane Filtration

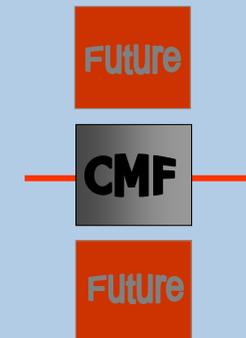
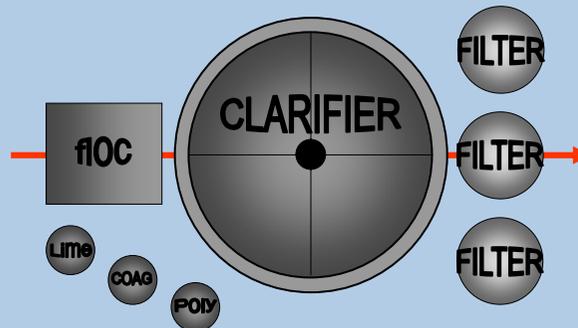
Footprint

500 gal / day / ft<sup>2</sup>  
(0.85 m<sup>3</sup> / hr / m<sup>2</sup>)

2,500 gal / day / ft<sup>2</sup>  
(4.25 m<sup>3</sup> / hr / m<sup>2</sup>)

Reliable

Schematic



Established

Simple

Compact

■ Same flow rate, better quality in 20% of floor space

Flexible

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CMF saves valuable plant space for expansion & other needs

# Same Membranes, Different Options

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**Drivers**

**Reliable**

**Established**

**Simple**

**Compact**

**Flexible**

## Pressurized



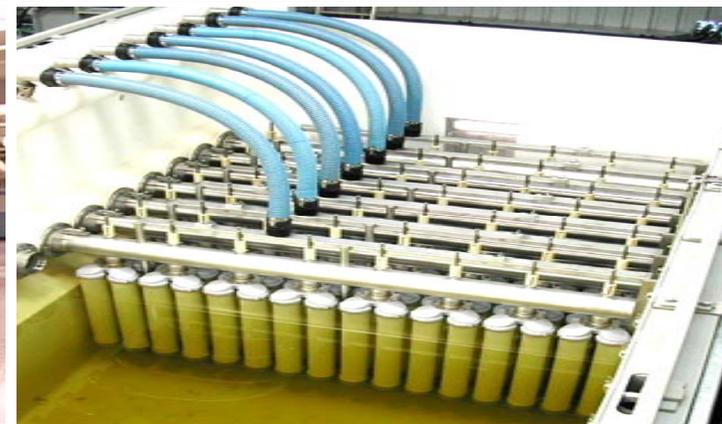
Pressure driven filtrate

Requires membrane pressure vessels

Can be installed in pressurized line

Economical for low flows

## Submerged



Suction driven filtrate

Membrane pressure vessels not required

Gravity fed system

Economical for large flows

**Choice depends on your needs, not what company sells**

**Surface Waters**

**Nuclear power plant replaces clarifiers and filters with membrane filtration**

**Waste Waters**

**Coal fired plant utilizes treated municipal sewage for boiler feedwater**

**Waste Waters**

**Large-scale membrane filtration systems replenish aquifers and serve industries**

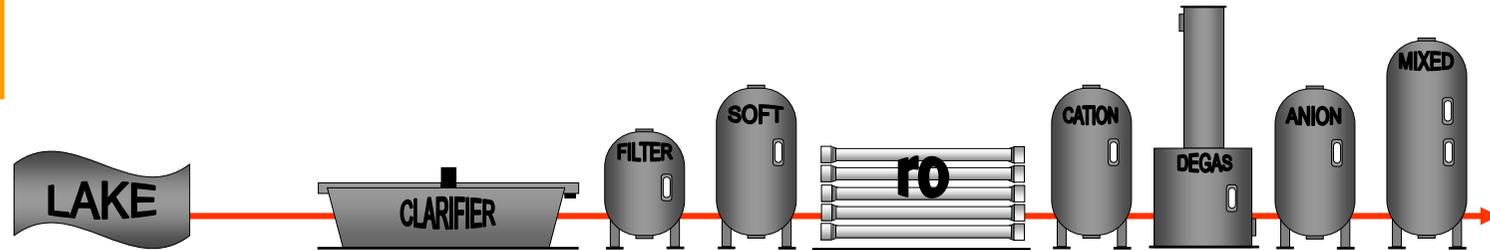
# Surface Water

# SIEMENS

## Process

- Existing process costly to operate and unreliable

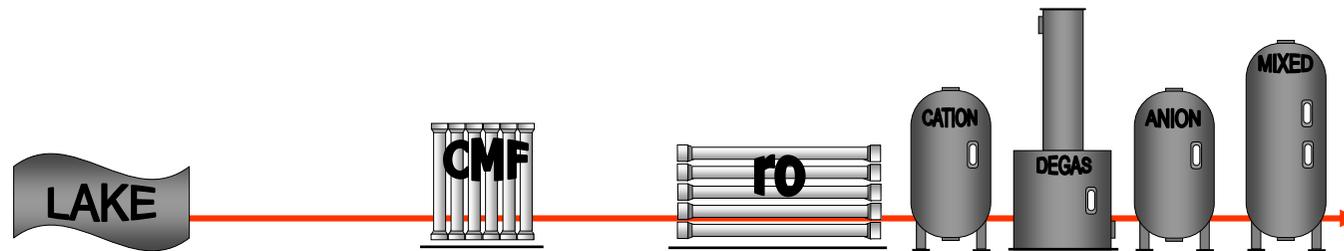
## Performance



## Results

- Clarifier and filter replaced with Membrane Filtration

## Others



Client Point Beach Nuclear      Flow 400 gpm      Start-Up 2004

# Surface Water

# SIEMENS

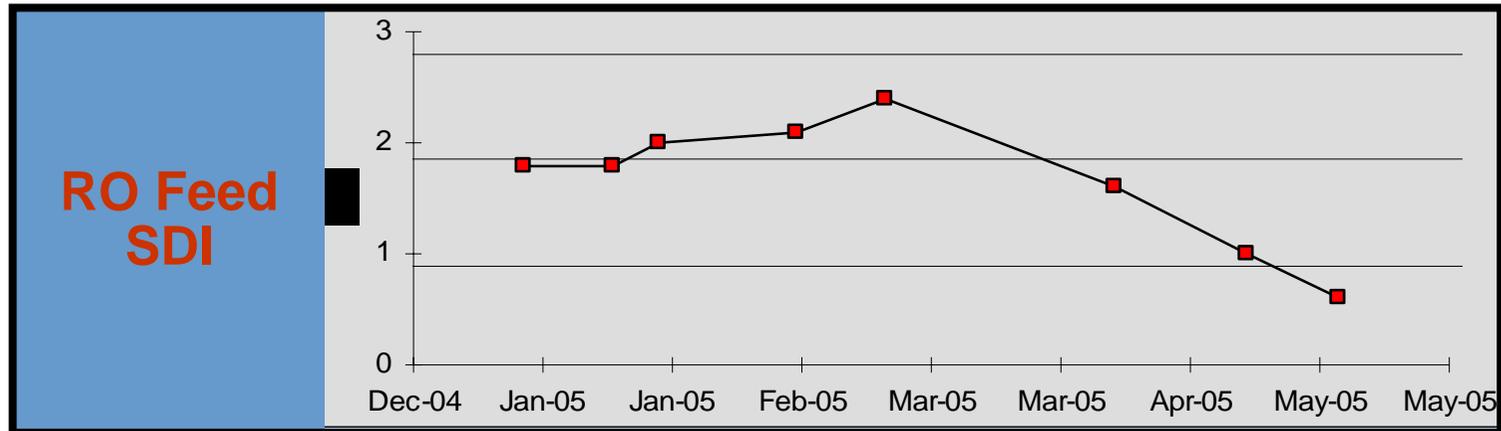
Process

Performance

Results

Others

Parameter	Feed	Conventional	CMF Treated
Turbidity (NTU)	1 - 70	1	< 0.1
TSS (mg/L)	2 - 500	2 - 3	< 1.0
SDI	Not measured	3 - 5+	1 - 2



# Surface Water

# SIEMENS

Process

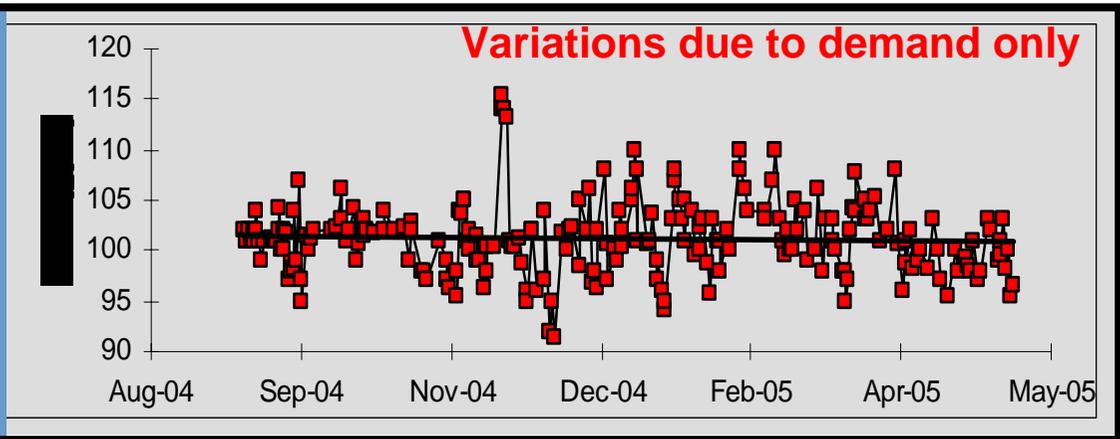
Parameter	Conventional	CMF Treated
Flux (GFD)	15.6	15.6
CIP (weeks)	< 12	>52
Life (years)	< 3	???

Performance

Results

Others

RO Flow Rates



## Surface Water

## SIEMENS

Process

Performance

Results

Others

Criteria	Conventional	MF Treated	Yearly Savings
Chemicals	\$122,000	\$24,000	\$98,000
Consumables	\$9,000	\$2,000	\$7,000
Labor	\$525,000	\$65,000	\$460,000
Waste	\$54,000	\$5,000	\$49,000
Total	\$710,000	\$96,000	\$614,000

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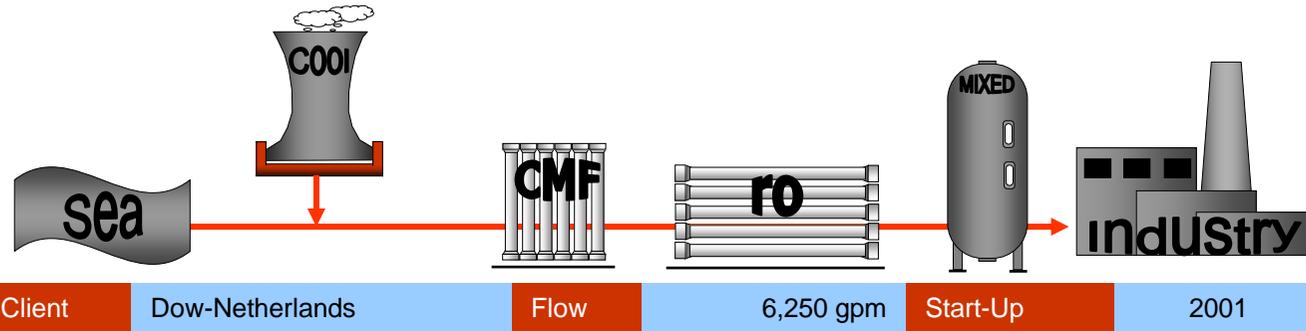
CMF requires less chemicals and labor, generates less waste

- Chemical manufacturing relies on CMF/RO

Process

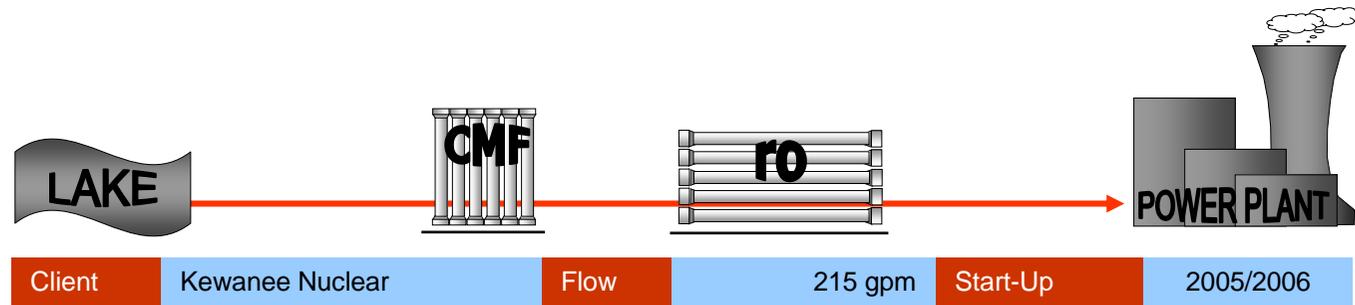
Performance

Results



- Another nuclear plant will rely on CMF/RO soon

Others



Surface Waters

Nuclear power plant replaces clarifiers and filters with membrane filtration

Waste Waters

Coal fired plant utilizes treated municipal sewage for boiler feedwater

Waste Waters

Large-scale membrane filtration systems replenish aquifers and serve industries

# Sanitary Wastewater

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- Existing water source expensive with limited supply

Process

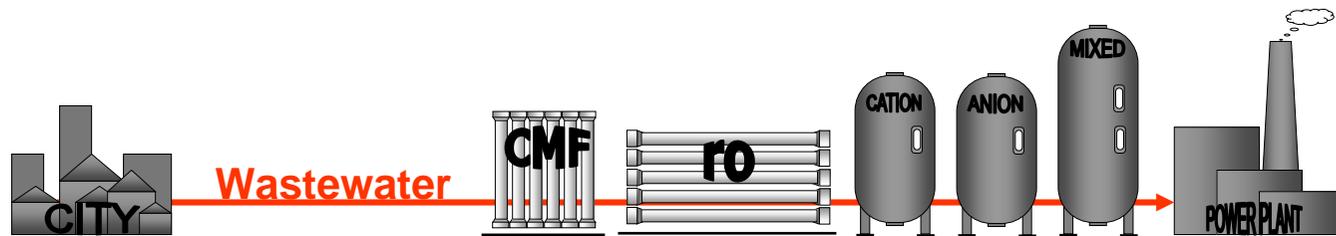


Performance

Results

Others

- Utilize wastewater with CMF/RO for boiler feedwater



Client	Eraring Power, NSW	Flow	380 gpm	Start-Up	1995
			190 gpm	Phase 2	2000

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Partnership with municipality critical for success

## Sanitary Wastewater

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Process

- Plant in operation for over 9 years

Performance

Criteria

Performance

RO  
Feedwater

< 2.0 SDI

MF Recovery

90%

RO Recovery

80%

Results

Others



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**0.2 micron PP membranes provide excellent RO feed water**

## Sanitary Wastewater

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Process

- Lower TDS in feedwater to DI system saves money

Performance

- Elimination of potable water for non-potable use saves money

Results

- Redirecting treated sewage to power plant saved city \$4M

Others

Criteria

Results

MF life

8.5 years

MF CIP

Every 4 weeks

RO life

10 years

RO CIP

Every 2 years

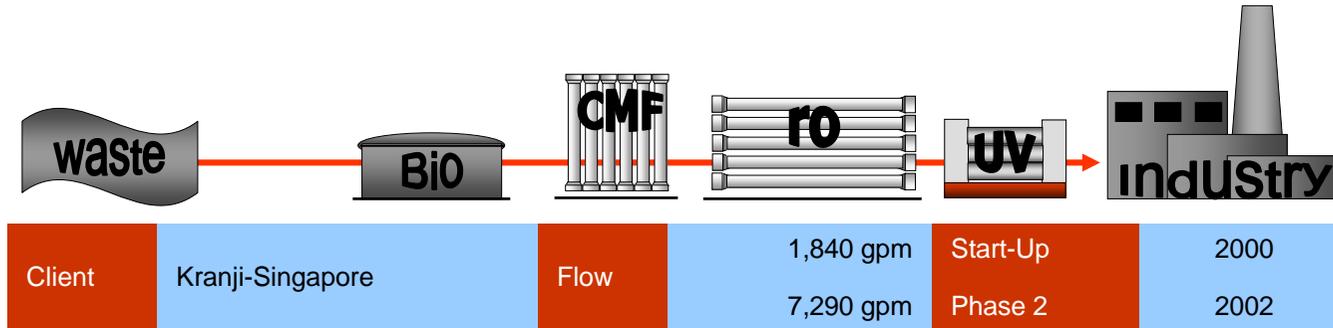
Annual Savings

\$800,000

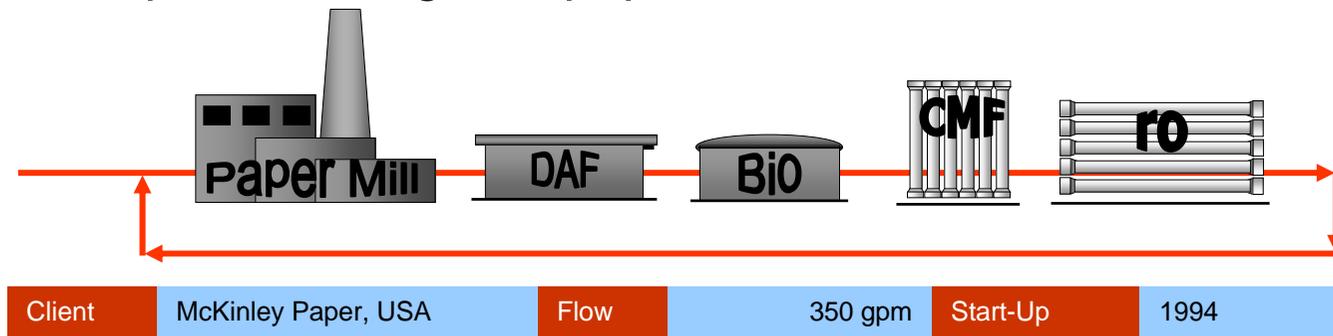
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CMF extends RO membrane life

- Semiconductor manufacturing relies on CMF/RO



- Zero liquid discharge for paper mill relies on CMF/RO



Process

Performance

Results

Others

Surface  
Waters

Nuclear power plant replaces clarifiers and filters with membrane filtration

Waste  
Waters

Coal fired plant utilizes treated municipal sewage for boiler feedwater

Waste  
Waters

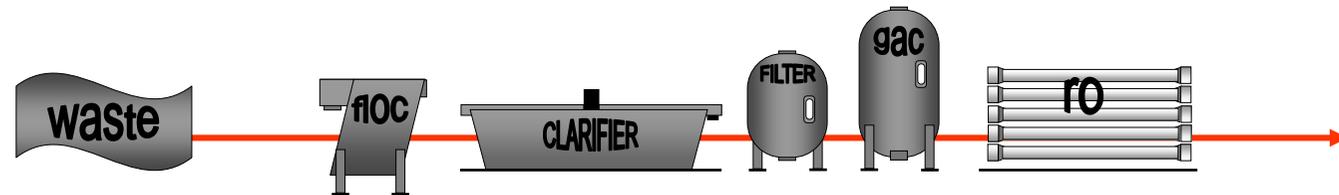
Large-scale membrane filtration systems replenish aquifers and serve industries

# Sanitary Wastewater

**SIEMENS**

- Existing process very expensive to operate

**Process**



**Performance**

**Results**

- New process economical and reliable

**Others**



Client	Orange County, USA	Flow	500 gpm	CMF Pilot	1994
			160 gpm	CMF-S Pilot	2000
			4,200 gpm	Phase 1	2004
			55,000 gpm	Phase 2	2007

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**New process studied and tested for years: CMF selected**

# Sanitary Wastewater

# SIEMENS

Process

Performance

Results

Others

Parameter	Feed	Conventional	CMF Treated
Turbidity (NTU)	2 – 5	1	< 0.1
TSS (mg/L)	5 – 10	2 – 3	< 1.0
SDI	> 6	5 – 6	1 - 2



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Fiber and system integrity critical to application

## Sanitary Wastewater

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**Process**

**Performance**

**Results**

**Others**

Cellulose Acetate RO system	Parameter	Conventional Treatment	CMF Treated	Results
	Flux (GFD)	10	12	20% improvement
	CIP (weeks)	4	16	400% improvement

Polyamide RO system	Parameter	Conventional Treatment	CMF Treated	Results
	Flux (GFD)	10.4	10.4	N/A
	CIP (weeks)	6	36	600% improvement
	Life (years)	5	7	140% improvement

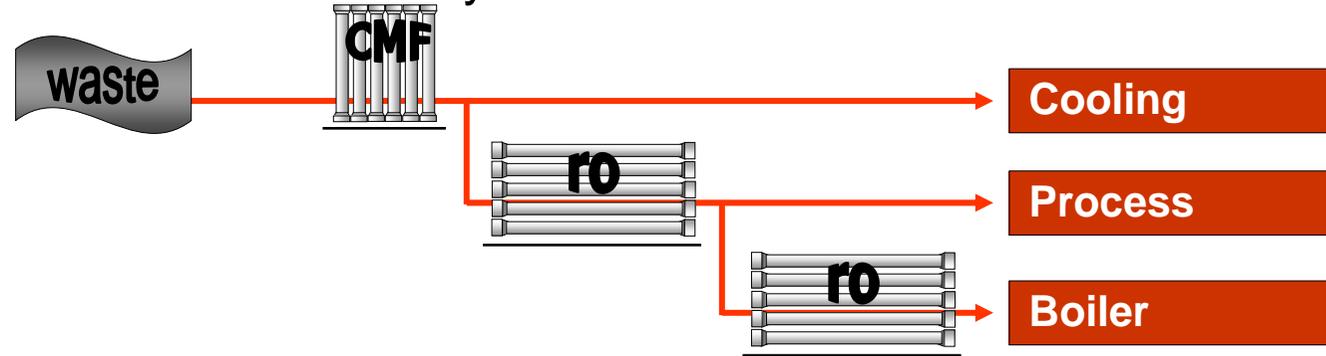
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**CMF = higher flux, fewer cleanings and longer life of RO**

# Sanitary Wastewater

# SIEMENS

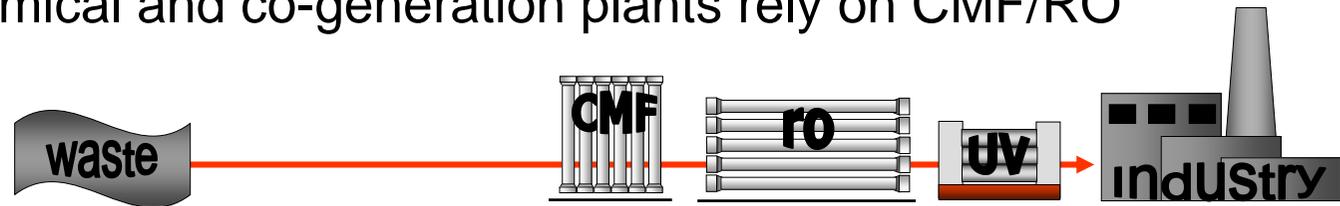
- Petroleum refineries rely on CMF/RO



Client	West Basin, USA	Flow	12,500 gpm	Start-Up	1998
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## Others

- Chemical and co-generation plants rely on CMF/RO



Client	Honouliuli, USA	Flow	2,300 gpm	Start-Up	2000
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## Surface Waters

Consistently low SDI in RO feedwater

Elimination of solid waste handling

Saved \$614,000 annually



## Waste Waters

Saved community drinking water supply

Plant utilized "cheap" water source

Plant saved \$800,000 annually

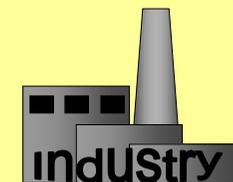


## Waste Waters

Simpler to operate and maintain

Reduced O & M costs

Utilized alternative water source





## Conclusion

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### Drivers

- Membrane filtration is reliable and established
  - ◆ Over 700 plants in operation around the globe
  - ◆ Some of the worlds largest filtration plants utilize membranes

### Reliable

- Membrane filtration is simple and compact

### Established

- ◆ Replaces several process steps with one
- ◆ Saves valuable plant space for other uses

### Simple

- Membrane filtration has many benefits and uses

### Compact

- ◆ Improve performance of RO systems
- ◆ Reduce operating costs of boiler feedwater systems
- ◆ Take advantage of less expensive (alternate) water
- ◆ Potable water for plant employees

### Flexible

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**How can CMF improve the performance of your RO system?**

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Thank you very much for your attention.