Industrial Water Conservation

TURA Resource Conservation Training/Workshop

April 23, 2026

Kelsey Klucas

University of Minnesota

Driven to Discover[SM]

Overview

- **Introduction – MnTAP, Why water?**
- **Review strategies for water efficiency**
  - Find water efficiency opportunities
  - Define water efficiency opportunities
  - Identify co-benefits
  - Develop the business case
  - Resources
- **Conduct a water efficiency assessment**
  - Practice, practice
  - Discuss opportunities and challenges

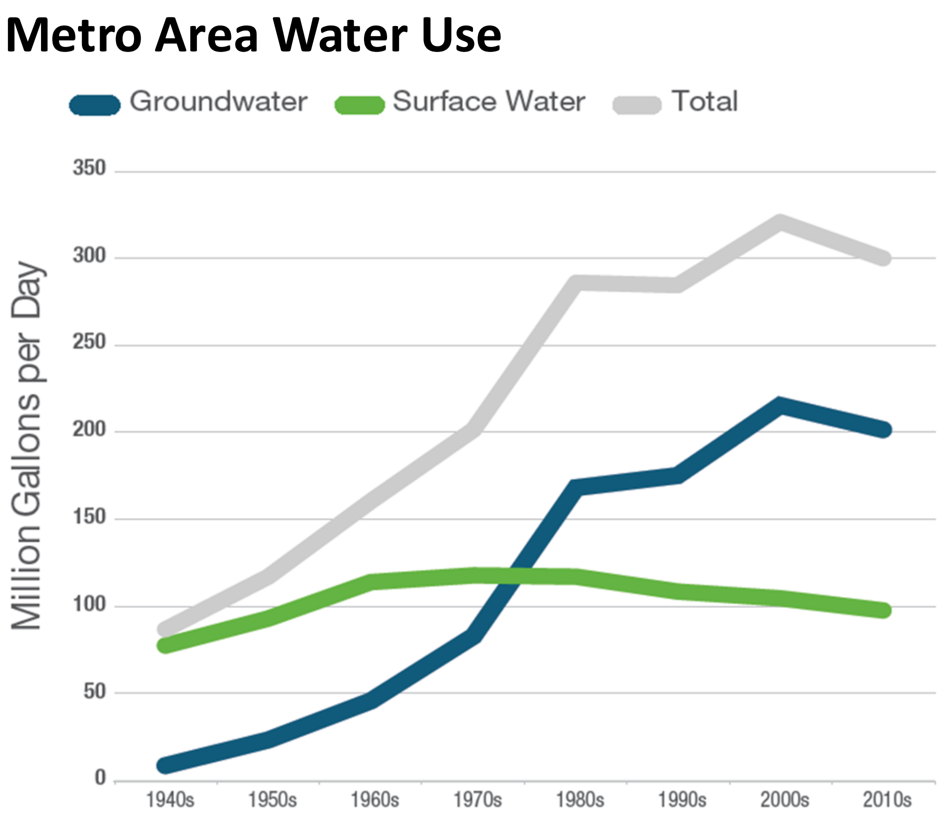
Minnesota Technical Assistance Program

Strengthening Minnesota businesses by improving efficiency while saving money through energy, water, and waste prevention.

MnTAP

- **Established in 1984**
- **University of Minnesota, SPH**
  - Outreach and assistance unit
  - Grant and partner funded
- **Confidential, no-cost engineering assistance for Minnesota businesses**
- **Site Assessments, interns, teams**
- **http://www.mntap.umn.edu**

Why Water Efficiency in the Land of 10,000 Lakes



- Use increase with population
- Groundwater vs. Surface Water
- Unsustainable groundwater recharge
- Surface water impacts
- Contamination
- Cost avoidance
- Resource stewardship

Industrial Water Use

Many industries use large quantities of water—but where should efforts to improve water use start?

It starts by understanding how the water is being used.

Industrial Water Use

Total water withdrawals and consumption by subsector and state

Figure 4 provides a breakdown of U.S. manufacturing total water withdrawals and consumption by subsector. In order, the pulp and paper (322), primary metals (331), chemicals (325), petroleum refining (324), and food (311) sectors have the greatest water withdrawals of any manufacturing subsector. See Appendix B for a listing of 3 digit NAICS code for reference.

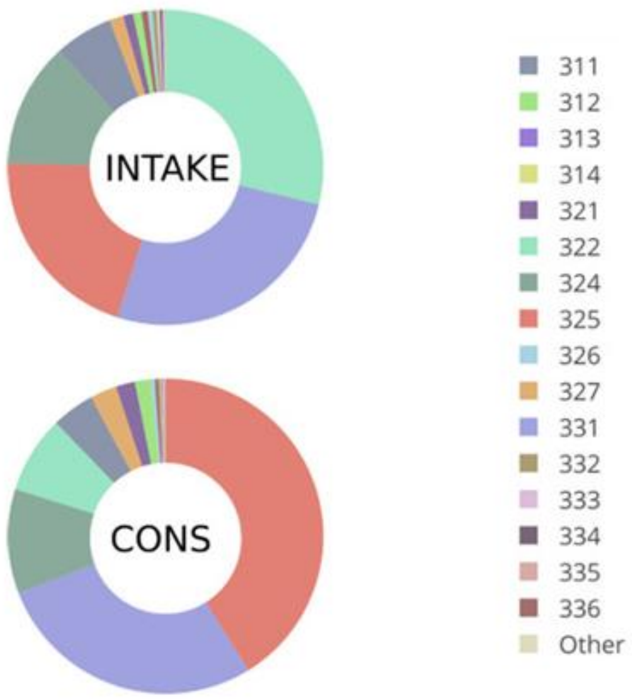


Figure 4: U.S. manufacturing total water intake (top) and consumption (bottom) by subsector using USGS and Canadian data

NAICS Code	Industry Description
311	Food manufacturing
312	Beverage and tobacco product manufacturing
313	Textile mills
314	Textile product mills
321	Wood product manufacturing
322	Paper manufacturing
324	Petroleum and coal product manufacturing
325	Chemical manufacturing
326	Plastics and rubber products manufacturing
327	Non-metallic mineral product manufacturing
331	Primary metal manufacturing
332	Fabricated metal product manufacturing
333	Machinery manufacturing
334	Computer and electronic product manufacturing
335	Electrical equipment, appliance and component manufacturing
336	Transportation equipment manufacturing
Other	Other Industries

https://www.aceee.org/files/proceedings/2017/data/polopoly_fs/1.3687919.1501159097!/fileserver/file/790285/filename/0036_0053_000025.pdf

Examples of water use in the work place

- Washing and rinsing
- Product transport
- Product processing
- Product ingredient
- Process sanitation
- Evaporative cooling
- Heating
- Water treatment and purification
- Domestic uses

Photo credit: Alliance for Water Efficiency
www.allianceforwaterefficiency.org/

So where to begin?

Strategies for water efficiency – the 4 Ms

Map

- Measure
- Value
- Plan

Maintain

- Inspect
- Repair
- Prevent
- Repeat

Manage

- HP-LF
- High Eff.
- Automate

Modify

- Reduce
- Reuse
- Recycle

Strategies for water efficiency - Map

Get a picture of how water is actually used throughout the site

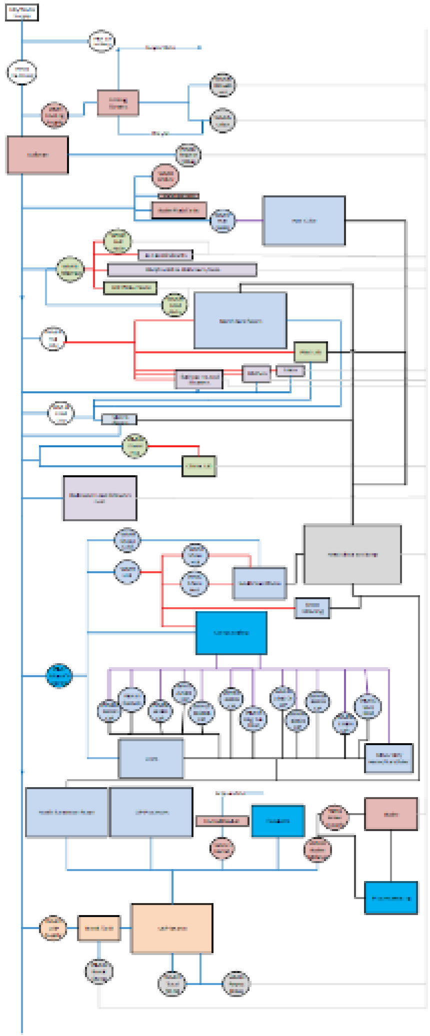
Map

- **Measure**
- **Value**
- **Plan**

- First step in any water assessment
- Minimizes bias for/against operations
- May require multiple data sources, measurements, and conversations
- Allows site to get best "return" on effort
- Facilitates site long term water efficiency strategy development - continuous improvement

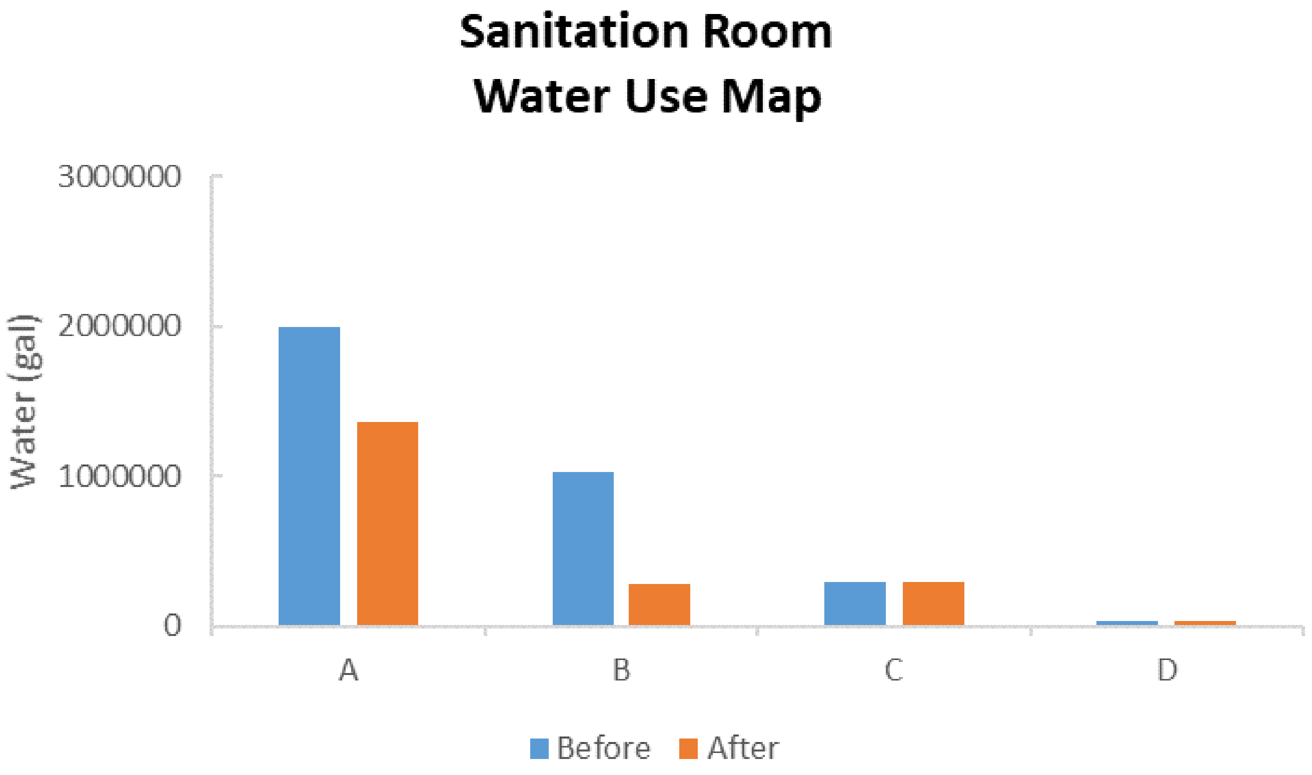
Map water use – Aveda Blaine, MN

- **Company's motivation**
  - 22 million gpy water use
  - 25% used in cleaning
  - Reduce water use and costs
- **Approach**
  - Analyzing water meters
  - Observe CIPs and manual sanitization
  - Flow rate measurements
  - Talking with workers
  - SAP reports



http://www.mntap.umn.edu/download/270/meghan-pieper/15179/meghan-pieper-aveda-corporation-summary-2018.pdf

Water efficiency opportunity - Aveda



- **Facility water mapping**
  - 15% - Sanitation room
    - 4 operations
    - Manual and automated
  - Changes in two operations
    - High efficiency spray nozzle
    - High efficiency spray ball
  - Savings
    - 1.4 million gpy (40% of area use)
    - 7,300 therms
    - 56,000 kWh
    - $20,000/yr (<1yr ROI)

Strategies for water efficiency - Maintain

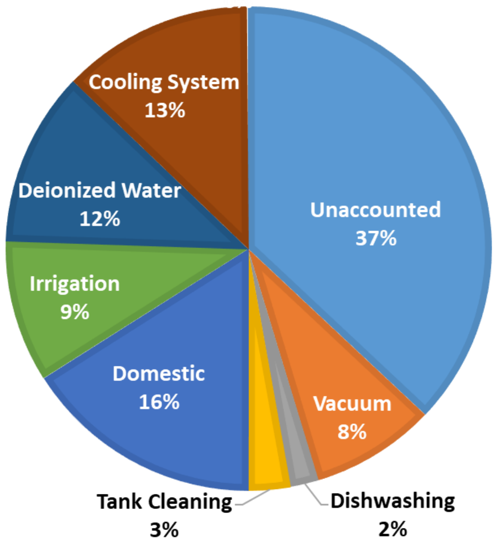
Repairing existing processes to operate as designed

Maintain

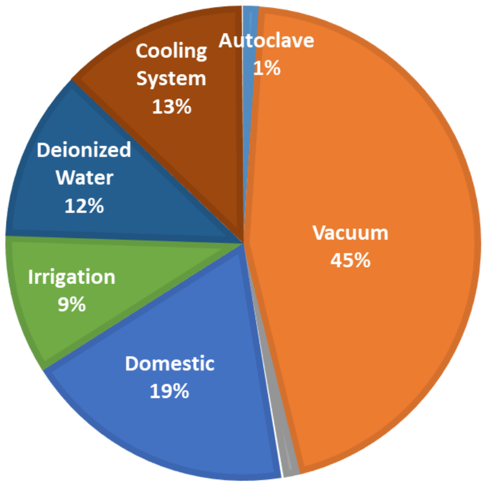
- **Inspect**
- **Repair**
- **Prevent**
- **Repeat**

- Low hanging fruit, but can be significant
- Low cost within maintenance budget
- Requires staff time/attention
- Often postponed if not urgent
- Generally recurring
- Prevention is possible
  - Analyze leak incidents/recurrences
  - Add to PM schedule
  - Change materials or processes

Maintain operations – Diasorin Inc., Stillwater, MN



Initial water map

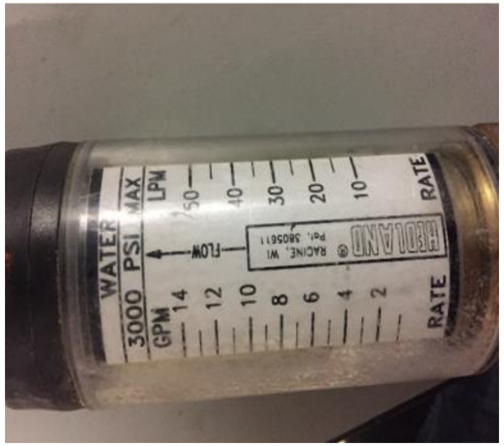


Final water map
Full water accounting

- Motivation
  - 8.5 million gpy water use
  - 37% - 3.1 million gpy unaccounted
  - Avoid SAC increase
    - up to 74 units at $2,500/unit
  - Reduce costs and water use
- Approach
  - Create map of water use
  - Close water balance
  - Identify reduction strategies

http://www.mntap.umn.edu/download/200/2017/14153/yohanes-agustinus-diasorin-summary-2017.pdf

Water Efficiency Opportunity – Diasorin Inc., Stillwater, MN



- **Facility water mapping**
  - Detailed inspection – no inconsistency
  - City meter identified leaks
- **Vacuum system optimization**
  - Liquid ring seal corroded
    - 3 gpm continuous leak
    - 1 million gpy direct to drain
  - Replace broken flow meter
    - 12.8 gpm actual flow vs 2.8 gpm target
    - 2.1 million gpy water savings
  - Implement maintenance check
- **Results**
  - 3.1 million gal water
  - $23,000

Strategies for water efficiency - Manage

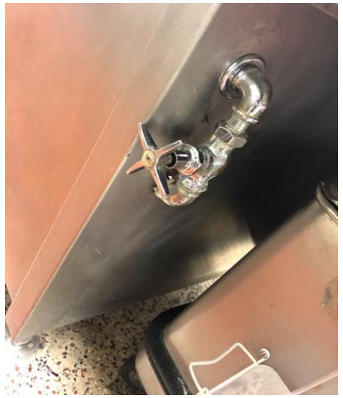
Optimizing existing process and equipment operation

Manage

- **HP-LF**
- **High Eff.**
- **Automate**

- Second level of complexity
- Can be achieved with low or modest cost
- Reset operation within current system limits
- Retraining operations staff
- Changing SOPs or practices
- Add operating controls/automation
- Replacing like for more efficient like
- Ideal for Plan, Do, Check, Act approach

Manage Process – North Memorial Hospital Kitchen, Golden Valley, MN



- Motivation
  - Soup kettle trough used 1.5 million gal, 127^{o}F water per year
  - Flow often left on when not needed
- Approach
  - Install solenoid and timer to replace hand valve - $26
- Results
  - 1.3 million gal water/yr
  - 7,000 therms/yr
  - $13,000/yr

http://www.mntap.umn.edu/download/245/2018/15172/christopher-leppla-north-memorial-health-summary-2018.pdf

Strategies for water efficiency - Modify

Implementing significant change to process or equipment

Modify

- **Reduce**
- **Reuse**
- **Recycle**

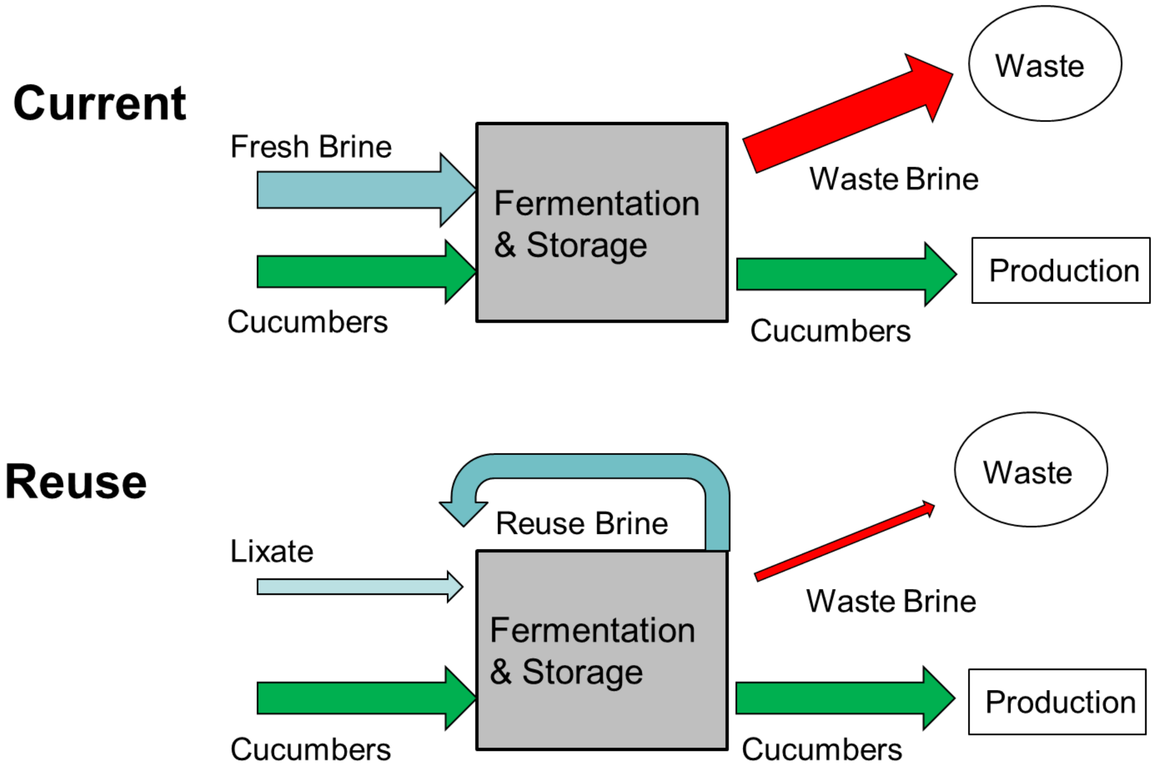
- High level of complexity
- Often presents some risk to the process
- Requires site champion to execute
- May require process redesign
- May require capital investment
- May require multiple levels of authorization
- Likely to require extended time to implement

Modify - Gedney Foods, Chaska, MN

- Motivation
  - Reduce demand on well supply
  - Reduce wastewater discharge
  - Water not a production bottleneck
- Approach
  - Map water use
  - Identify water savings options
  - Reduce salt use

http://www.mntap.umn.edu/download/141/2013/11648/ryan-venteicher-gedney-foods-summary.pdf

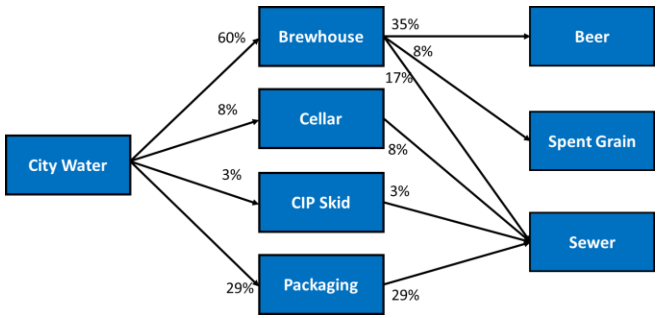
Water Efficiency Opportunity – Gedney Foods



- **Steam Pasteurizer Overflow**
  - 2 systems – steam and hot water
  - Reuse steam overflow as makeup water for hot water feed
- **Fermentation Brine**
  - Current - fresh brine for each tank
  - Proposed - reuse brine solutions
- **Results**
  - •5 million gal water
  - •213,000 lb salt
  - •22,000 therms heat energy
  - •$32,000

Using the 4 Ms at Fulton Beer Company

Map



- Motivation
- Company commitment to minimize water use
- Prepare operations for growth

Maintain

- Repair broken valve
- 74,000 gpy water reduction
- 540 therm water heating
- $1,100

Manage and Modify

- Install high efficiency rinse nozzle
- Reuse inside can rinse for outside rinse
- 150,000 gpy water reduction
- $1,500

http://www.mntap.umn.edu/wp-content/uploads/simple-file-list/Intern/2010-2019/2017/Karl-Wuolo-Journey-Fulton-Beer-Summary-2017.pdf

Water Treasure Hunt
Site Assessment Simulation

Scenario

- You have been contacted by a company called "Optics R Us"
- Company has increased their plant water usage by 500,000 gpy over 3 years, resulting in increased water and sewage costs
- They are looking for opportunities for ≥ 500,000 gpy water savings
- To help them, our job is to:
  1. Identify all water usage in the plant
  2. Identify potential water efficiency strategies
  3. Make a business case

Company Information– Optics R Us

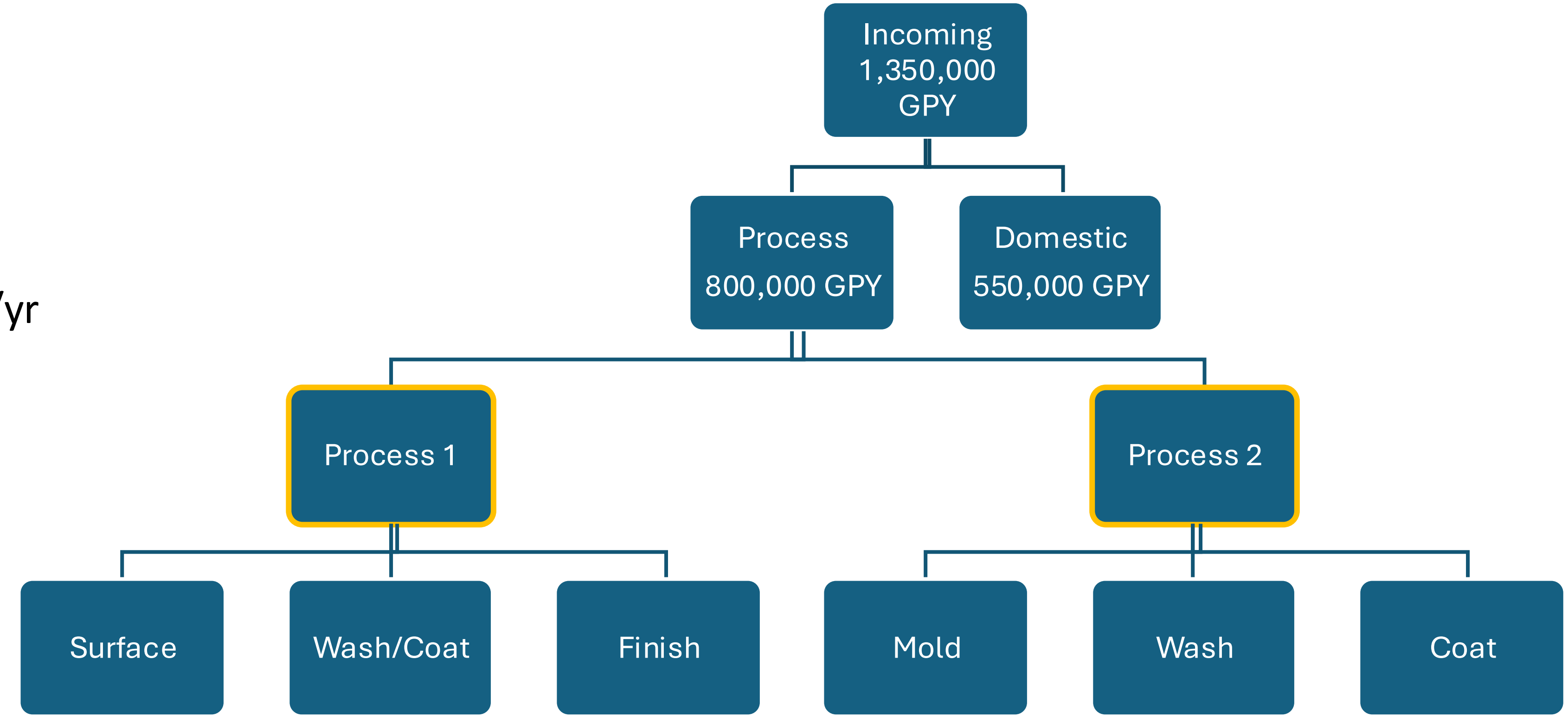
- Manufactures optical lenses with 110 employees
- Manufacturing Process 1
  - Converts purchased lens blanks
  - Traditional operational process
  - Three work areas – **Surface, Wash/Coat, Finish**
- Manufacturing Process 2
  - Molds lenses on site
  - Operating for 2 years
  - Three work areas – **Mold, Wash, Coat**

Before the site visit

- **Questions for us to consider:**
  - What other research can you do before coming on site?
  - What may have changed to cause the increase in water use?
  - What other information do you need before stepping foot on site?

Before visit - Begin identifying all water usage

- **We asked for preliminary water usage before the site visit.**
- **This site provided their meter readings:**
  - Total water: 1,350,000 gpy
  - Industrial (process) use meter: 800,000 gpy and costs $2,400/yr for water & sewer
  - Domestic use meter: 550,000 gpy and costs $1,650/yr for water & sewer
- **Do we know anything more?**
  - Yes, we have 2 manufacturing processes
  - We also know the process steps



Site Visit

Notes we wrote down during call:

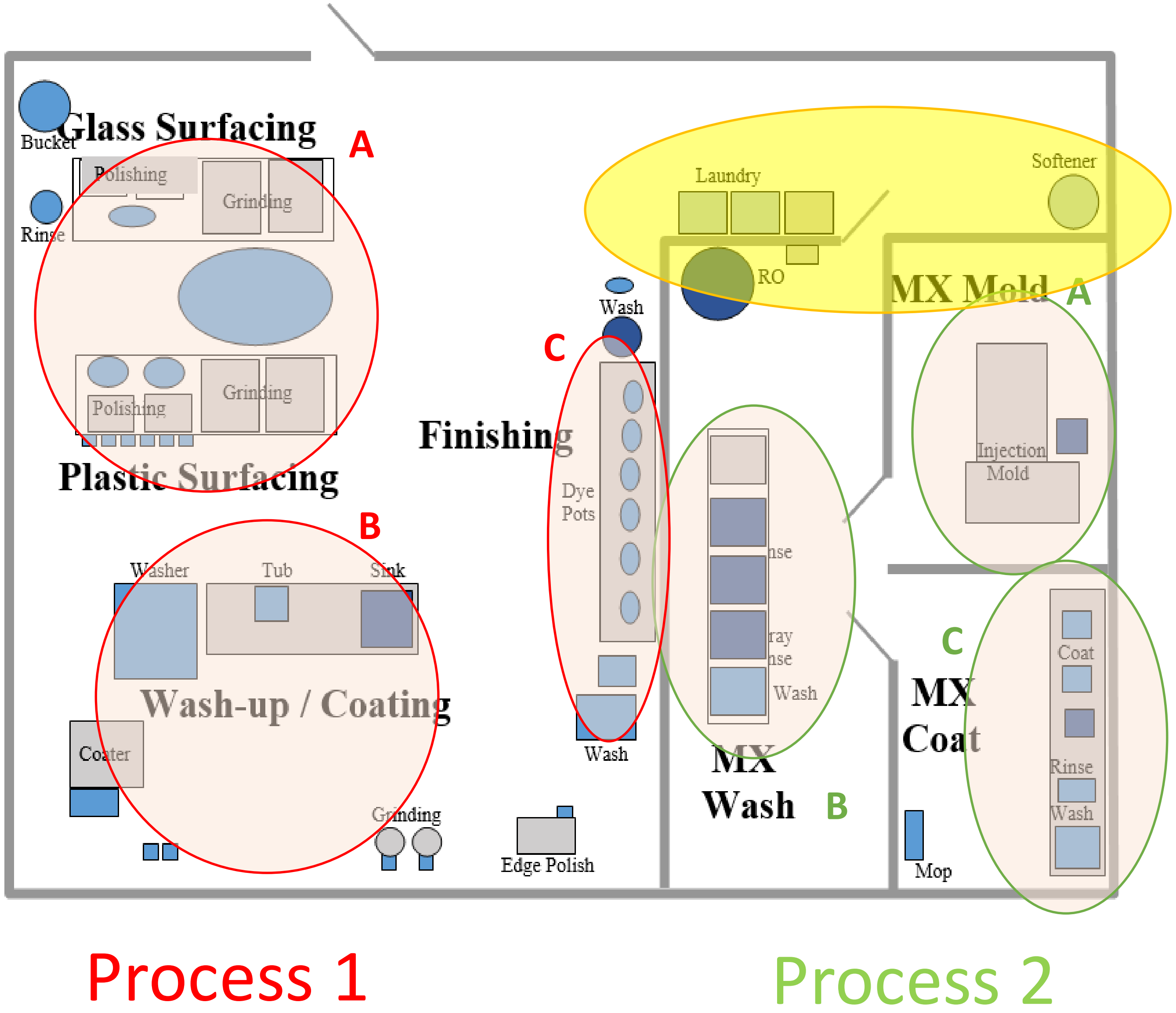
Manufacturing Process 1

- Converts purchased lens blanks
- Traditional operational process
- Three work areas – **Surface, Wash/Coat, Finish**

Manufacturing Process 2

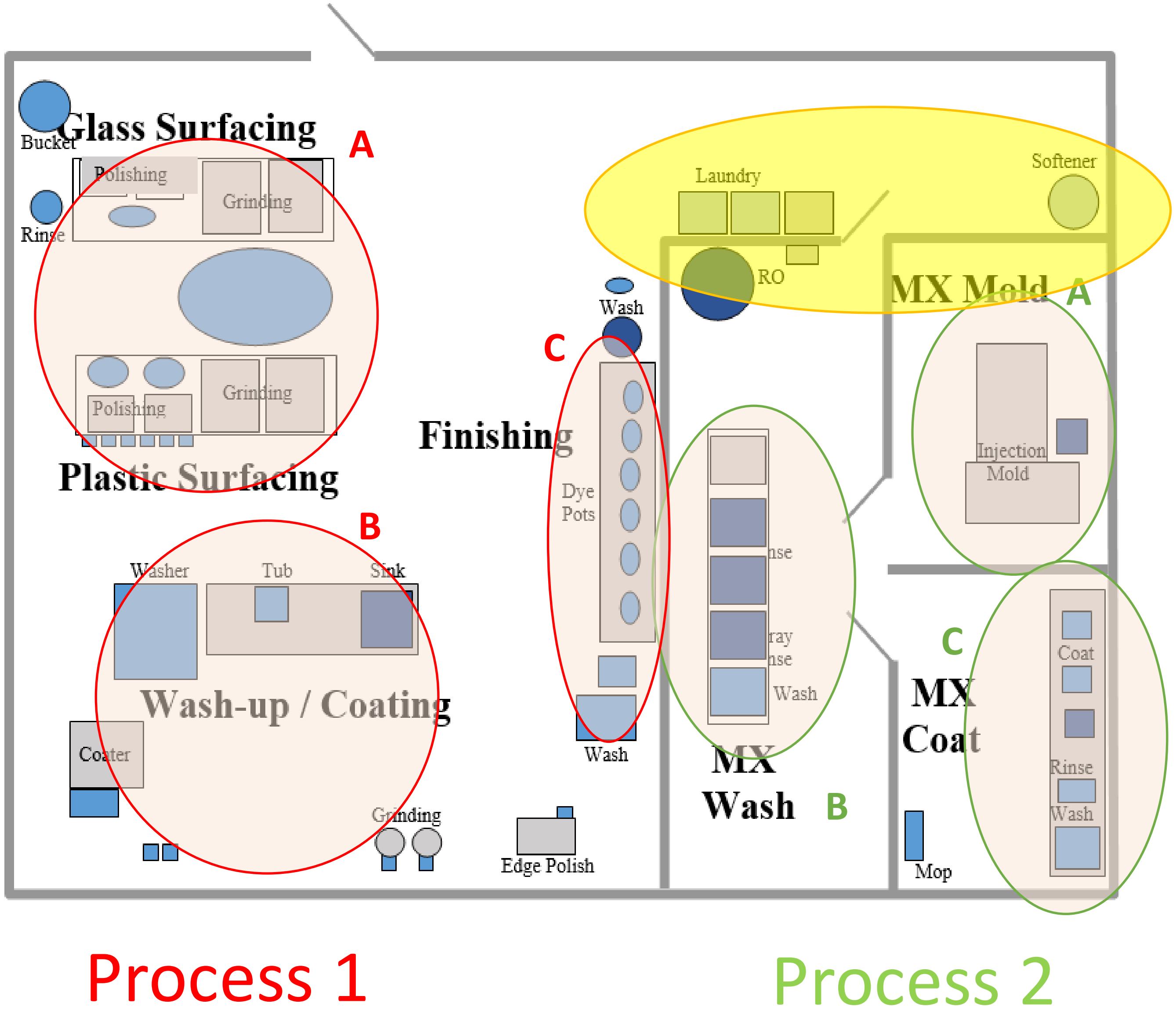
- Molds lenses on site
- Operating for 2 years
- Three work areas – **Mold, Wash, Coat**

Is there anything else of note?



Discussion: Site Visit

- What do you need more information on?
- Where could you gather this information?
- What strategies do you employ to succeed in getting the information you need?



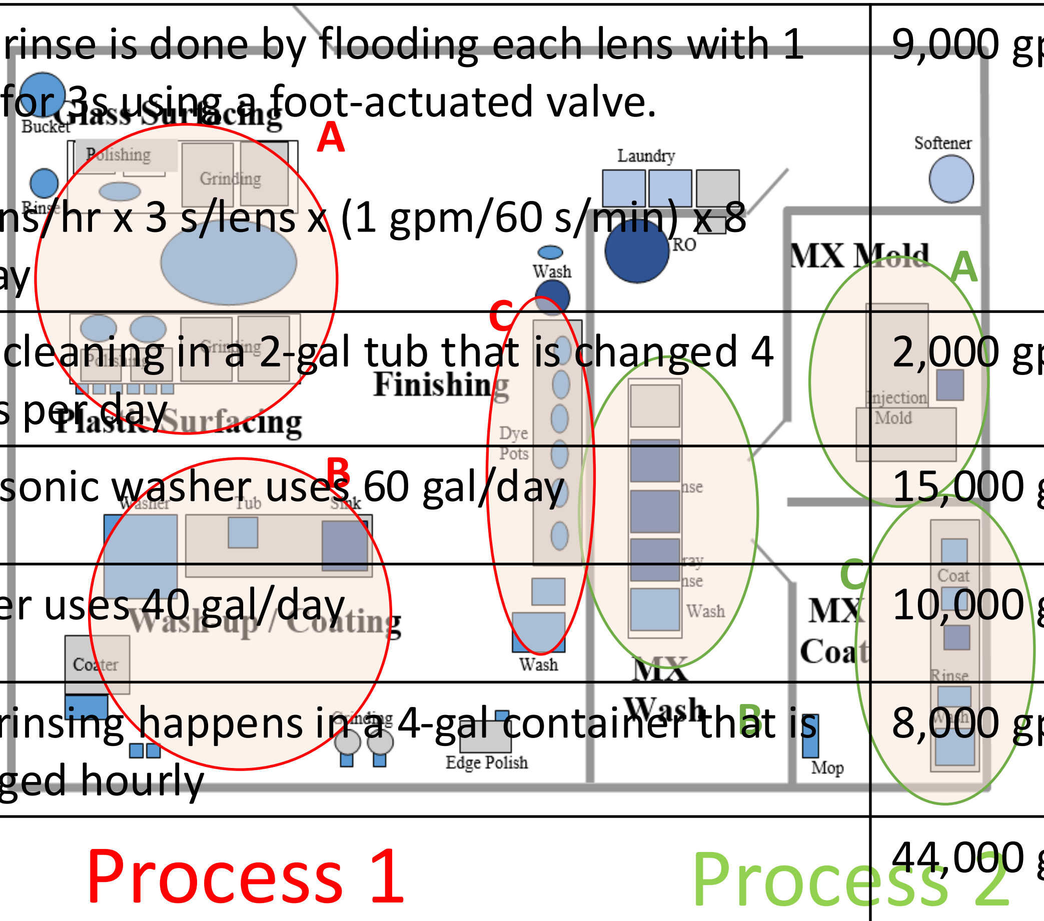
Conversations with Operator

Operators often have the most information related to process

- Ask a lot of questions
- Request SOPs

Here is the information obtained from the Wash Line and Coating Operator – **Process 1, Step B**

Lens rinse is done by flooding each lens with 1 gpm for 3s using a foot-actuated valve. 90 lens/hr x 3 s/lens x (1 gpm/60 s/min) x 8 hr/day	9,000 gpy
Spot cleaning in a 2-gal tub that is changed 4 times per day	2,000 gpy
Ultrasonic washer uses 60 gal/day	15,000 gpy
Coater uses 40 gal/day	10,000 gpy
Tool rinsing happens in a 4-gal container that is changed hourly	8,000 gpy
Total	44,000 gpy



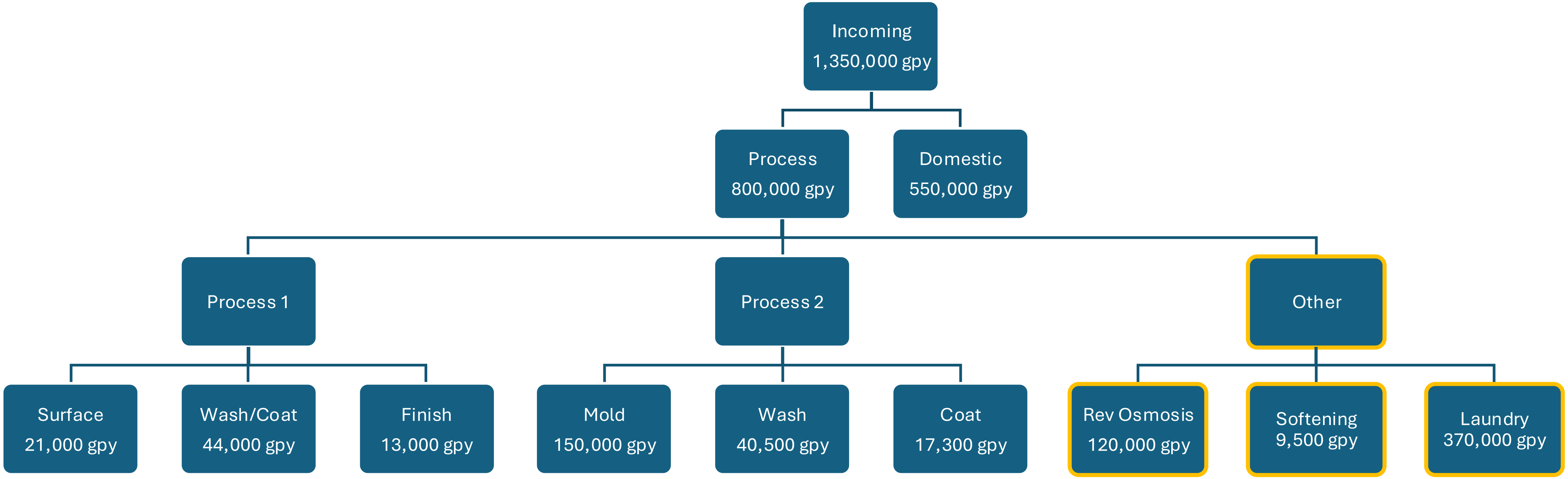
Use information obtained in site visit to complete the water map

- Information from workers on the production line
- Meter readings
- Additional process areas

- Can often be an iterative process
  - Access to operators' knowledge is typically only available during site visit
  - Try to identify your data needs as much as you can upfront
  - Once off-site, create an easy-to-follow list of data needs

Many diligent hours later…

Completed Process and Water Map



We've learned the following about the operations:

Process Area	Operation	Water Use (gpy)
Process 1	Plastic Surf. – Solutions/tanks Glass Surf. – Hose flow Wash/Coat – Rinse flow/ tanks Shaping/Finishing – Solutions/tanks	14,000 7,000 **44,000** 13,000
		78,000
Process 2	Mold - tempering Wash – Spray flow Coat – Rinse and Tanks	**150,000** **40,500** 17,300
		207,800
Other	Laundry Reverse Osmosis - Reject Water Softening - Regeneration	**370,000** **120,000** 9,500
		499,500
Domestic	Fixtures/Irrigation	**550,000**

Discussion: How do you identify targets for water efficiency recommendations?

Process Area	Maintain	Manage	Modify	Water Savings (gpy)
Laundry		HE washer		160,000
Laundry		HE washer	3 to 2 cycles	230,000
Laundry			Outsource	370,000
Reverse Osmosis	70% Permeate			100,000
MX Wash Sprayer		0.3 to 0.15 gpm		80,000
MX Wash System	70% Permeate	0.15 gpm sprayer		130,000
Mold Tempering		Control temp (30%)		45,000
Mold Tempering			Reuse RO reject	120,000
Domestic Use		WaterSense Fixtures		100,000

Total Recommendation Water Efficiency Opportunity – 645,000 gpy

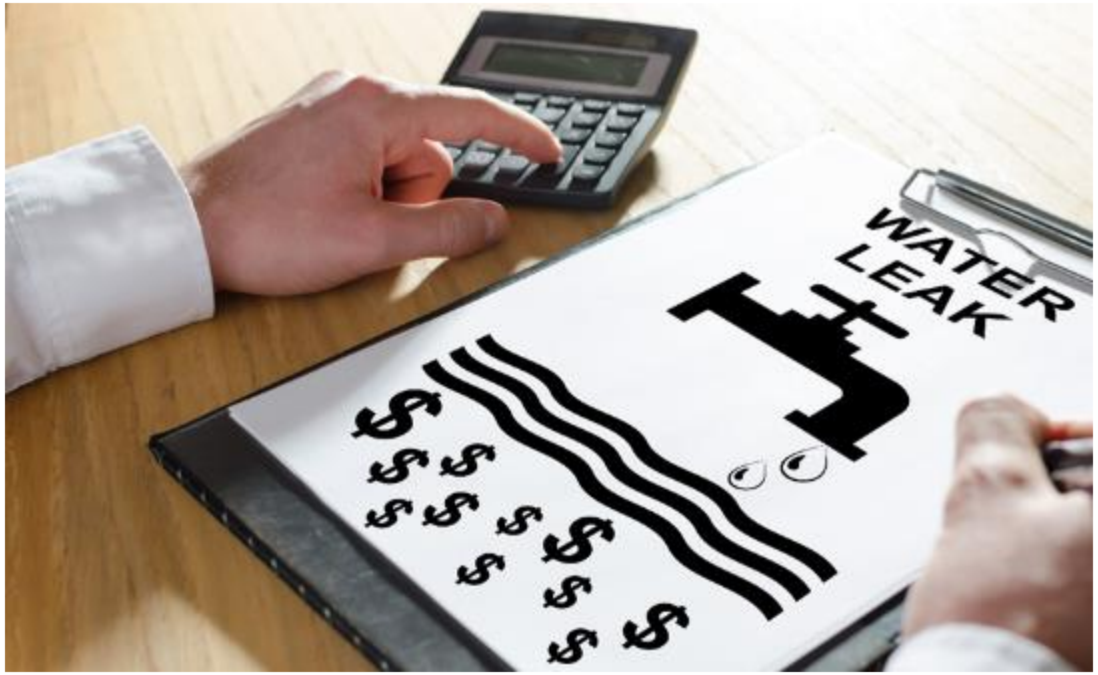
Discussion: How do we build a business case for conserving water?

Water is generally considered “cheap” in the United States. So how to make a business case for conserving?

The answer lies in the water itself and typically is found during the water mapping exercise and utility bill analysis.

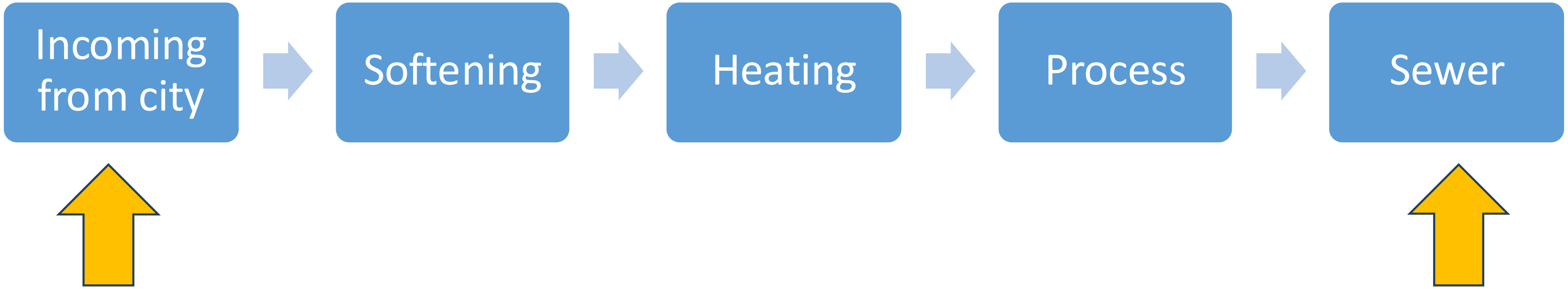
Water: limited resource with real costs

- **Water costs industry *THREE* times**
- **Incoming supply cost**
- **Processing cost**
  - Purification
  - Heating/Cooling
  - Pumping
  - Treatment
- **Discharge**



True cost of water

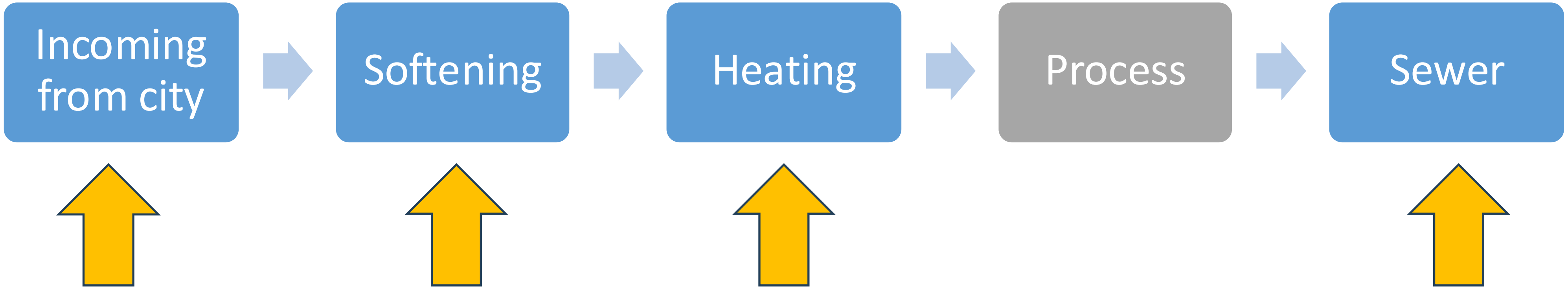
Straight “city water” is almost never used in industrial processes. Very often, it follows the following path:



Typically, when calculating the cost of water, we only look at these.

True cost of water (continued)

However, each of these steps has a cost associated with it. To capture the true cost of water, you need to look at *each of them.

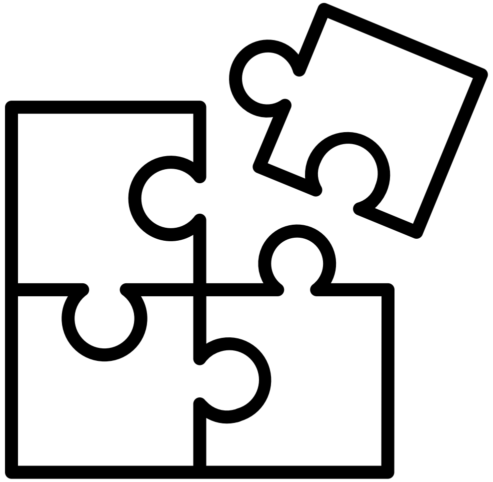


*To be conservative, and consistent, we usually ignore the process in this concept and calculation.

How to calculate savings for 160,000 gal/yr?

Break it down into pieces:

- **Incoming water from the city**
  - Where to find the cost of incoming water?
- **Softening water**
  - What information would help you calculate this?
- **Heating water**
  - What do you need to know about the process?
- **Sewering water**
  - Where to find the cost of sewering water?
  - Are there any other considerations to add to your costs?
- **Other fixed ongoing costs**
  - Are you pre-treating your water some way?



Incoming water:

Customer	Service Address	Meter #
Fake name	Not a real address	1234546

Bill Number	Bill Date	Due Date	Account Number	Parcel ID	# of Units
123456	03/15/2013	04/16/2013	12345678	000-00	0

Description	Current Read Date	Previous Read Date	Current Meter Reading	Previous Meter Reading	Read Code*	Usage	Charge
SEWER							623.47
WATER	02/28/2013	11/30/2012	1012500	675000	A	10227	389.03

Previous Balance	Payments, Credits & Adjusts	Interest	Current Charges	Total Due
		.00	1012.50	$1012.50

Block	Water	Sewer
10	3.0200	7.8600
100	3.2400	8.3200
500	3.4400	8.9300
2500	3.6500	9.6200
99999	3.9600	10.2300

* READ CODE:
A ACTUAL READ
E ESTIMATED READ
F FINAL READ
M MANUAL READ

If payment is not made by the due date, an interest charge of 14% per annum will be assessed on the unpaid balance from the bill date until the payment is received.

For questions regarding payments contact the Finance Department at 555-555-5555

For questions regarding meter readings, change of address, final bills, and service calls contact the Water Department at 555-555-5555

Pay on-line at www.notarealcity.gov

CHARGES IN CCF, 100 CUBIC FOOT, APPROXIMATELY 750 GALLONS

Total water savings: 160,000 gal/year

Cost: $389.03/qtr

Usage: 10227 units/qtr

1 unit =750 gals

10227*750 = 337,500 gals/qtr

$389.03/337,500 gal = $0.0012/gal

Incoming water cost:

160,000 gal/yr*$0.0012/gal = $184.43/yr

Sewering water:

Customer			Service Address		Meter #
Fake name			Not a real address		1234546
Bill Number	Bill Date	Due Date	Account Number	Parcel ID	# of Units
123456	03/15/2013	04/16/2013	12345678	000-00	0

Description	Current Read Date	Previous Read Date	Current Meter Reading	Previous Meter Reading	Read Code*	Usage	Charge
SEWER							623.47
WATER	02/28/2013	11/30/2012	1012500	675000	A	10227	389.03

Previous Balance	Payments, Credits & Adjusts	Interest	Current Charges	Total Due
		.00	1012.50	$1012.50

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10	3.0200	7.8600
100	3.2400	8.3200
500	3.4400	8.9300
2500	3.6500	9.6200
99999	3.9600	10.2300

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CHARGES IN CCF, 100 CUBIC FOOT, APPROXIMATELY 750 GALLONS

Total water savings: 160,000 gal/year

Cost: $623.47/qtr

Usage: 10227 units/qtr

1 unit =750 gals

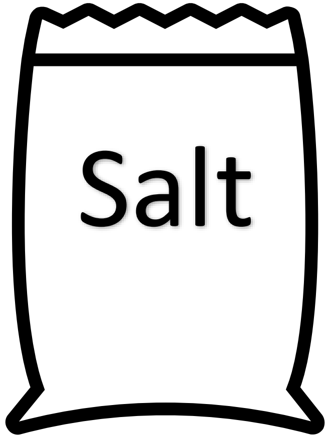
10227*750 = 337,500 gals/qtr

$623.47/337,500 gal = $0.0018/gal

Sewering water cost:

160,000*$0.0018 = $295.57/yr

Softening water:



Total water savings: 160,000 gal/year

How much salt is being purchased each year?

- **Records show 5,250 lbs/year @ $5.50 per 40lb bag**
- **$0.0005/gal**

Assuming all water is softened:

- **160,000 gal x $0.0005/gal**
- **$85.56/year**

- **Discussion point: are there additional costs associated with the softening process. What ways might you reduce this?**

Additional treatment options…

http://www.ameriwater.com/wp-content/uploads/2013/09/HRO-horizontal.jpg

Additional treatment considerations:

- Granulated Activated Carbon (GAC)
- Reverse Osmosis
- Deionized water

Discussion: Are you using any of these? Are there maintenance costs? Other benefits of removing these contaminants?

Heating water:

Total water savings: 160,000 gal/year

How is the water being heated?

- Maintenance lead indicates natural gas boiler

What does it cost to heat?

- Boiler efficiency 95%
- Natural gas $0.97/therm
- Incoming water temp 50°F
- Outgoing water temp 140°F

- Discussion: does this spur any thoughts on how to reduce the energy associated with heating water?

Cost of Heating Water					
Gas Price	$ 0.97	$/therm			
Boiler efficiency	95%	<<<found on boiler name plate			
Specific heat of water @50F					
1.001	Btu/lbF				
Density of water @ 50F					
50	F	<<<assumed incoming temp			
62.4	lb/ft^3	<<<density retrieved from calculator	https://www.engineeringtoolbox.com/water-density-specific-weight-d_595.html		
1000	gal				
134	ft^3				
8,343	lbs	<<<mass of water @ 50F			
99976.1	BTU/therm				
Energy used to heat water @ 50F					
Heating Temps	ΔT	Btus needed	Btus used	Therms used	Cost/kGal
90	40	334,053.9	351,635.6	3.5	$ 0.003
120	70	584,594.3	615,362.4	6.2	$ 0.006
140	90	751,621.2	791,180.2	7.9	$ 0.008

Heating water (continued):

Total water savings: 160,000 gal/year

How hot is the water?

- They are using 130°F
- We are heating to 140°F in boiler
- We need to mix in cold water!

What does it cost to heat for laundry?

- (130°F /140°F)*160,000 gal/year
- 148,571 gal hot water
- 148,571 gal*$0.008/gal
- $1,146/yr

Cost of Heating Water					
Gas Price	$ 0.97	$/therm			
Boiler efficiency	95%	<<<found on boiler name plate			
Specific heat of water @50F					
1.001	Btu/lbF				
Density of water @ 50F					
50	F	<<<assumed incoming temp			
62.4	lb/ft^3	<<<density retrieved from calculator	https://www.engineeringtoolbox.com/water-density-specific-weight-d_595.html		
1000	gal				
134	ft^3				
8,343	lbs	<<<mass of water @ 50F			
99976.1	BTU/therm				
Energy used to heat water @ 50F					
Heating Temps	ΔT	Btus needed	Btus used	Therms used	Cost/Gal
90	40	334,053.9	351,635.6	3.5	$ 0.003
120	70	584,594.3	615,362.4	6.2	$ 0.006
140	90	751,621.2	791,180.2	7.9	$ 0.008

True cost of water calculated

Total water savings: 160,000 gal/year

- **Incoming water**
  - $184/yr
- **Sewering water**
  - $295/yr
- **Softening water**
  - $85/year
- **Heating water**
  - $1,146/yr

Total cost of water = $1,710/yr

Discussion: How do you build a business case?

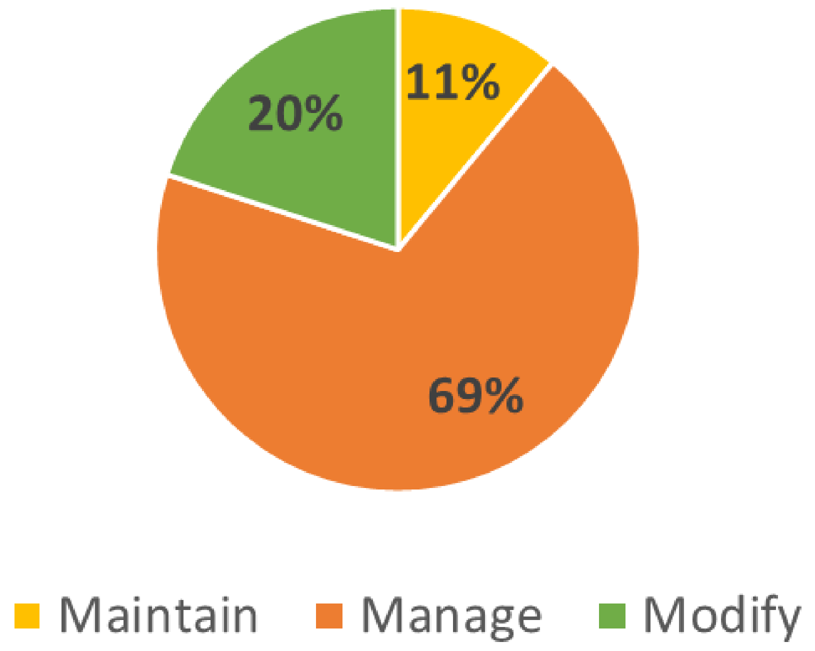
Operation	Resource	Amount	Cost
Outsource Laundry	Water	370,000 gal	$1,110
	Detergent/chemicals	500 lb	$500
	Energy - water/washer/drier	13,250 kWh	$1,060
	Labor	1,750 hr	$43,750
MX Wash and RO	Water	130,000 gal	$390
	RO energy	2,000 kWh	$160
Mold Tempering	Water	45,000 gal	$130
Domestic Fixtures	Water	100,000 gal	$300
Service Availability (SAC)	One time charge for extra water		$14,000
Total			**$61,400**

Supporting Implementation

Motivations study 2018

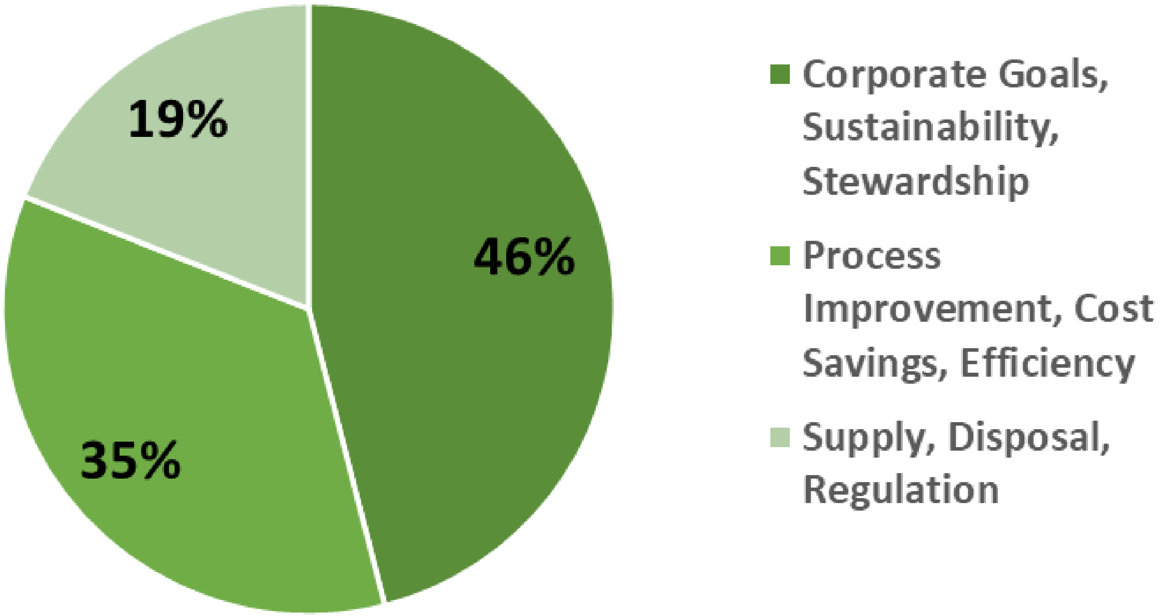
- Looked at MnTAP water conservation recommendations from 2012 – 2018
- Asked the questions:
  - Where is the motivation?
  - What are the barriers?

Recommendation Types from 2012 - 2018 in Study

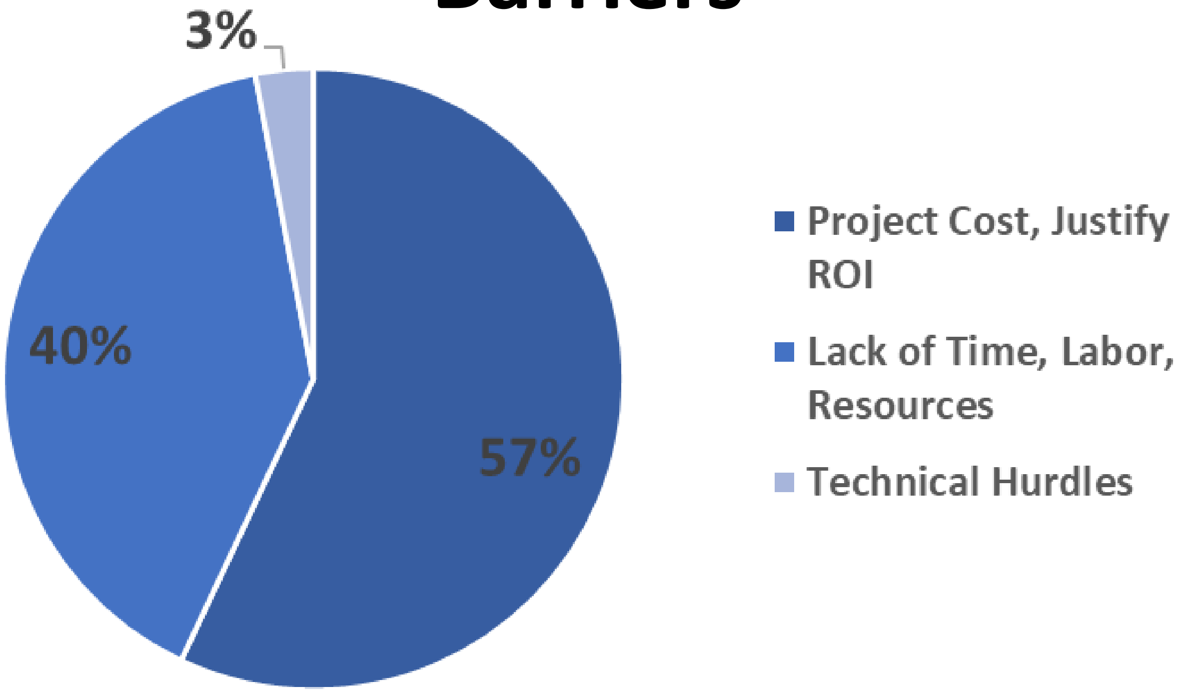


Supporting Implementation

Motivations



Barriers



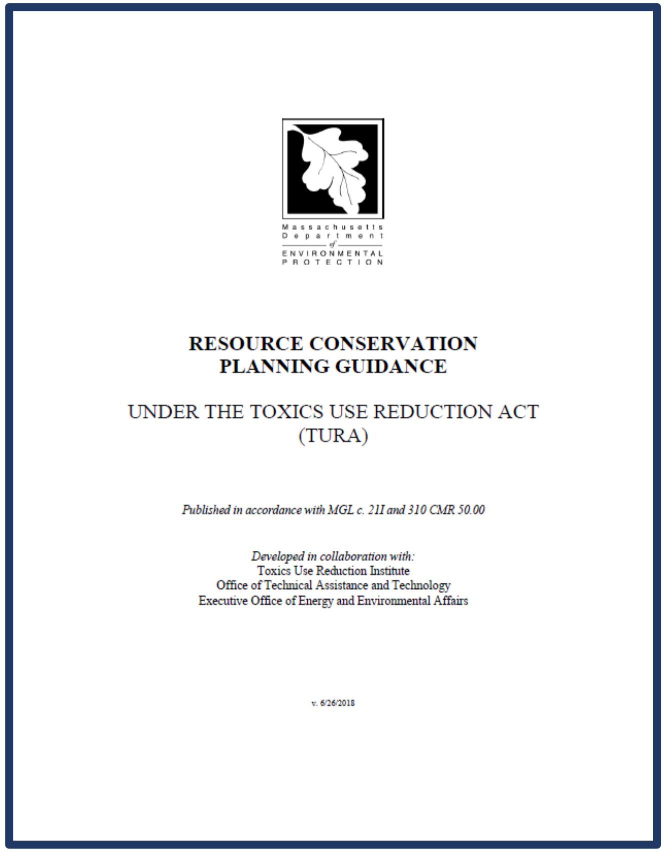
Summary

- **Billions of gallons of ground water used for industry**
  - Critical asset
  - Ample efficiency opportunity
  - Continue attention needed
- **Company benefits from industrial water efficiency**
  - Reduce costs
  - Support expansion
  - Meet corporate sustainability goals
- **Other benefits from industrial water efficiency**
  - Avoid more well pumping and water treatment
  - Decrease volume to wastewater treatment facilities
  - Decrease energy and chemical use
  - Increase action to protect and preserve water sources

Summary – Assessor's Role

- **Show where water is used**
  - Create the site map
  - Identify site opportunities
- **Develop actionable recommendations**
  - Maintenance – short term and ongoing
  - Manage – Do what you do - better
  - Modify – Rethink the process to minimize inputs
- **Build the business case for implementation**
  - Reduce costs
  - Support expansion
  - Meet corporate sustainability goals

Resources for your project



Massachusetts Department of ENVIRONMENTAL PROTECTION

RESOURCE CONSERVATION PLANNING GUIDANCE

UNDER THE TOXICS USE REDUCTION ACT (TURA)

Published in accordance with MGL c. 21I and 310 CMR 50.00

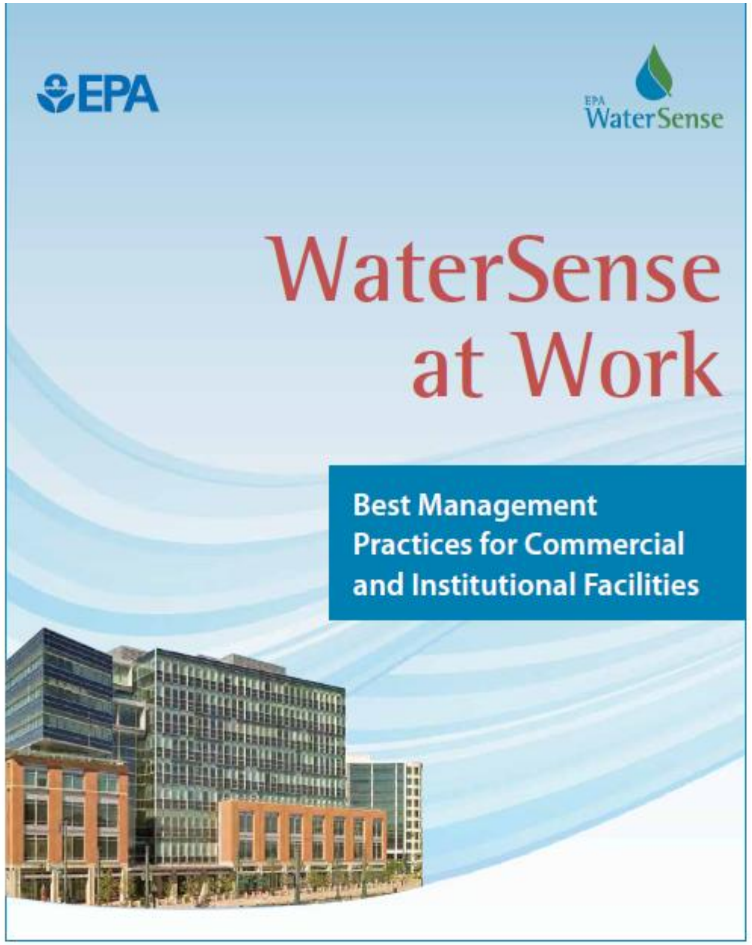
Developed in collaboration with:
Toxics Use Reduction Institute
Office of Technical Assistance and Technology
Executive Office of Energy and Environmental Affairs

v. 6/26/2018

https://www.mass.gov/files/documents/2016/08/rq/rcplguid.pdf

https://www.mass.gov/service-details/water-conservation-techniques-and-resources-for-massachusetts-industries

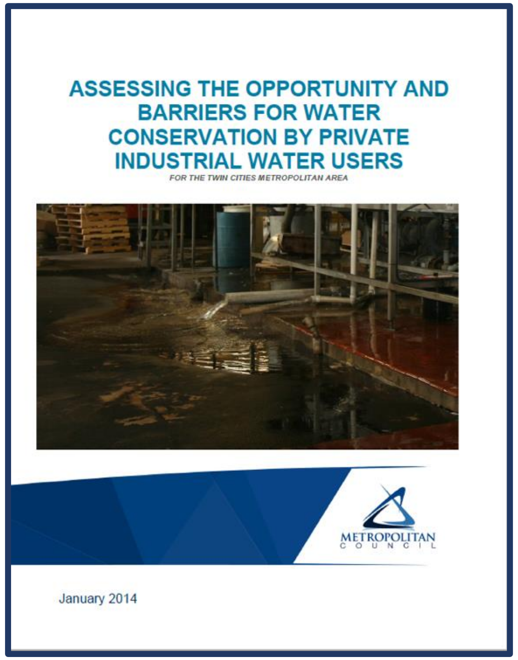
References for your project

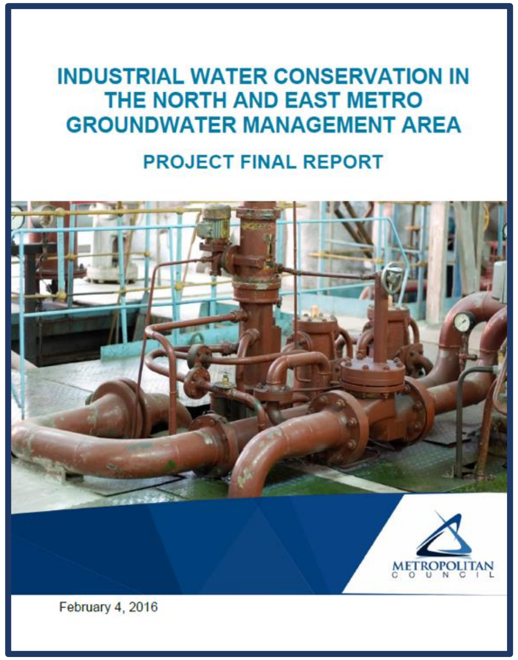


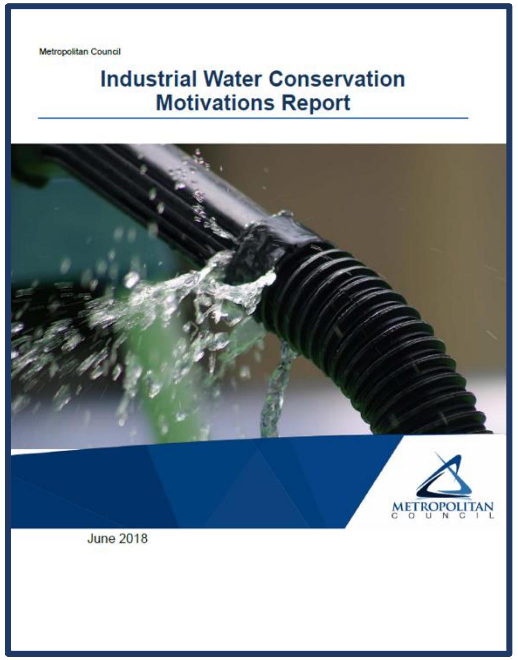
https://www.epa.gov/sites/production/files/2017-02/documents/watersense-at-work_final_508c3.pdf

http://www.allianceforwaterefficiency.org/resource-library/default.aspx

MnTAP Water Efficiency Studies/Publications







https://metrocouncil.org/Wastewater-Water/Publications-And-Resources/WATER-SUPPLY-PLANNING/Water-Conservation-by-Private-Well-Industries.aspx
https://metrocouncil.org/Wastewater-Water/Publications-And-Resources/WATER-SUPPLY-PLANNING/Industrial-Water-Conservation-North-East-Metro-G.aspx
https://metrocouncil.org/Wastewater-Water/Publications-And-Resources/WATER-SUPPLY-PLANNING/Industrial-Water-Conservation-Motivations-Report.aspx
http://www.mntap.umn.edu/resources/publications/solutions/ - 2013 - present

MnTAP Water Efficiency Tools

- **MnTAP developed 2 new tools related to water efficiency in 2021**
- **Industrial Water Efficiency Optimization Search Tool**
  - Search MnTAP Intern summaries
  - Recommendations by industry and operation
  - Identify related recommendations and case studies
  - http://www.mntap.umn.edu/resources/tools-calculators/water-tool/
- **Industrial Water Softening Chloride Reduction Tool**
  - BMPs to reduce chloride discharge to WWTPs from industrial water softening
  - Softener assessment strategies
  - Efficient softening systems conserve water
  - http://www.mntap.umn.edu/resources/tools-calculators/chloride-reduction-tool/

Thank You!

Kelsey Klucas

Director

Minnesota Technical Assistance Program

University of Minnesota

612-624-4619

kluc0035@umn.edu

http://www.mntap.umn.edu