

# **BUILDINGENERGY NYC**

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## **The Water-Energy Nexus**

**Andy Padian (Association for Energy Affordability)**

*Curated by Jodi Smits Anderson and Sanjana Nagaraj*

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**Northeast Sustainable Energy Association (NESEA) | October 24, 2024**

# THE WATER-ENERGY NEXUS

IT TAKES WATER TO MAKE ENERGY

IT TAKES ENERGY TO MAKE WATER

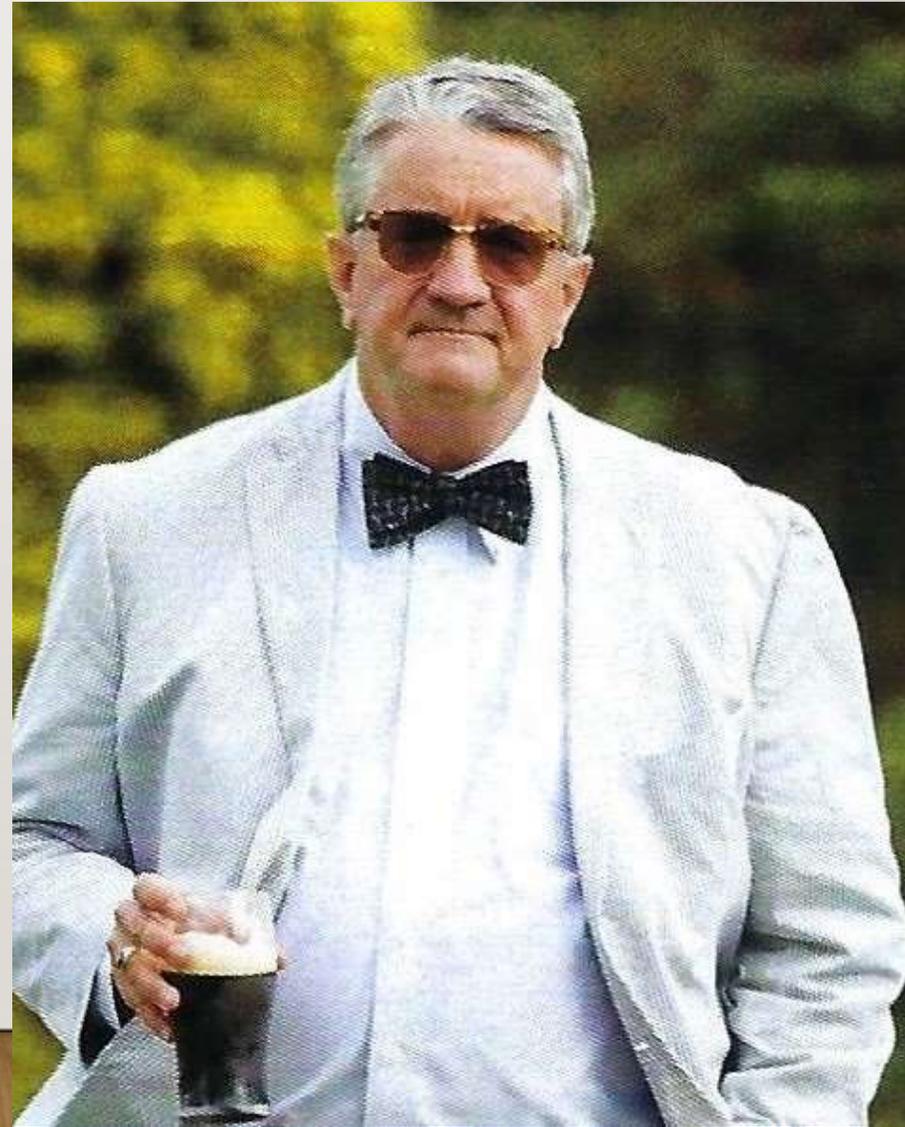
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Andy Padian  
Sr. Dir. Of Building Science  
Association of Energy Affordability

# LEARNING OBJECTIVES

- **At the completion of this session, attendees will :**
- **Use the cost of water in projects to better inform budgets, policies, projects, planning**
- **Explain the role of electricity in water use and the role of water use in electricity generation**
- **Explain the general percentage of water waste in buildings, and describe ways to reduce that waste**
- **Cite the range of water use in the manufacture of typical products**
- **Work BEYOND COMPLIANCE!**

- 40+ Years in the field
- Over 2000 ASHREA II audits
- Presentations + articles nationwide
- Helped create and train many BPI certs
- Huge proponent of Energy+H<sup>2</sup>O Efficiency
- Lifetime NESEA Member
- Co-Creator of BE-NYC
- First BENYC Planning Mtg. 10.26.12



Mary Biddle  
Steve Bluestone  
Peter Bourbeau  
Erica Brabon  
Elizabeth Derry  
Coleen Flynn  
Skye Gruen  
Donna Hope  
Ariel Krasnow  
Andrea Mancino

Heather Nolen  
Sadie McKeown  
Andy Padian  
Lindsay Robbins  
Samantha Schoenberger  
Katie Schwab  
Nicole Sherwood  
Erica Suarino  
Mary Tchamkina  
Johanna Walczyk

- Planning meeting was 3 days before Sandy
- Conference went on 35 days later
- And made a profit



# SURVEY/CALISTHENICS

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- WAP Managers/Staff?
- Contractors?
- Field Personnel??
- Gubment?
- Utility?
- Bankers/Finance
- Product Rep/Supplier?
- Engineer/Architect?
- Student? University?
- Army/Navy/Air Force/Marines?
- Other?

## SO LET'S START WITH THE COST OF ENERGY AND WATER IN NYC!

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- Cost/Gallon for water in NYC?
  - 5 cents?
  - 10 cents?
  - 15 cents?
  - Survey says.....
  - 1.67 cents
- Cost/therm for gas in NYC?
  - 80 cents?
  - \$1.20?
  - \$1.50?
  - \$2.00?
  - \$38.56?

# COST PER KWH OF ELECTRICITY FOR A SINGLE-FAMILY HOME OR APARTMENT IN NYC LAST YEAR?

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- 15 cents?
- 20 cents?
- 25 cents?
- 30 cents?
- Survey says.....

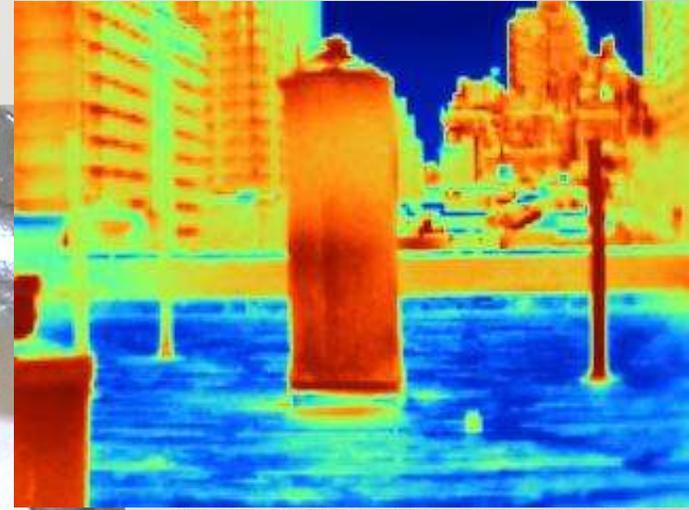
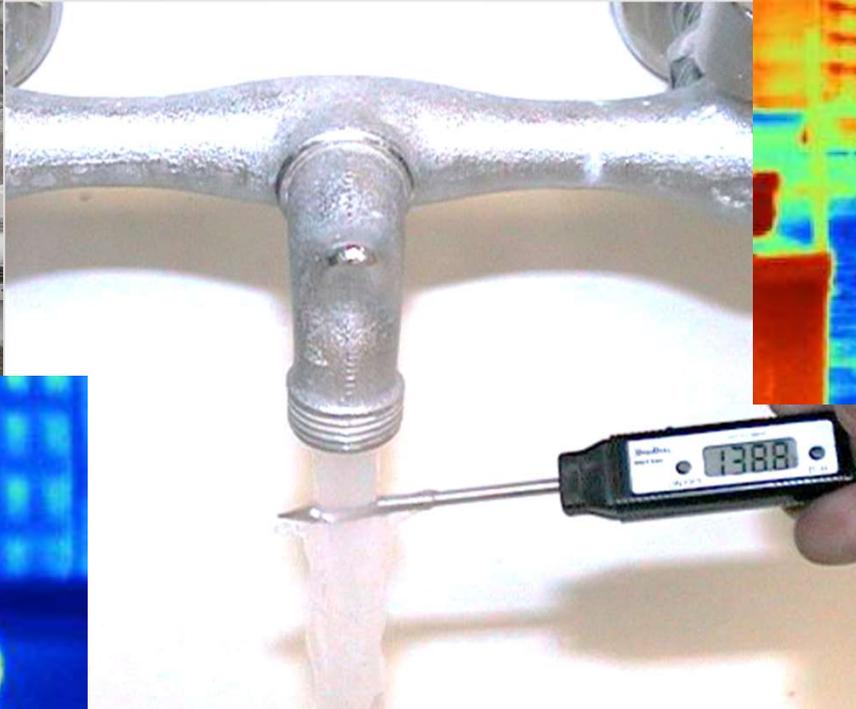
<b>Period Ending</b>	<b>Cost/KWH (\$)</b>
11/16/23	.3506
12/19/23	.3302
1/19/24	.3647
2/20/24	.3480
3/20/24	.3946
4/18/24	.3474
5/18/24	.3505
6/18/24	.3596
7/18/24	.3558
8/16/24	.3258
9/17/24	.3245
10/16/24	.3589
<b>Average 12 Months</b>	<b>.3509</b>

## **ELECTRICITY AT 35 CENTS PER KWH EQUALS:**

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- **Natural gas at \$10.25/therm?**
- **#2 oil at \$13.85/gallon?**
- **Just sayin....our energy is expensive!**

# IN NYC, WE WASTE A LOT OF WATER AND ENERGY!

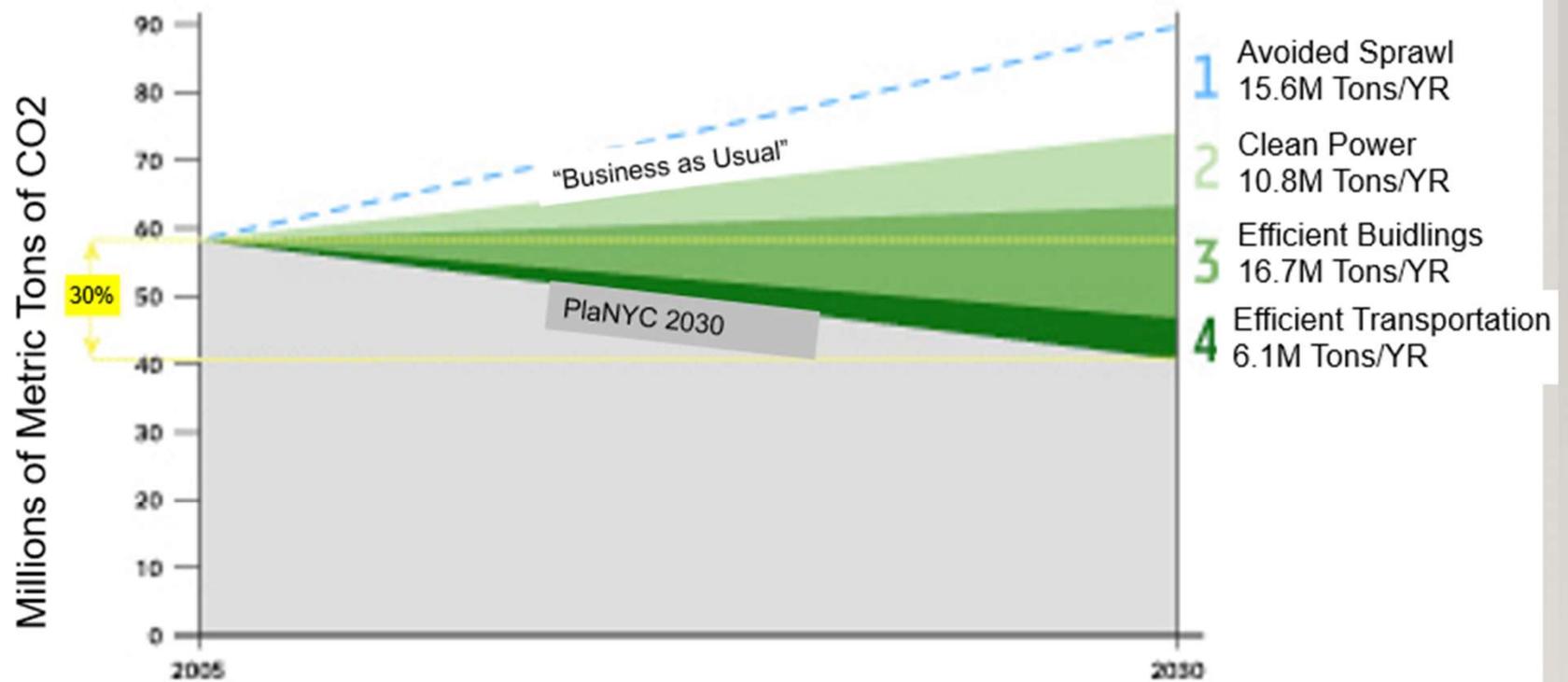


## NYC RESIDENTS ARE ENERGY AND WATER PIGS!

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- The average NYC Apartment uses more than 300 gallons of water per day
  - = \$1850/YEAR
- The average NYC apartment uses 300 kwh per month
  - =\$1511/Year

## Improving the Efficiency of Buildings is the Most Significant Component of NYC's Plans to Reduce Greenhouse Gas Emissions by 30% by 2030



Source: NYC Mayor's Office of [Long Term](#) Planning and Sustainability

# Housing Units Added to NYC from 2002 – 2005 Represented 1.6% of the Overall Housing Stock

52,000 units added 2002 - 2005



Source: 2005 NYC Housing Vacancy Survey

3.2 Million Units Total

NYC Department of City Planning Estimates an Additional  
1.1 Million New Yorkers in 2030, and an Estimated 250,000  
New Units of Housing Will Be Required

Built 2005 – 2030 (7%)



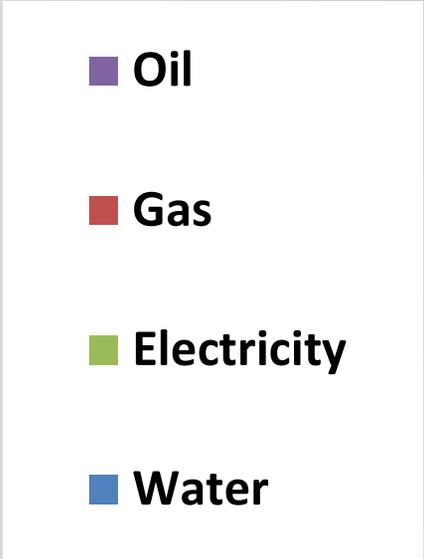
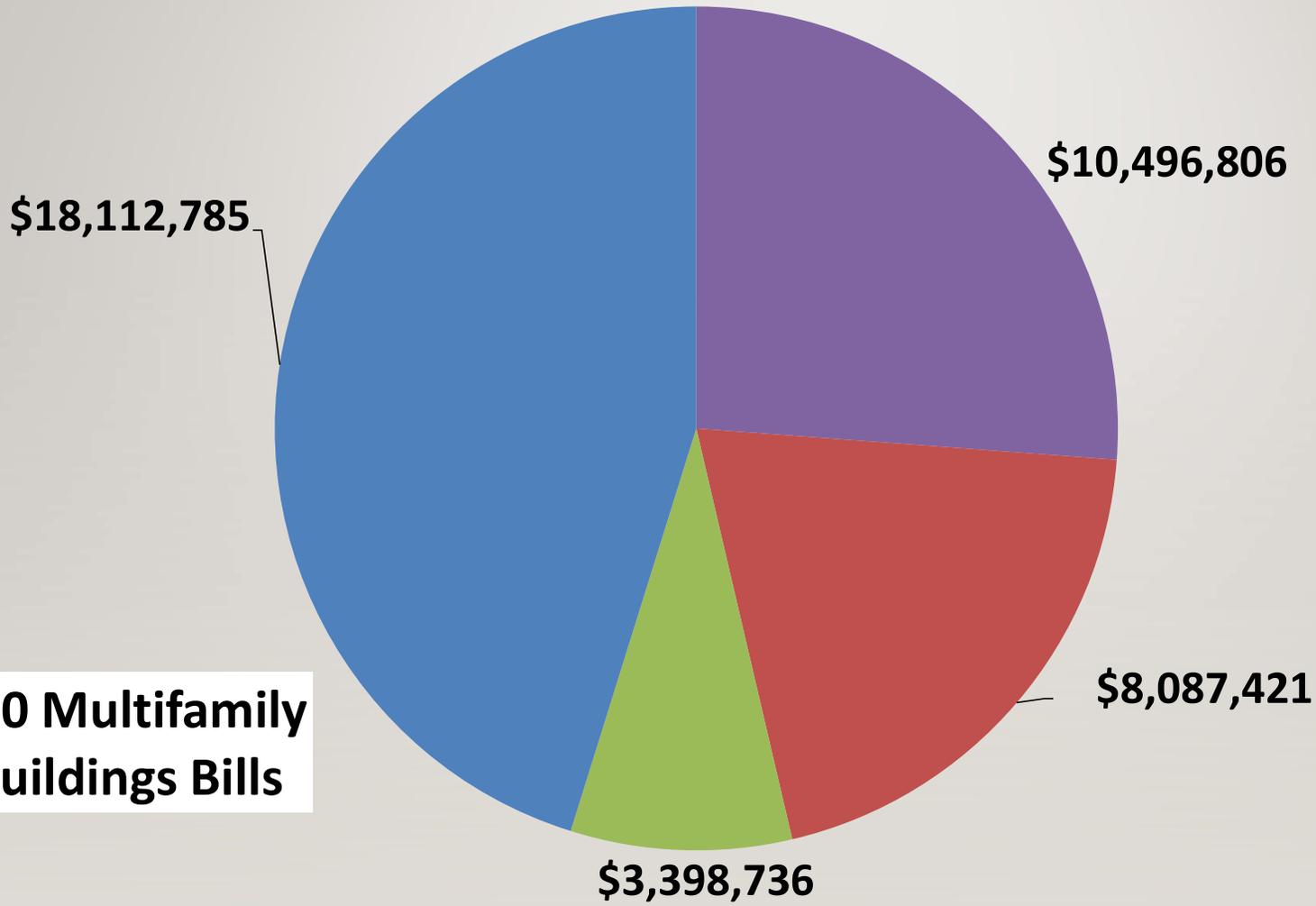
3.45 Million Units Total

**Existing Stock Today Will Comprise Over 90% of Units in 2030!**

**BOSTON PROPERTY  
MAINTENANCE  
COSTS FOR ONE  
COMPANY, MANY  
BUILDINGS, PER  
APARTMENT**

	<b>Low</b>	<b>Mean</b>	<b>High</b>
Water and sewer	\$117	\$516	\$977*
Pest control	\$32	\$75	\$156
Painting	\$13	\$72	\$189
Landscaping	\$0	\$72	\$187
Appliances	\$0	\$22	\$79
Cabinets - Maintenance	\$0	\$34	\$83
Cleaning supplies	\$2	\$33	\$65
Lighting fixtures + bulbs	\$6	\$17	\$38
Ovens and ranges	\$0	\$15	\$26
Windows	\$0	\$5	\$26
Lighting – Fixtures only	\$0	\$9	\$18
Kitchen and bath fans	\$0	\$9	\$2
Lighting - Bulbs only	\$0	\$3	\$6

**750 Multifamily  
Buildings Bills**



TODAY, NYC IS IN A DROUGHT CONDITION WITH OUR RESERVOIRS AT 69.1% AND LITTLE RAINFALL THE LAST 3 MONTHS



## New York City's Water Supply System

October 22, 2024

### Total Storage (% of Capacity)

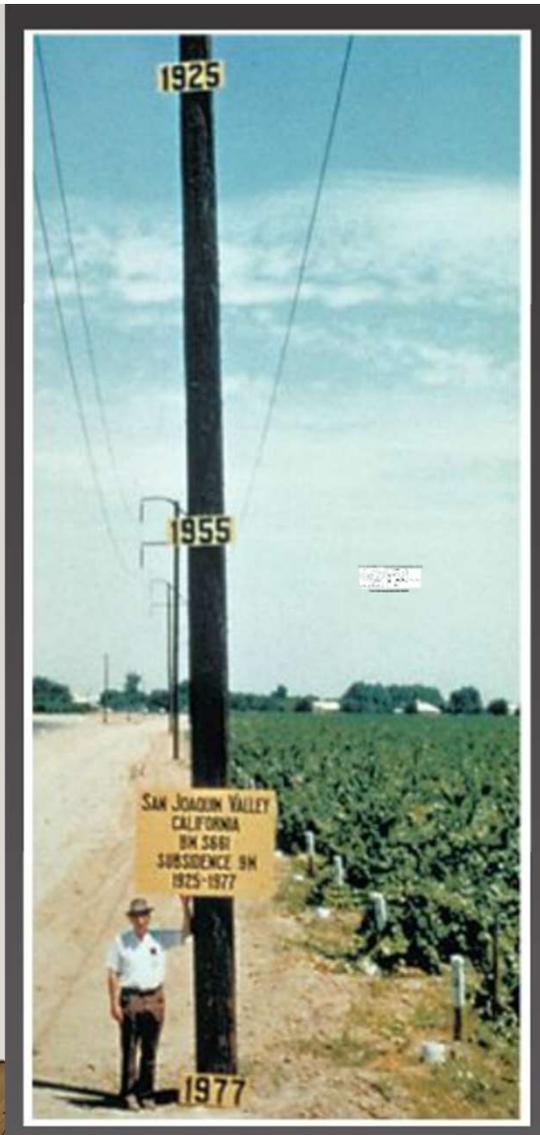
Current:	69.1
Normal:	75.3

### Consumption (billion gallons)

10/21/24	1.02
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### Average Precipitation (inches)

	Actual	Historical
August:	5.78	4.30
September:	1.36	4.72
October:	0.79	2.56



BUT ELSEWHERE IS THE COUNTRY AND THE WORLD, IT IS WORSE BECAUSE OF EXTREME DROUGHT, EXTRACTION OF WATER FROM THE GROUND, AND DIVERGENCE OF WATER FOR ELECTRICITY GENERATION AND FARMING.

← SAN JOAQUIN VALLEY CA

# WATER EFFICIENCY AS PART OF RETROFIT OR NEW CONSTRUCTION

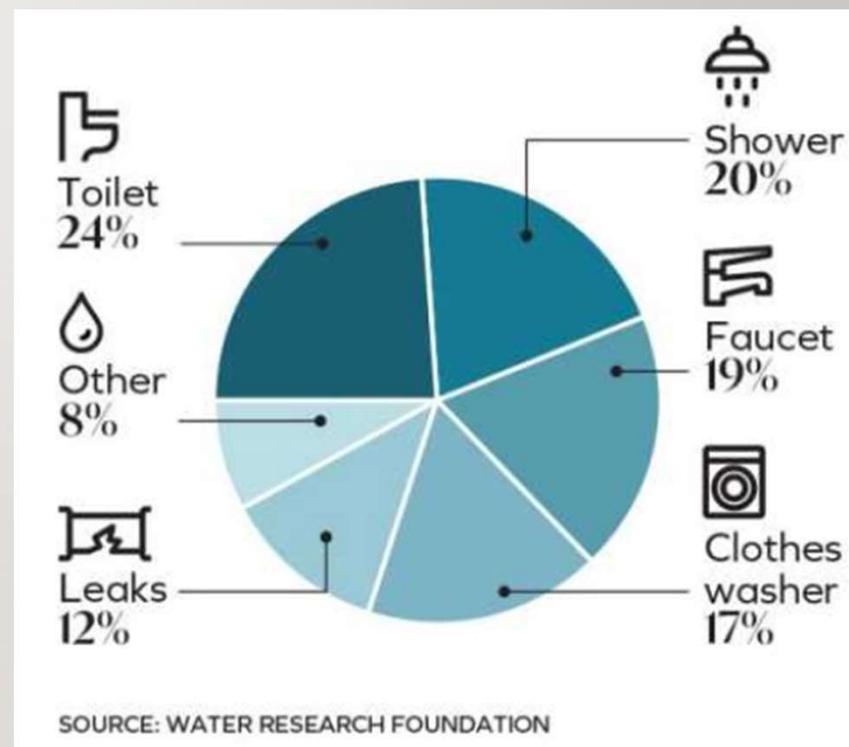
.....it might be the cash flow that actually makes  
your net operating income work

## WATER + SEWER FEES = TOTAL COST

- The charge for water billed on the basis of metered consumption is \$3.81 per one hundred cubic feet. One hundred cubic feet is approximately seven hundred forty-eight gallons.
- The wastewater charge for any property supplied with water from the Water Supply System is one hundred fifty-nine percent (159%) of the charges for water supplied to that property from the system, including any surcharges, unless otherwise provided in this Rate Schedule (\$6.06)
- **\$9.87/ccf or 1.32 cents per gallon**
- **\$13.20 per 1000 gallons**

## WHAT ARE THE MAJOR USES OF POTABLE WATER?

- Toilets
- Showers
- Sinks for washing dishes
- Leaks
- Clothes washing
- Washing sidewalks, cars, equipment
- Pools, gardens, lawns, and other outdoor uses



# WATER EFFICIENCY CONSERVATION EFFORT

Water usage	Non-conserving home	Conserving home
Gallons per person per day	72.5	49.6
Savings	<b>32%</b>	

Source: NYC D.E.P.

# TOILETS!

- **Average household flushes 4.1 times/person/day**
- **Toilets leak at the flapper, go flapperless or powerflush**
- **Reference: Maximum Performance Testing Program (MaP)**
- **Joint study between US and Canada**
- **45% of “off the shelf” toilets tested failed to remove the minimum acceptable solid “material” (250g)**
- **Performance ranged from 100g to 900g**



SOY PASTE  
MEDIUM →



# SOY PASTE EXTRUSION

26



**WEIGH IN:  
350 GRAMS  
EACH**







SO BESIDES ARTIFICIAL POOP, WHAT  
ELSE DID MAXIMUM PERFORMANCE  
(MAP) TOILET TESTING DO?

**CHANGED THE MARKET!**

AND ENCOURAGED EPA TO START THEIR WATER SENSE PROGRAM

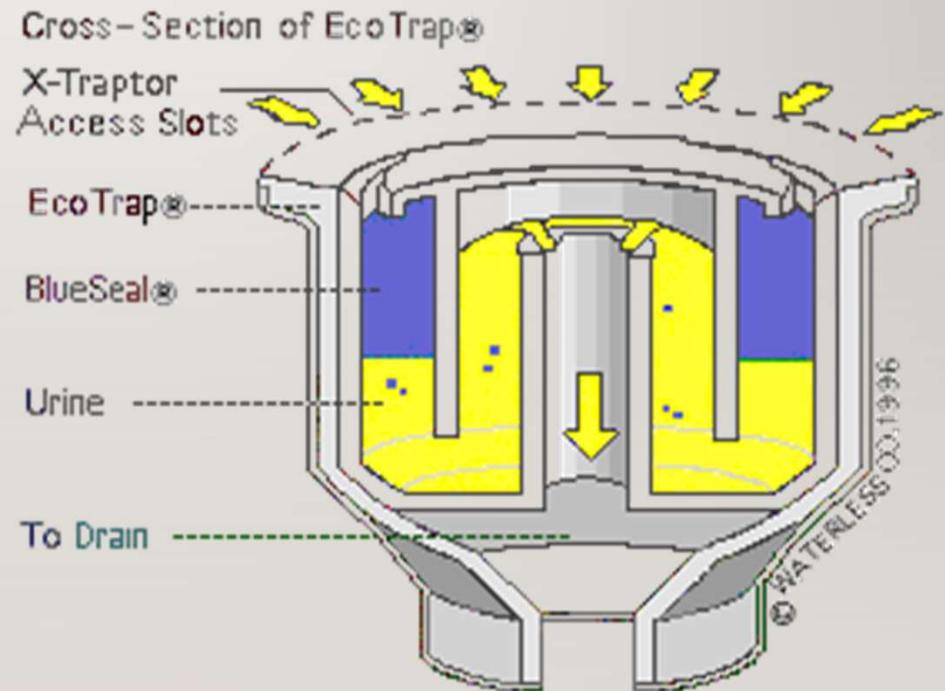


Please  
hold  
flush button  
down for  
10 seconds.



Please  
hold  
flush button  
down for  
10 seconds.

# CONSIDER WATERLESS URINALS





Happy 66<sup>th</sup> Birthday Toilet!



# WATER SAVINGS!

17 apartments  
High Water Bills  
Changed Toilets to 1.1 GPF  
No Flapper Valve  
40% SAVINGS  
1.2 Year Payback





# SHOWERS

- Some measured at over 12 gallons per min (gpm), average range is 2.5-4 gpm
- Many low-flow models (2-2.5 gpm) are awful
- Many inexpensive low flow models are great
- Great results from the Niagara Sava Spa 1.25 gpm →



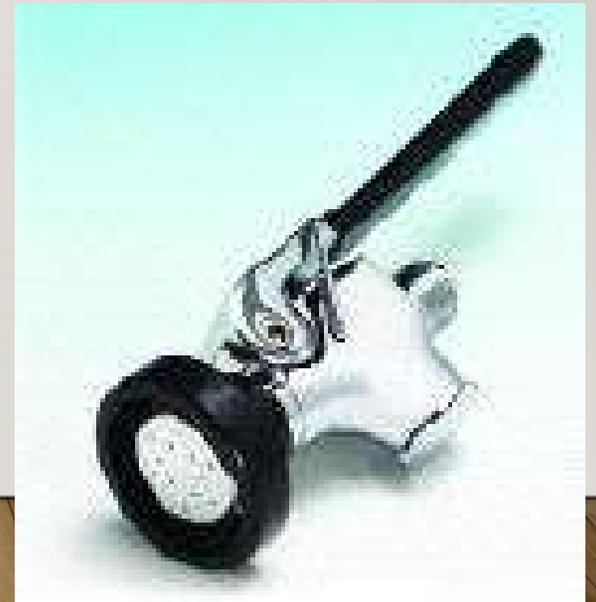
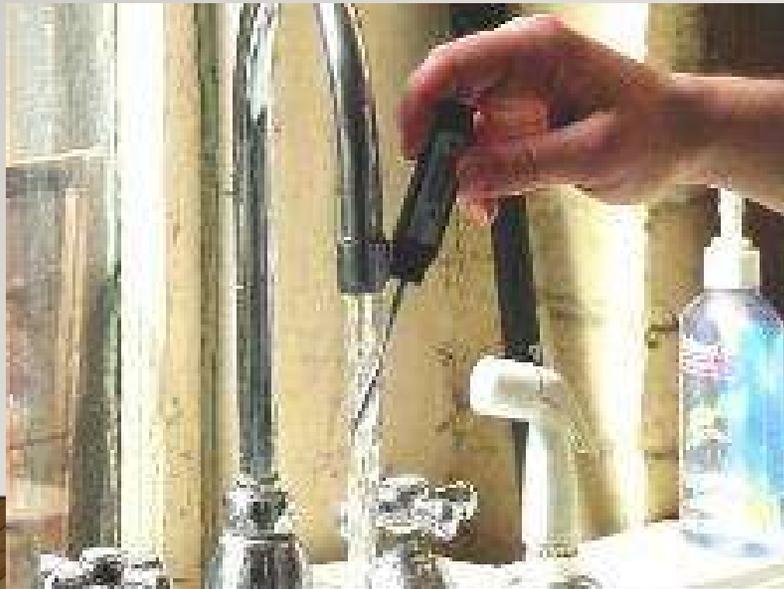
# THE BATHROOM SINK

- Primarily used for hand-washing and tooth-brushing
- Do these activities really require high volumes of water?
- Most lavatory and bathroom applications can easily get by on 0.5 gpm
- 9000 apartment audits: avg bath sink gpm is more than avg shower gpm



# SINKS FOR WASHING DISHES

- Average faucet uses 0.5 – 5.0 gpm
- Sinks should have flows of under 2.0 gpm, many can get by on 1.0 or less
- Water temperatures should be reduced to 120° F at the point of delivery





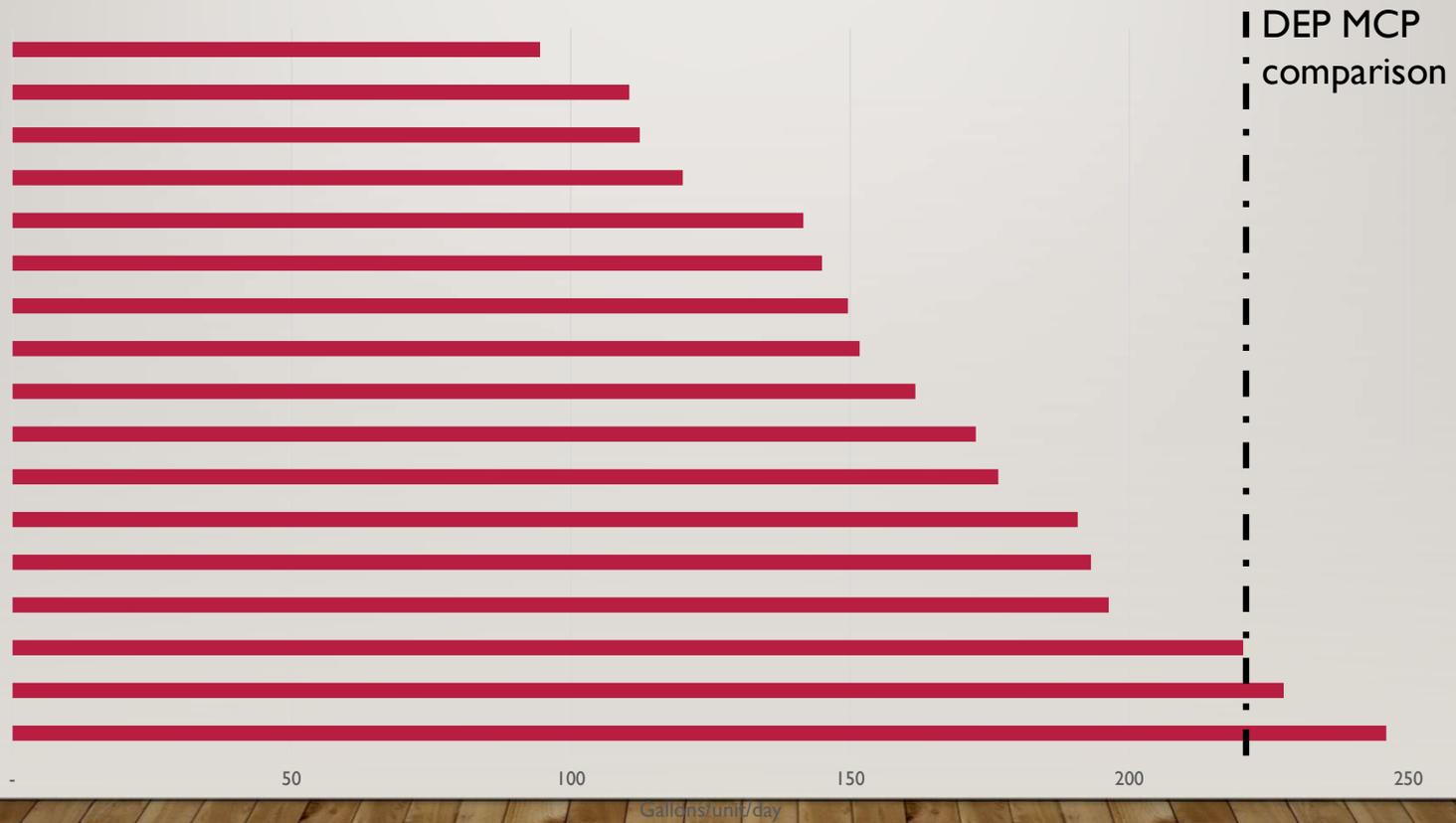
## WATER TEMPERATURE AND SCALDING

<b>Temperature Hot water</b>	<b>Time to produce 2nd &amp; 3rd degree burns</b>
<b>160 Degrees F</b>	<b>About 1/2 second</b>
<b>150 Degrees F</b>	<b>About 1 1/2 seconds</b>
<b>140 Degrees F</b>	<b>less than 5 seconds</b>
<b>130 Degrees F</b>	<b>About 30 seconds</b>
<b>120 Degrees F</b>	<b>More than 5 minutes</b>

## NYC DEP MULTIFAMILY CONSERVATION PROGRAM

- 6+ unit dwellings
- Owner must install low consumption plumbing hardware and fixtures
- The fixed charges for water and wastewater services are assessed for the Fiscal Year and are payable on the first day of such year as follows:  
Dwelling Unit \$1285.11
- This assumes 76,210 gallons per apartment per year
- 208.8 gallons per apartment per day

# WATER USAGE AT PROPERTIES



## North Street Apartments Canandagua, NY

- 131 unit electric heated, individually metered building.
- Apartment airsealing performed, avg CFM 50pa reduction of 24%, apartment electric bills reduced by 25%.
- New gas hot water makers were installed to replace older models, low flow showerheads and aerators were also installed.
- In less than one month, the building recorded 46% reduction in gas usage and 21% reduction in water usage.

P.S. Today, they are “Heat Pump Ready”



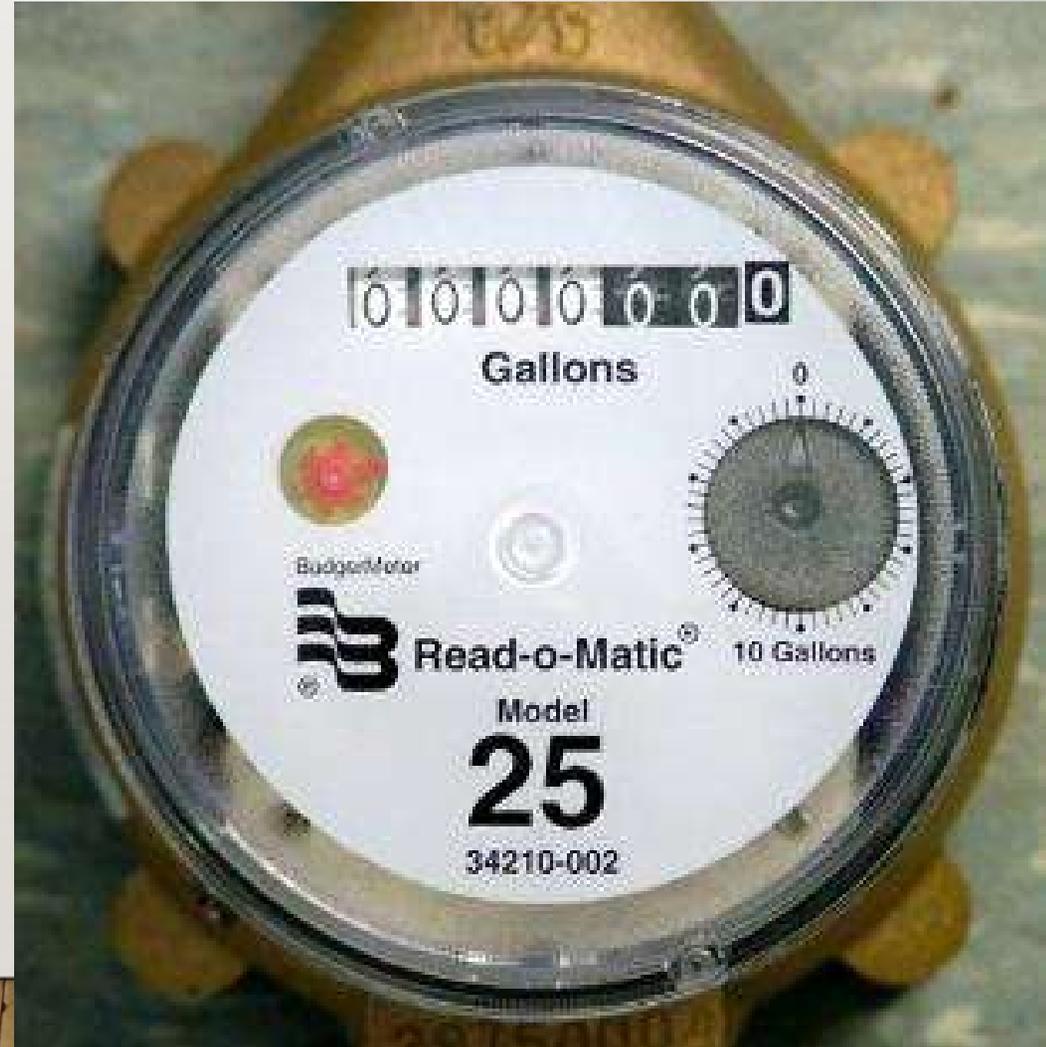
## DISHWASHERS VS. HAND WASHING

- A 2.5 gpm faucet will use 25 gallons of water in 10 minutes
- Dishwashers use 5-15 gallons of water per load
- Energy Star dishwashers use 25% less energy than federal standards



# FINDING LEAKS

- **Severe leaks can best be found by looking at your water meter between 2-4am**
- **Water running at that time is typically from leaks**
- **Much metering online today**

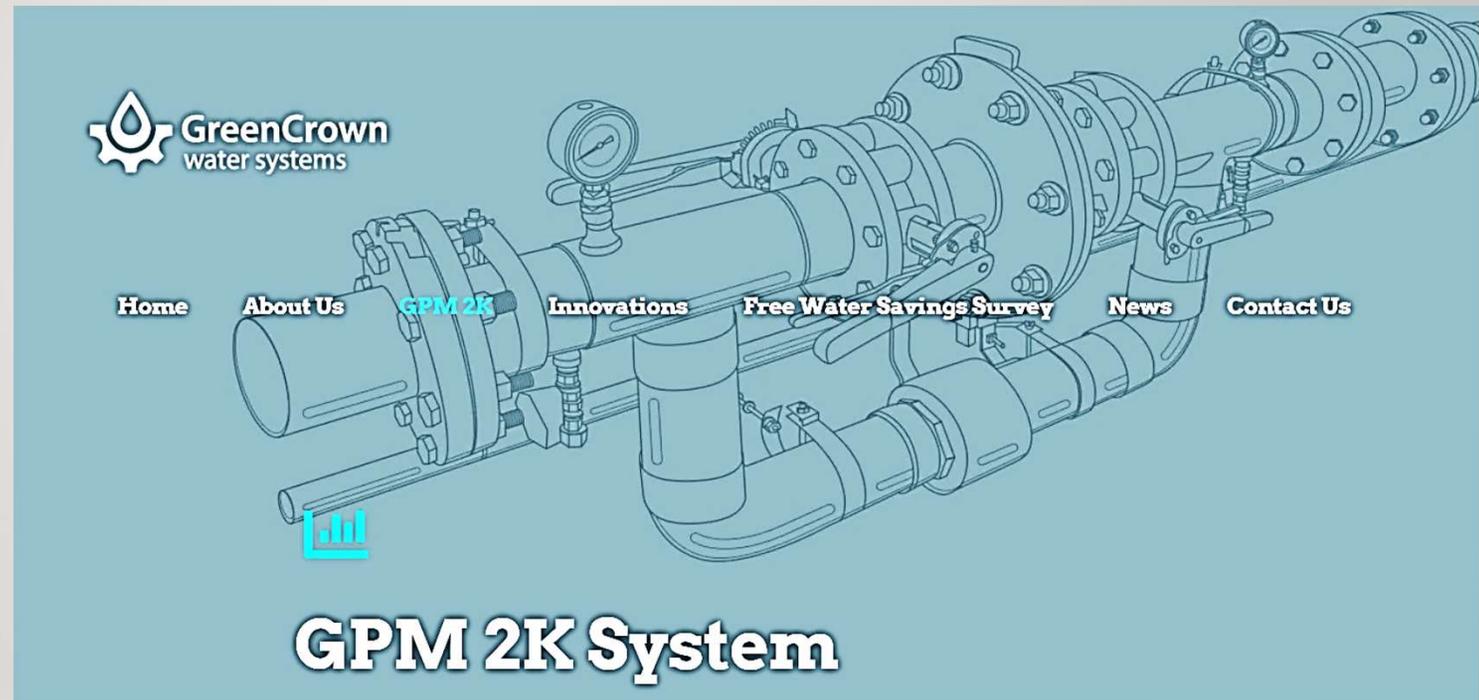


# HOW MUCH IS FIXING A LEAK WORTH?

(ASSUMES NYC 1.3 CENTS PER GALLON COST)

	<b>GPD</b>	<b>Daily Total</b>	<b>Annual Total</b>
<b>Slow drip</b>	<b>36</b>	<b>\$0.48</b>	<b>\$173.45</b>
<b>Steady drip</b>	<b>180</b>	<b>\$2.38</b>	<b>\$867.24</b>
<b><u>Toilets</u></b>			
<b>Seeping</b>	<b>30</b>	<b>\$0.40</b>	<b>\$144.54</b>
<b>Leaking</b>	<b>250</b>	<b>\$3.30</b>	<b>\$1204.50</b>
<b>Running</b>	<b>6000</b>	<b>\$79.20</b>	<b>\$28,908.00</b>

# 21<sup>ST</sup> OR 22<sup>ND</sup> CENTURY ITEMS.....



We have seen this device in one complex, it has been installed in many MF buildings. It controls flow without reducing pressure; independent tests done in the building we saw had 24% savings. It controls non-volumetric not volumetric (ie showers and sinks vs toilets and washing machines) use.

## CASE STUDY: THE SOLAIRE

- Stormwater collection system retains 10,000 gallons of stormwater in a tank in the basement
- Retained water is used for irrigation for roof plantings and adjacent park
- System will capture 170,000 gallons of water per year
- System was sized to accommodate the irrigation requirements of the site



## CASE STUDY: THE SOLAIRE

- Blackwater treatment and recycling system
  - Recaptures 100% of the building's wastewater
  - Recaptured water is used to supply the cooling tower and the toilets
- Building uses 50% less potable water than conventional building
- No potable water is used outdoors
- Daily water use per occupant: 21 gallons

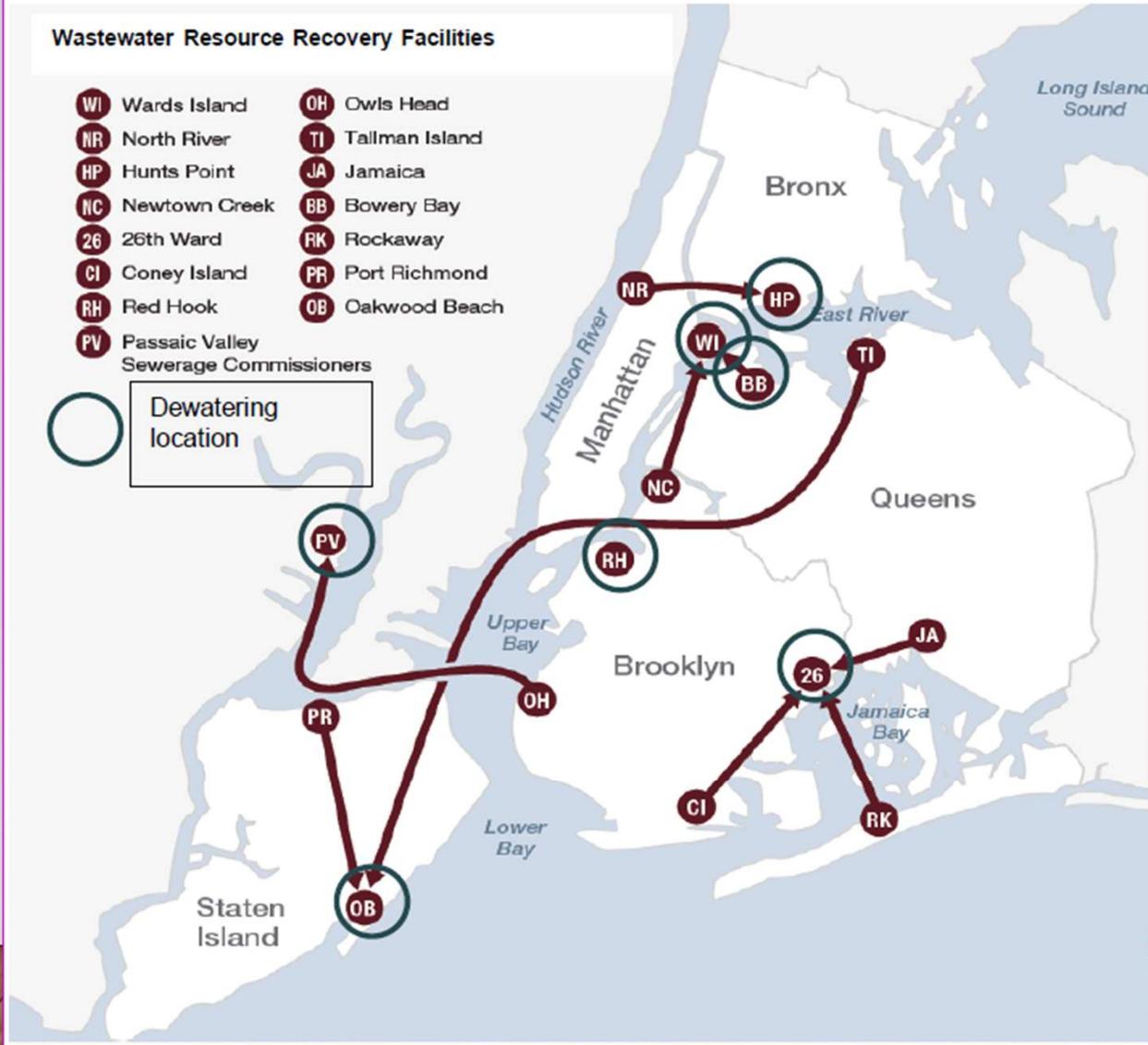


# GETTING ENERGY FROM (WASTE) WATER

### Wastewater Resource Recovery Facilities

- |                   |                   |
|-------------------|-------------------|
| WI Wards Island   | OH Owls Head      |
| NR North River    | TI Tailman Island |
| HP Hunts Point    | JA Jamaica        |
| NC Newtown Creek  | BB Bowery Bay     |
| 26 26th Ward      | RK Rockaway       |
| CI Coney Island   | PR Port Richmond  |
| RH Red Hook       | OB Oakwood Beach  |
| PV Passaic Valley |                   |
- Sewerage Commissioners

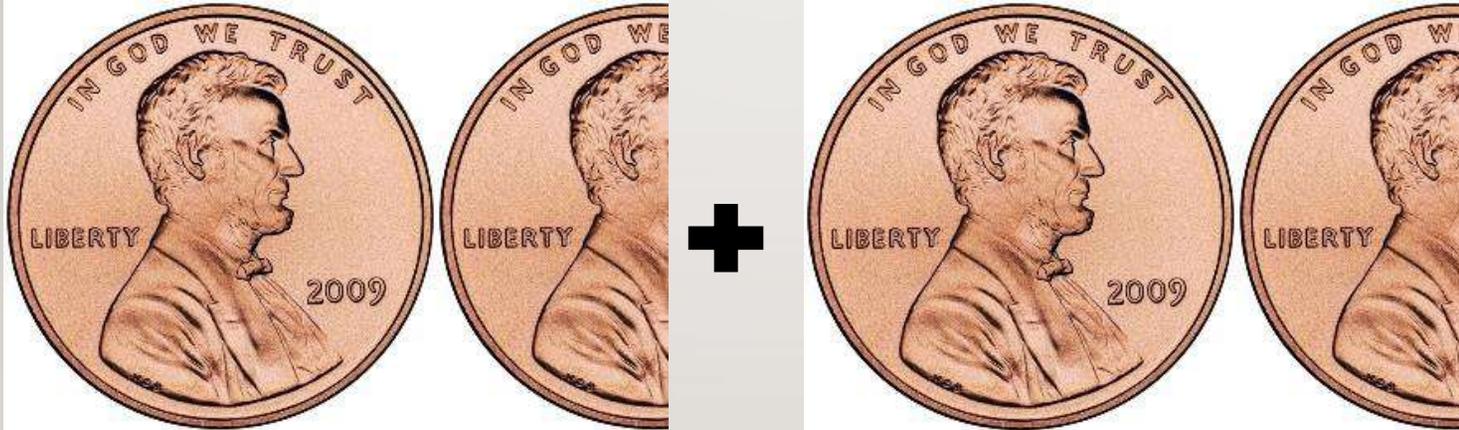
 Dewatering location



# **TURNING WASTE GAS TO CLEAN ENERGY: BROOKLYN'S NEWTOWN CREEK WASTEWATER PLANT CONVERTS HARMFUL METHANE TO RENEWABLE NATURAL GAS FUEL**



# THE FULL COST OF USING HOT WATER



**About a penny  
and a half a  
gallon for the  
water**

**About a penny  
and a half a  
gallon to heat  
the water**

# ELECTRICITY + WATER

- **On average, it takes  $\frac{1}{2}$  kwh of electricity to deliver one gallon of  $H^2O$  to a building**
- **On average, it takes  $\frac{1}{2}$  kwh of electricity to process one gallon of  $H^2O$  in sewage treatment**

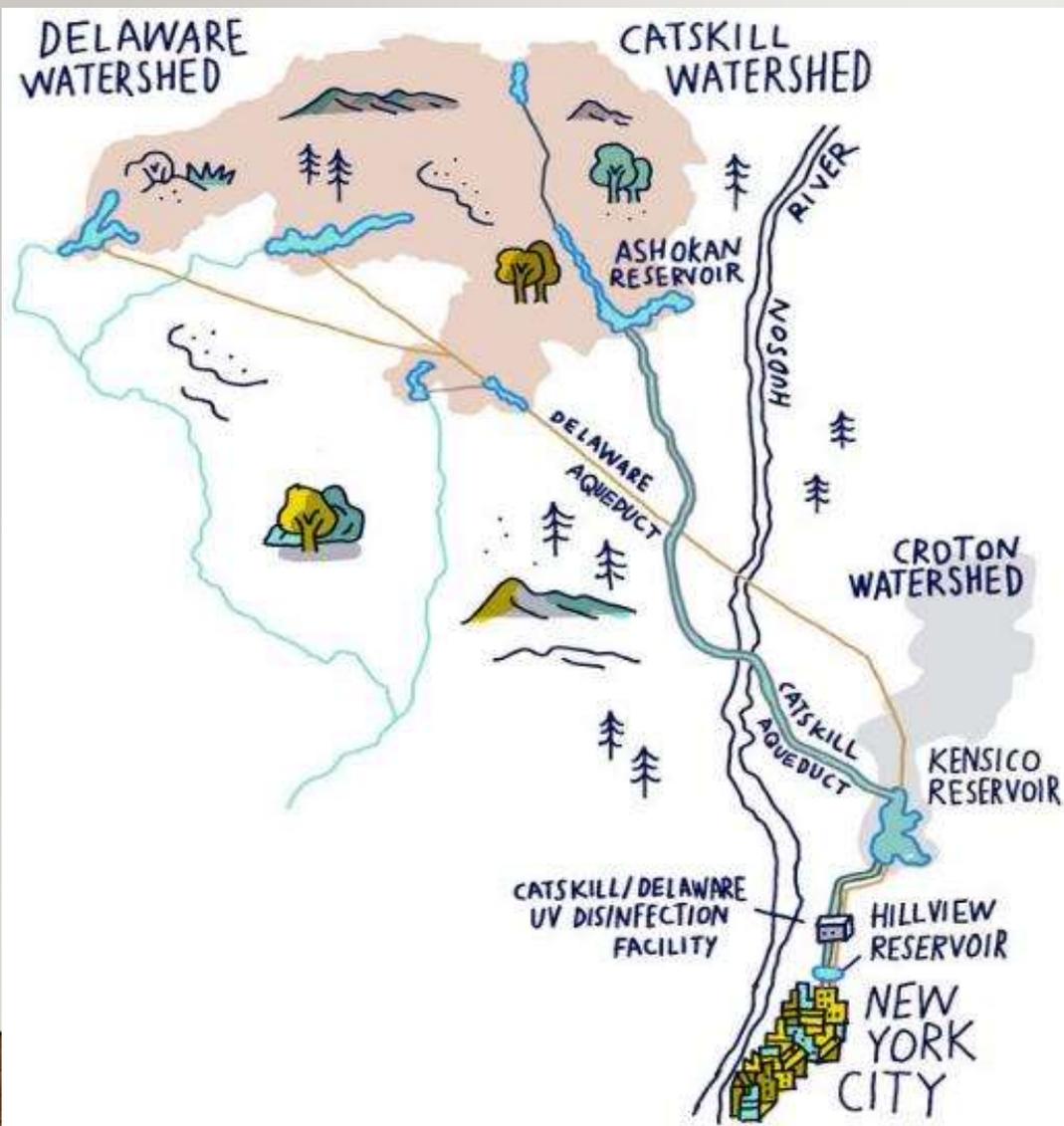
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**EXCEPT IN NYC.....**

# HOW CLEAN IS NYC WATER?

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The New York Times decided to look at how New York City delivers what has been called the champagne of drinking water to 9.5 million people.



THE CATSKILL/DELAWARE WATERSHED, WHICH EXTENDS 125 MILES NORTHWEST OF THE CITY, PROVIDES MORE THAN 90 PERCENT OF THE CITY'S SUPPLY. THE REST COMES FROM THE CROTON WATERSHED. SOURCE: NY TIMES

SAFEGUARDING THE CITY'S WATER BEGINS WITH PROTECTING LAND THAT SURROUNDS THE STREAMS, RIVERS, LAKES AND RESERVOIRS.

THE CATSKILL/DELAWARE WATERSHED ENCOMPASSES MORE THAN A MILLION ACRES. THE CITY, STATE AND LOCAL GOVERNMENTS AND NONPROFIT LAND CONSERVANCIES OWN 40 PERCENT OF THE LAND.

THE REST IS PRIVATELY OWNED, BUT DEVELOPMENT IS REGULATED TO PREVENT POLLUTANTS FROM GETTING INTO THE WATER SUPPLY. SOURCE: NY TIMES

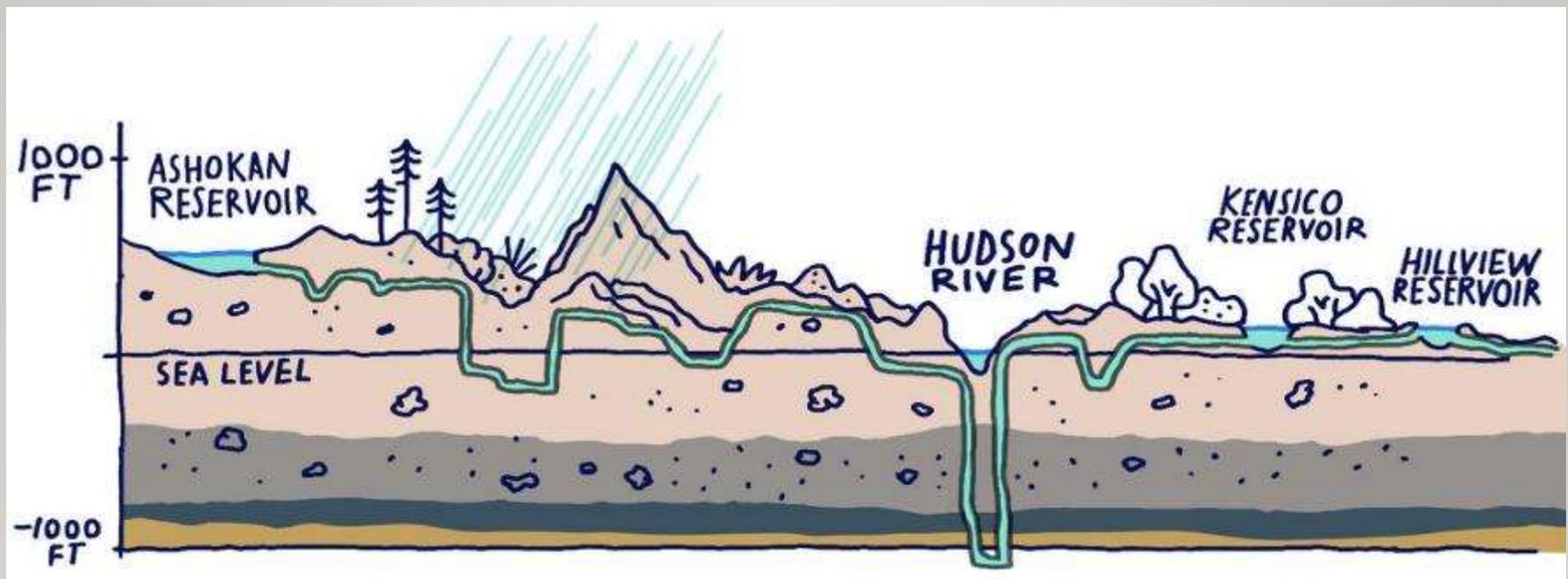


THE CITY HAS ALSO UPGRADED SEPTIC SYSTEMS AND WASTEWATER TREATMENT PLANTS IN COMMUNITIES AROUND THE WATERSHED AND HELPED BUILD MUNICIPAL SALT SHEDS AND MANURE SHEDS ON DAIRY FARMS TO PREVENT HARMFUL RUNOFF. SOURCE: NY TIMES



AS A RESULT,THE FEDERAL ENVIRONMENTAL PROTECTION AGENCY (EPA) EXEMPTS WATER ORIGINATING IN THE CATSKILL DELAWARE WATERSHED FROM ITS USUAL FILTRATION REQUIREMENTS,A DISPENSATION THE AGENCY GIVES TO ONLY A FEW OTHER MAJOR CITIES. SOURCE: NY TIMES

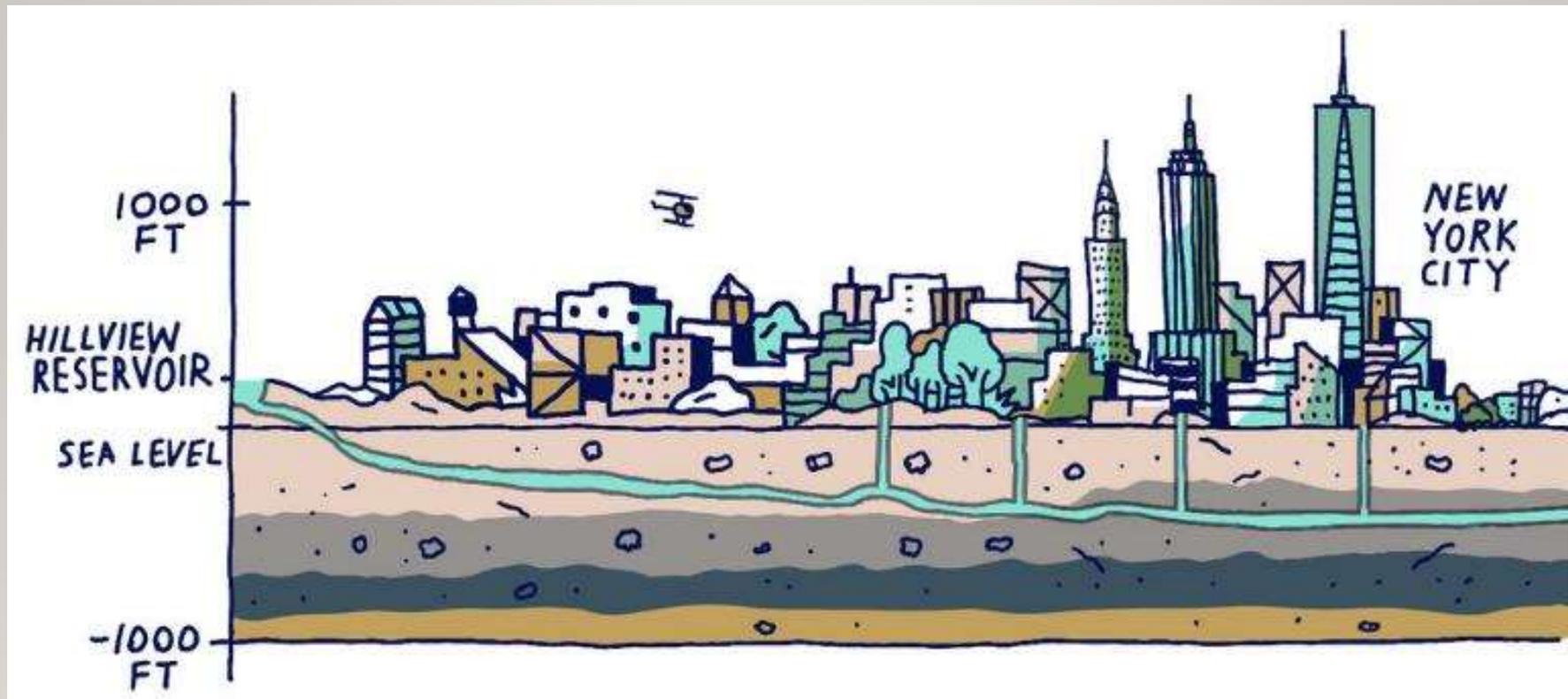




AN ENGINEERING MARVEL: THE 92-MILE-LONG CATSKILL AQUEDUCT, WHICH PLUNGES 1,100 FEET UNDERNEATH THE HUDSON RIVER, WAS CONSTRUCTED A CENTURY AGO. IT CAN TAKE ANYWHERE FROM 12 WEEKS TO A YEAR FOR WATER TO WIND ITS WAY TO THE CITY FROM THE STREAMS, TUNNELS, DAMS AND RESERVOIRS IN THE CATSKILLS. ALL OF IT IS DELIVERED TO THE CITY BY GRAVITY ALONE. SOURCE: NY TIMES

THE CITY HAS SPENT BILLIONS OVER MANY YEARS FOR HUNDREDS OF PROJECTS TO FIX DECAYING INFRASTRUCTURE. AMONG THE ITEMS IS A NEW TUNNEL TO BYPASS A PORTION OF THE DELAWARE AQUEDUCT THAT HAS BEEN LEAKING MORE THAN 18 MILLION GALLONS A DAY FOR DECADES. SOURCE: NY TIMES





THE HILLVIEW RESERVOIR IS THE LAST STOP BEFORE THE CITY'S WATER MAINS. THINK OF IT AS A 900-MILLION-GALLON BATHTUB, WITH ENOUGH WATER TO SUPPLY THE CITY FOR ONE DAY. BEFORE THE WATER IS SENT ON TO THE CITY, CHLORINE, PHOSPHORIC ACID AND SODIUM HYDROXIDE ARE ADDED TO DISINFECT IT AND RAISE THE PH LEVELS TO PREVENT PIPES FROM CORRODING AND RELEASING HARMFUL METALS, LIKE LEAD. SOURCE: NYTIMES



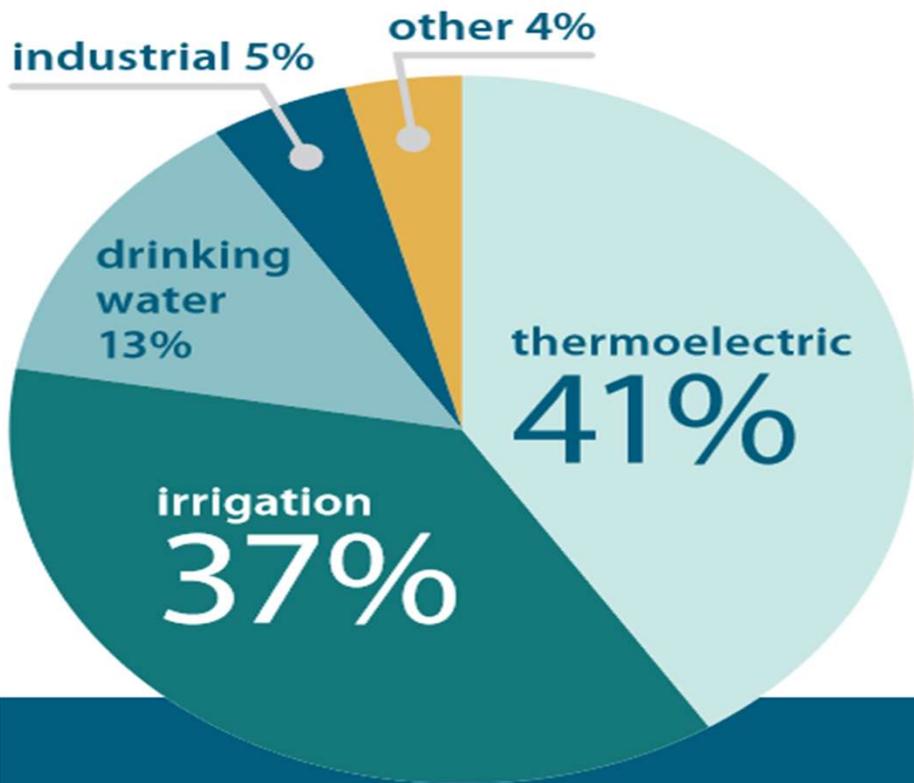
**BUT THAT'S NOT WHERE  
WE ALL USE THE MOST  
WATER.....**

WHICH USED MORE WATER EACH DAY IN 2010?

1) THE CITY OF NY?

OR

2) THE INDIAN POINT NUCLEAR POWER PLANT?



## U.S. freshwater withdrawals

Power plants account for the largest share of freshwater withdrawals in the United States.



## Understanding Power Plant Water Use

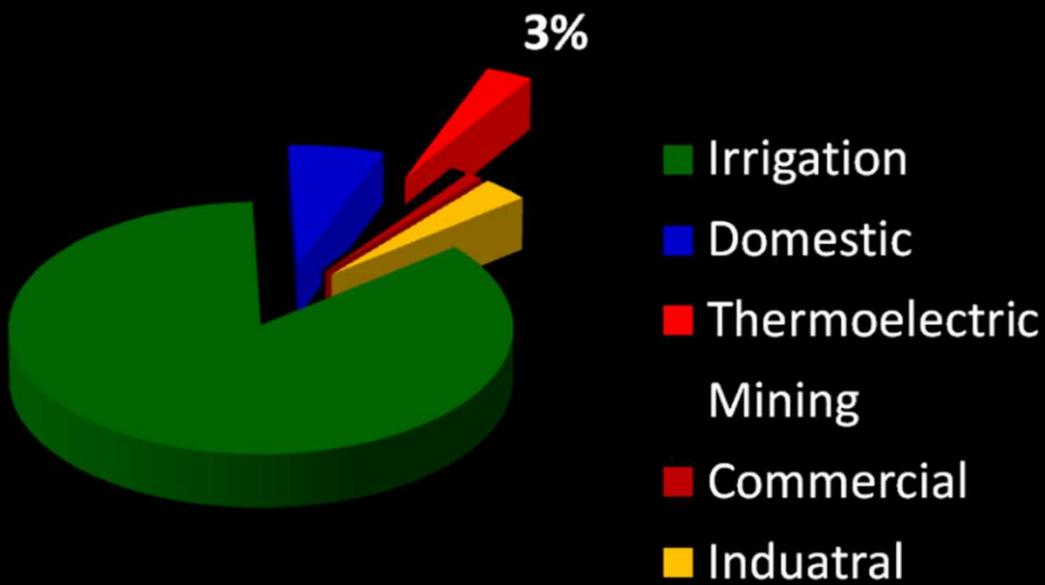
**Water withdrawal:** *The total amount of water taken from a surface- or ground-water source. In most cases, some fraction of that water will be returned to the water source and available for other withdrawals.<sup>18</sup> Water withdrawal can become a large problem during drought and heat waves: water can be too warm, or levels too low, to cool the power plant, or the cooling water used by the plant can be made too warm to safely discharge.*

**Water consumption:** *That part of withdrawn water that is not readily available for re-use because it is evaporated in power plants. The amount of water consumed by power plants is a particular concern in water-constrained regions (including large parts of the western United States).*



**Withdrawal**

## US Freshwater Consumption



**UTILITY  
CONSUMPTION  
IS SMALL**

**COMPARED TO  
DOMESTIC AND  
IRRIGATION**

**THAT'S CONSUMPTION!**



# TO PRODUCE ONE KWH.....

- **It takes ½ gallon of water if it's a conventional generating station**
- **It takes 18 gallons of water if it's a hydroelectric generating station**

**Source: Consumptive Water Use for US Power Production  
P.Torcellini, N. Long, & R. Judkoff, NREL**

<b>ITEM</b>	<b>H2O Usage for KWH Consumption</b>
Coffee pot w/hot plate	3 quarts per hour
20 incandescent 100W	1 gallon per hour
20 CFL 25W	1 quart per hour
Plasma TV	1 quart per hour
30 ft <sup>3</sup> Refrigerator	1 gallon per day
15 ft <sup>3</sup> ES Refrigerator	1/2 gallon per day
Electric Clothes Dryer	1 to 3 gallons per hour

# VIRTUAL WATER USE



53 Gallons =



0.5 Gallons +



1.5 Gallons +



3 Gallons +



48 Gallons +

**Virtual Water** is the water used to create the goods and services that we consume and use, It captures water use in all steps of the production chain

<b>ITEM</b>	<b>H2O Gallons to produce</b>
<b>12 oz baked potato</b>	<b>23</b>
<b>Quart of milk</b>	<b>3848</b>
<b>4 lb. chicken</b>	<b>2060</b>
<b>Dozen Eggs</b>	<b>636</b>
<b>4 lb. of pork chops</b>	<b>2284</b>
<b>4 pints beer</b>	<b>156</b>
<b>4-6 oz glasses wine</b>	<b>186</b>

<b>Food or diet</b>	<b>H2O Gallons to produce</b>
<b>Fast Food Burger</b>	<b>2700</b>
<b>3 starbucks 16oz coffees</b>	<b>178</b>
<b>3 starbucks 16 oz teas</b>	<b>43</b>
<b>Beef Eating diet per day</b>	<b>1320</b>
<b>Vegetarian diet per day</b>	<b>660</b>
<b>Vegan Diet per day</b>	<b>89</b>
<b>One Pound Almonds</b>	<b>2000</b>

## OUR VIRTUAL WATER USE: STUFF

<b>ITEM</b>	<b>H2O Gallons to produce</b>
<b>Cotton T-shirt</b>	<b>659</b>
<b>Cotton Jeans</b>	<b>2108</b>
<b>Smart phone</b>	<b>3190</b>
<b>Leather Shoes</b>	<b>3626</b>
<b>Car</b>	<b>13K-22K</b>
<b>One Gallon Water Bottle</b>	<b>2</b>
<b>Gallon of Gasoline</b>	<b>2.5</b>

BUT WE'RE ALL GOING TO FOCUS ON THE  
POSITIVE ASPECTS OF OUR WORK.....





QUESTIONS?

THANK YOU

CONNECT WITH ME:

[apadian@aeacleanenergy.org](mailto:apadian@aeacleanenergy.org)  
212 586-2940