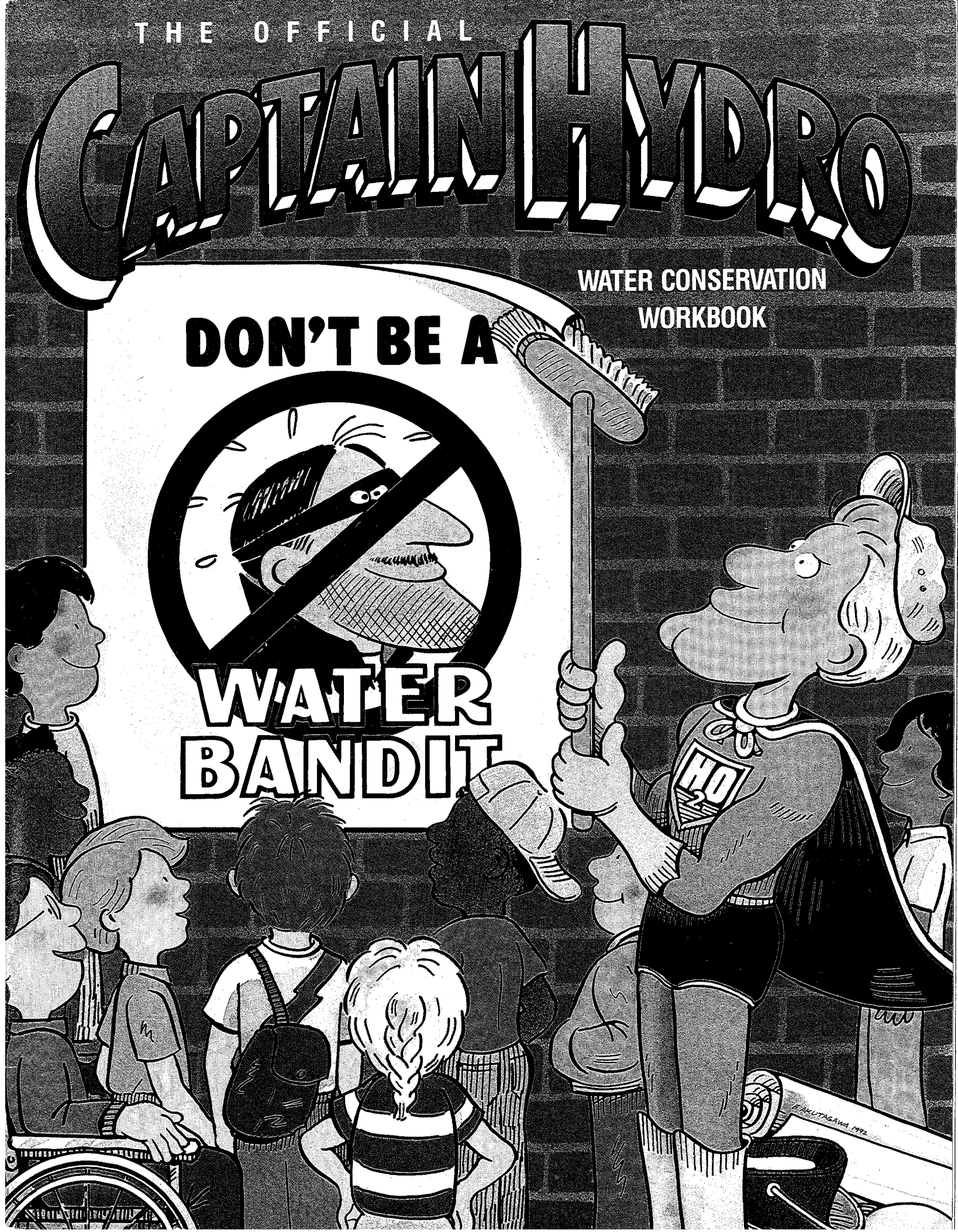
THE OFFICIAL

CAPTAIN HYDRO

WATER CONSERVATION WORKBOOK



THE OFFICIAL CAPTAIN HYDRO

WATER CONSERVATION WORKBOOK

Story and Original Lessons by Bob Johnson
Revisions and New Lessons by Marilynne and Wallace Homitz
Illustrations by Ben Akutagawa

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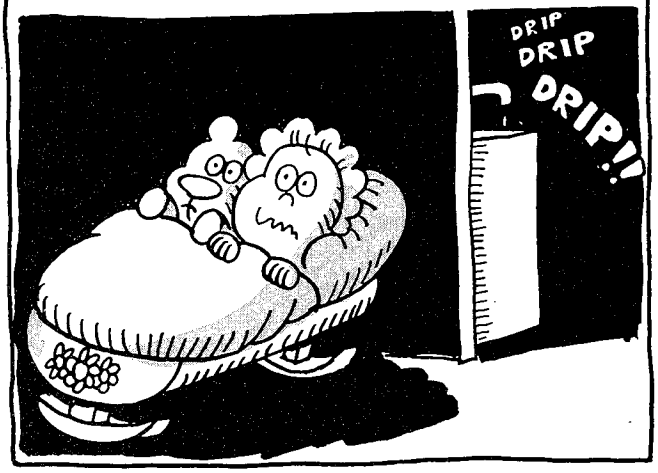
IN THE BEGINNING...

AS YOU MAY OR MAY NOT KNOW, CAPTAIN HYDRO STARTED HIS LIFE AS A NORMAL, ALL-AMERICAN BOY NAMED MARVIN PRIMINSKY-- KEPT AWAKE IN HIS CRADLE BY A LEAKY KITCHEN FAUCET, MARVIN DECIDED AS A BABY TO SPEND HIS LIFE **FIGHTING WATER WASTE!**



AS MARVIN GREW OLDER, HE BEGAN TO LEARN ABOUT WATER AND WATER CONSERVATION--- WHILE OTHER KIDS HIS AGE WERE BUILDING MODEL AIRPLANES, MARVIN WOULD BUILD-YES, YOU GUESSED IT,

MODEL FAUCETS!!

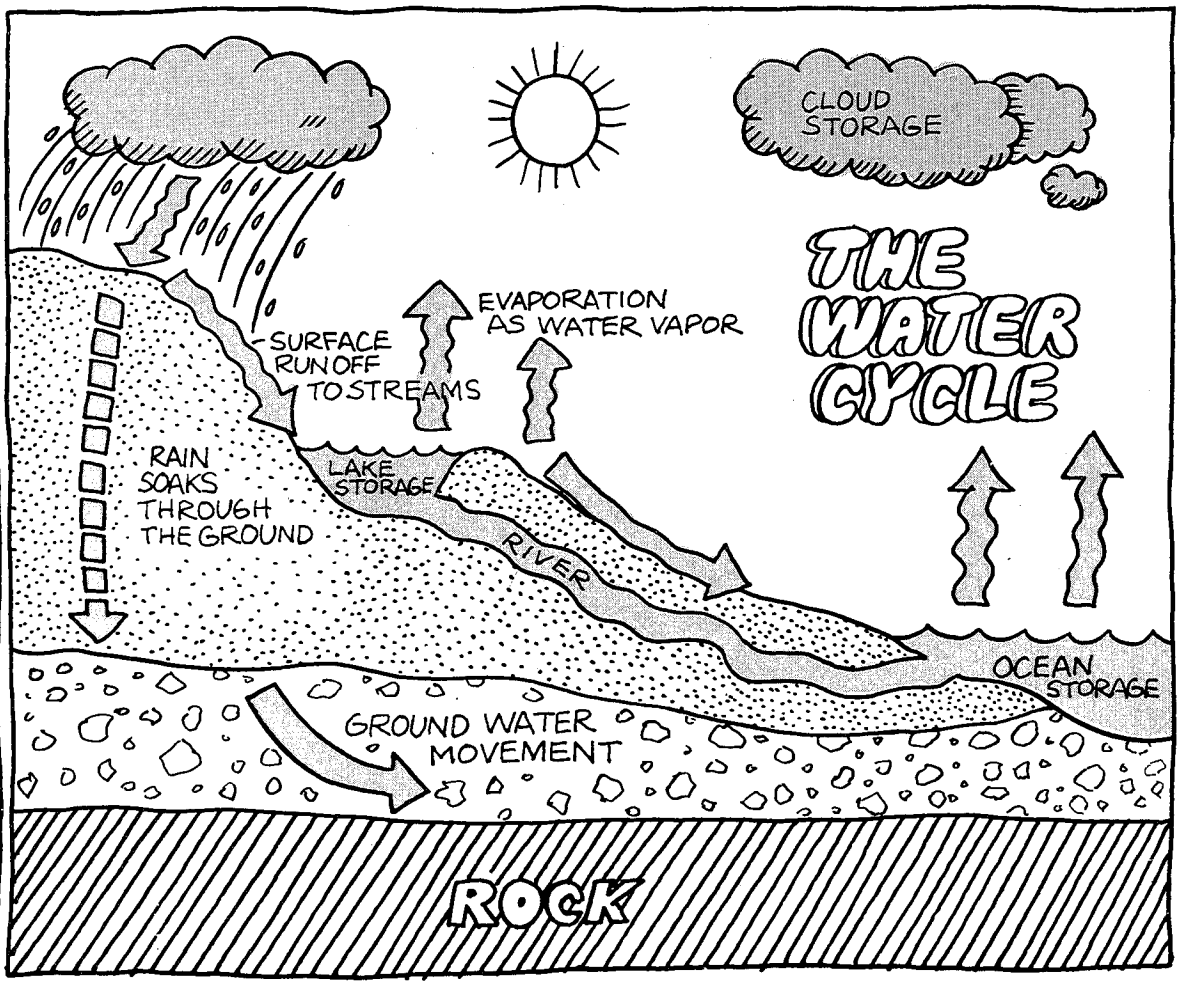
WE'LL HAVE TO ADMIT THAT MARVIN WAS SLIGHTLY WEIRD! --- OR WAS HE AHEAD OF HIS TIME?

MARVIN SWORE AT THIS EARLY AGE TO UPHOLD DECENCY IN THE AMERICAN WAY OF LIFE.. TO PROTECT MOM, THE FLAG, APPLE PIE, AND TO **STOP WATER WASTE EVERYWHERE!!**

HERE ARE SOME OF THE THINGS MARVIN LEARNED..

THE SOURCE OF WATER...

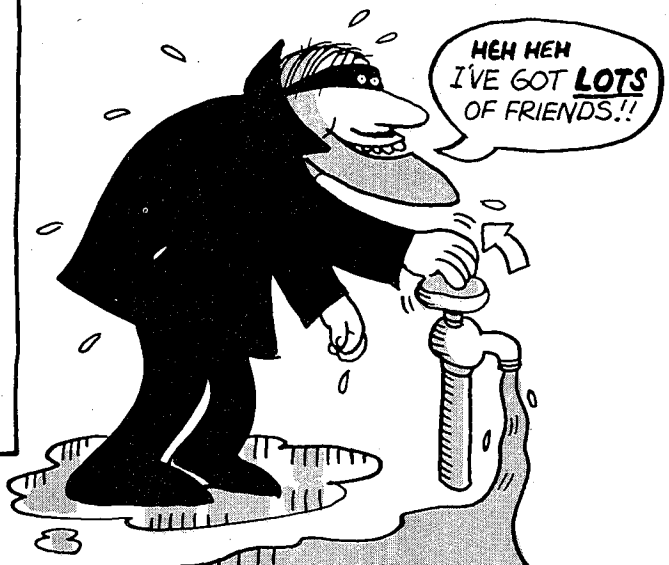
THE SOURCES OF ALL OUR WATER SUPPLIES ARE RIVERS, LAKES, AND UNDERGROUND RESERVOIRS. AS WE DRAW WATER FROM THESE, THEY ARE REFILLED BY SNOW AND RAIN. THE CONSTANT MOVEMENT OF WATER, FROM CLOUDS TO EARTH AND BACK IS CALLED THE **WATER CYCLE**



MARVIN'S STUDIES SURE MADE A LOT OF SENSE. HE LEARNED THERE WAS ONLY SO MUCH WATER TO GO AROUND - AND THAT MADE WATER CONSERVATION EVEN **MORE** IMPORTANT!

BUT! **LITTLE DID HE REALIZE HOW HARD HIS JOB WAS GOING TO BE - FOR HE WOULD HAVE TO DEAL WITH THE LIKES OF THE -**

WATER BANDIT!!



HIS FRIENDS...

THE WATER BANDIT LOVES TO DO THINGS COUNTER-CLOCKWISE AND BACK-WARDS -- HE EVEN EATS **DESSERT FIRST!!**

THE WATER BANDIT HAS HIS **OWN** MISSION IN LIFE - TO OPEN EVERY FAUCET IN THE TERRITORIAL UNITED STATES AND EVENTUALLY **FLOOD THE WORLD!!**

NOW... TO THE PRESENT. MARVIN GROWS UP TO BECOME A MILD-MANNERED ADULT... ONE NIGHT, IN LATE SEPTEMBER, AFTER A PEPPERONI PIZZA DINNER, MARVIN, AS YOU MIGHT GUESS, HAS A NIGHTMARE...

HE DREAMS THE WATER BANDIT IS TURNING ON THE MAIN WATER VALVE OF THE WORLD!!!

THE BIG ONE

UPON AWAKENING...

THAT DOES IT!! I'VE GOT TO STOP THE WATER BANDIT, BUT PRONTO!

BUT HOW?!!

I'VE GOT IT!! I'LL BECOME CAPTAIN HYDRO!!

MARVIN - IN HIS SELF-APPOINTED ROLE AS A CRUSADER AGAINST DRIPS AND DRIBBLES DECIDES HE MUST FIGHT IN A COSTUME TO STRIKE FEAR AND TERROR IN THE HEARTS OF ALL EVIL DOERS - BUT FIRST HE HAS TO PICK THE RIGHT OUTFIT....

COSTUMES INC.

THIS ISN'T QUITE WHAT I HAD IN MIND.

SO.. WHAT D'YA EXPECT FOR 3.98?

I DON'T THINK SO

GETTING CLOSER THOUGH..

FINALLY!!!

I'LL TAKE IT!!

THE NEXT DAY.. WHILE MARVIN PONDERS HIS NEXT PLAN OF ATTACK...

MARVIN.. GET A JOB!!!

THEY'RE RIGHT I GUESS - MAYBE THEY'VE GOT SOMETHING HERE

ACE EMPLOYMENT AGENCY

WE HAVEN'T HAD A CALL FOR A CAPED CRUSADER LATELY.. HOW ABOUT SOMETHING IN FIRE HYDRANTS?

CLOSE ENOUGH

AND SO, DISGUISED AS A MILD-MANNERED FIRE HYDRANT SALESMAN, MARVIN LOOKS LIKE ANY NORMAL, OR SEMI-NORMAL, LAW-ABIDING CITIZEN...

LOOK GEORGE

HERE'S ONE YOU MIGHT LIKE

BUT ONE DAY WHILE WALKING HOME...

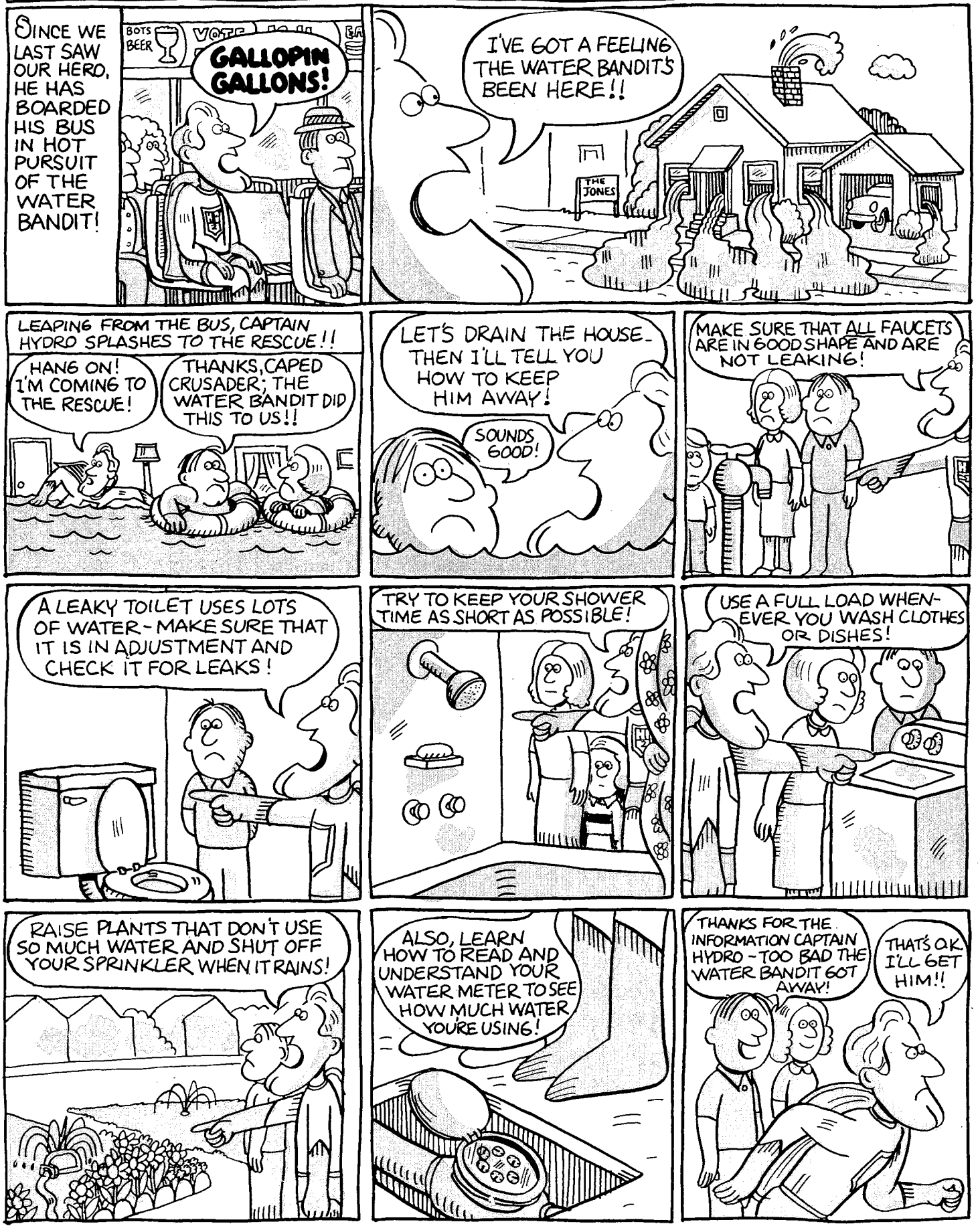
IT HAPPENS!! -- HE ENCOUNTERS THE WATER BANDIT!!!

HOLY HYDRAULICS!! IT'S HIM!!

HEH HEH

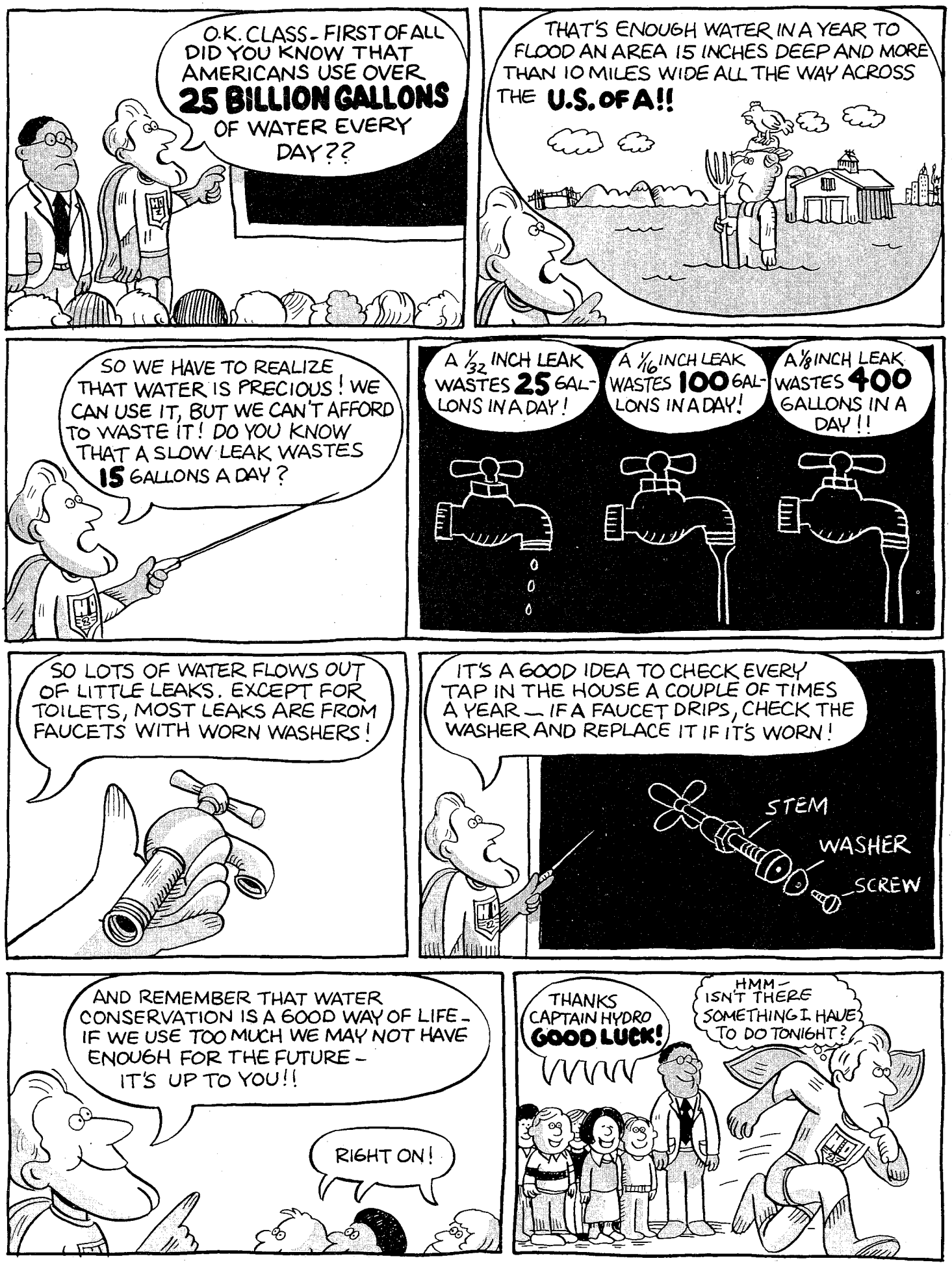

MARVIN QUICKLY DASHES INTO ACTION..
HEY! GET YOUR OWN PLACE TO CHANGE!
SORRY, MR. KENT
PHONE BOOTH
AND LOOKS FOR A PLACE TO CHANGE.....
FLETCHER'S LAUNDROMAT
I'LL TRY HERE!
10¢
TO EMERGE AS....
?
PRIVATE
CAPTAIN HYDRO!!!
WHAM!
SPRING
10¢
UNFORTUNATELY, A STUCK PANTS ZIPPER DELAYS OUR HERO FOR ABOUT 10 MINUTES....
NOW WHICH WAY DID HE GO?!
UNABLE TO FLY, OUR CHAMP-ION PURSUES THE WATER BANDIT ON THE 92ND STREET BUS...
GOOD THING HE LEFT A WATER TRAIL!
BUS
BUT WHAT A WASTE!
BUS
MARVIN CALCULATED THE WATER GOING DOWN THE DRAIN WITH HIS TRUSTY
WRIST DRIP-O-METER!
DRIP-O METER

HYDRO HELPS AT HOME



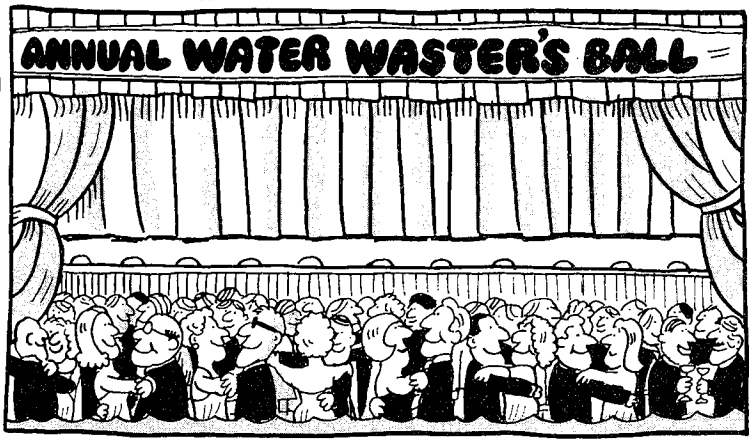
TARDY AGAIN!

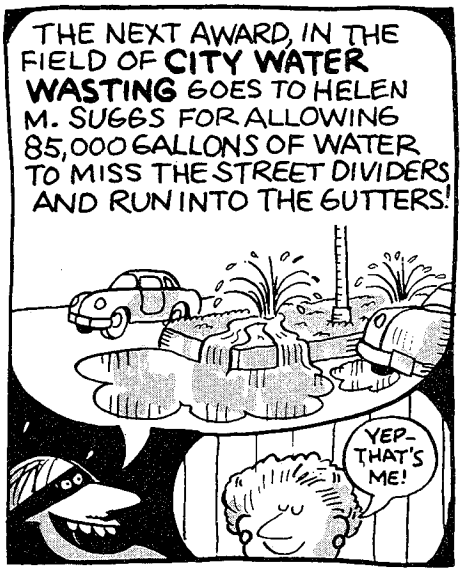

RING RING!
YES..YOU SAY THE FIRE HYDRANT IN FRONT OF YOUR SCHOOL IS LEAKING? I'LL BE RIGHT THERE PRINCIPAL!
I BET THIS IS THE WORK OF- YOU-KNOW-WHO!
THIS IS A JOB FOR CAPTAIN HYDRO!!
FLETCHER'S LAUNDROMAT
OH NO! NOT AGAIN!
UPON ARRIVING AT P.S.185-
HEY! THIS FIRE HYDRANT ISN'T THE ONLY THING THAT'S LEAKING!!
DRIP DRIP
P.S.185
HOT DOG! MAYBE THAT LITTLE RASCALS IN THERE!!
OOPS! IT'S CAPTAIN HYDRO!
CAPTAIN HYDRO HERE, PRINCIPAL!
HE WENT THATAWAY, HYDRO!
THAT GUY'S GETTING ON MY NERVES!!
HERE HYDRO- TAKE A WATER BLAST!! HEH HEH!
YI!
VOOM
FIRE
WHAT HAPPENED?
NICE TRY CAPTAIN- AT LEAST YOU MADE HIM LEAVE!
I NEVER REALIZED HOW MANY WAYS WATER CAN BE WASTED! SINCE YOU'RE HERE WOULD YOU TALK TO THE CLASS ABOUT IT?
MY PLEASURE
CLASS- MAY I INTRODUCE CAPTAIN HYDRO!
WHO?


O.K. CLASS - FIRST OF ALL DID YOU KNOW THAT AMERICANS USE OVER 25 BILLION GALLONS OF WATER EVERY DAY??
THAT'S ENOUGH WATER IN A YEAR TO FLOOD AN AREA 15 INCHES DEEP AND MORE THAN 10 MILES WIDE ALL THE WAY ACROSS THE U.S. OF A!!
SO WE HAVE TO REALIZE THAT WATER IS PRECIOUS! WE CAN USE IT, BUT WE CAN'T AFFORD TO WASTE IT! DO YOU KNOW THAT A SLOW LEAK WASTES 15 GALLONS A DAY?
A 1/32 INCH LEAK WASTES 25 GALLONS IN A DAY!
A 1/16 INCH LEAK WASTES 100 GALLONS IN A DAY!
A 1/8 INCH LEAK WASTES 400 GALLONS IN A DAY!!
SO LOTS OF WATER FLOWS OUT OF LITTLE LEAKS. EXCEPT FOR TOILETS, MOST LEAKS ARE FROM FAUCETS WITH WORN WASHERS!
IT'S A GOOD IDEA TO CHECK EVERY TAP IN THE HOUSE A COUPLE OF TIMES A YEAR — IF A FAUCET DRIPS, CHECK THE WASHER AND REPLACE IT IF IT'S WORN!
STEM
WASHER
SCREW
AND REMEMBER THAT WATER CONSERVATION IS A GOOD WAY OF LIFE - IF WE USE TOO MUCH WE MAY NOT HAVE ENOUGH FOR THE FUTURE - IT'S UP TO YOU!!
RIGHT ON!
THANKS CAPTAIN HYDRO GOOD LUCK!
HMM - ISN'T THERE SOMETHING I HAVE TO DO TONIGHT?

ON STAGE WITH CAPTAIN HYDRO

WHAT OUR HERO WAS TRYING TO REMEMBER WHEN WE SAW HIM LAST WAS THAT TONIGHT IS THE NIGHT OF THE **ANNUAL WATER WASTER'S BALL!!**

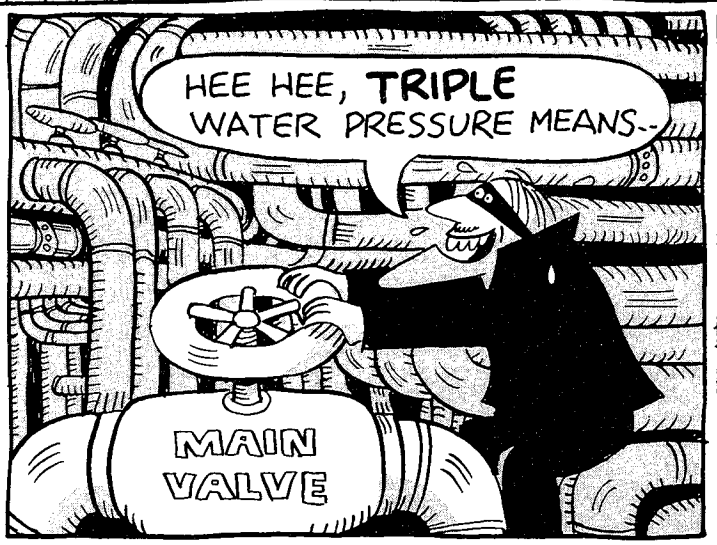


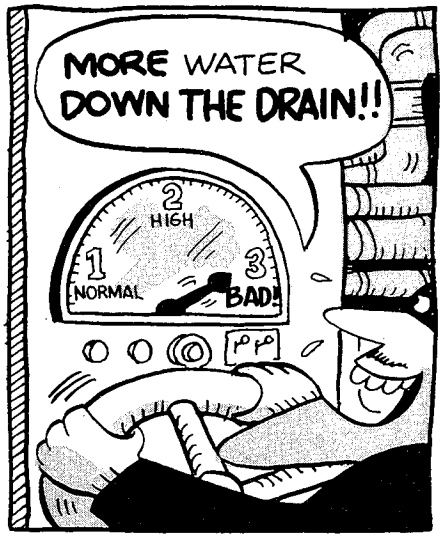


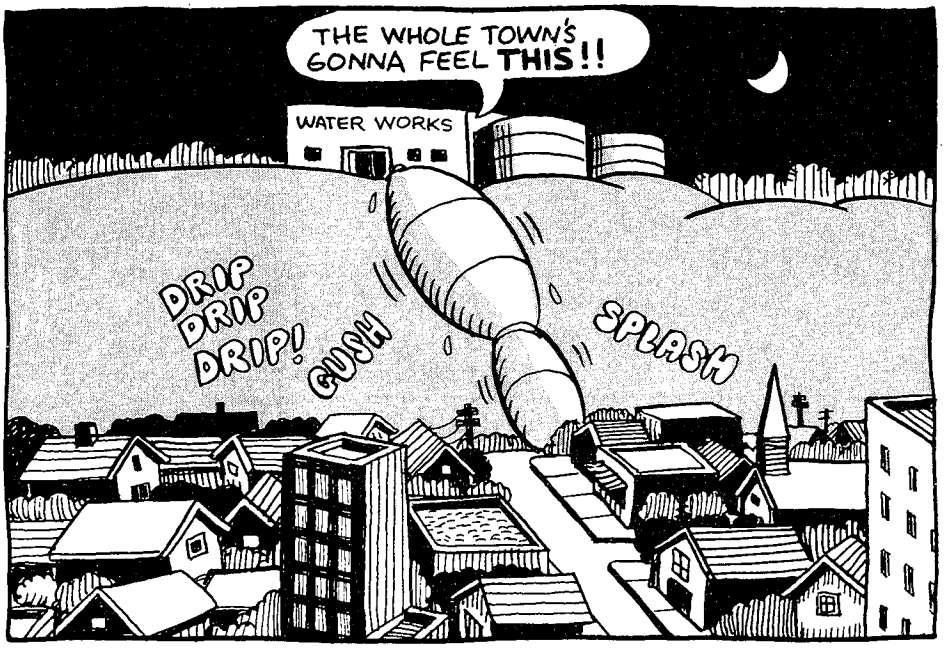
WILL HYDRO NAB THE BANDIT? WILL WATER WASTE EVER END? TURN TO PAGE 10 FOR THE DRAMATIC CONCLUSION!

THE DRAMATIC CONCLUSION!

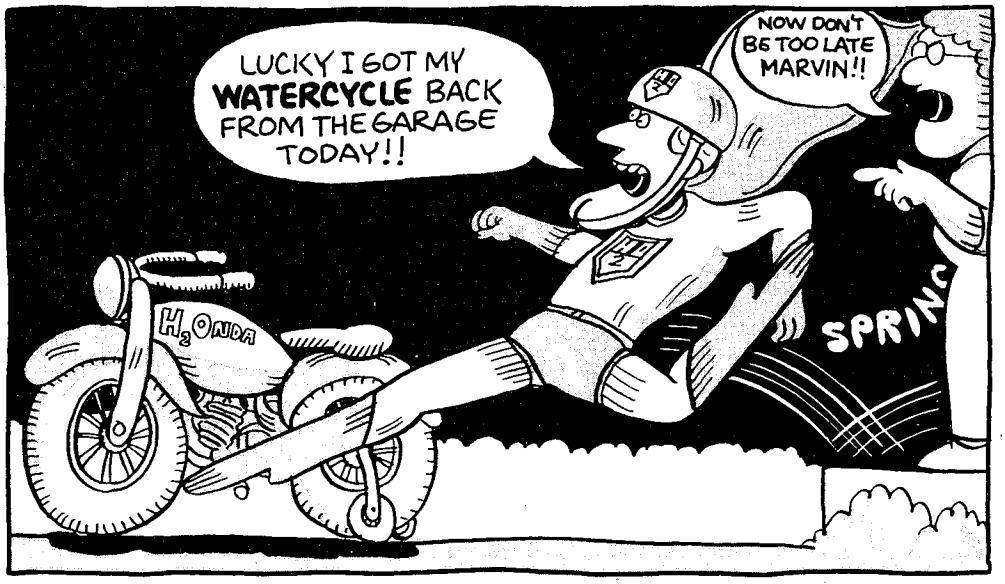
OT PAINS US TO REPORT THAT THE WATER BANDIT IS ATTEMPTING THE MOST DASTARDLY DEED OF HIS CAREER— **TRIPLING** THE TOWN'S WATER PRESSURE TO WASTE EVEN **MORE** WATER!!



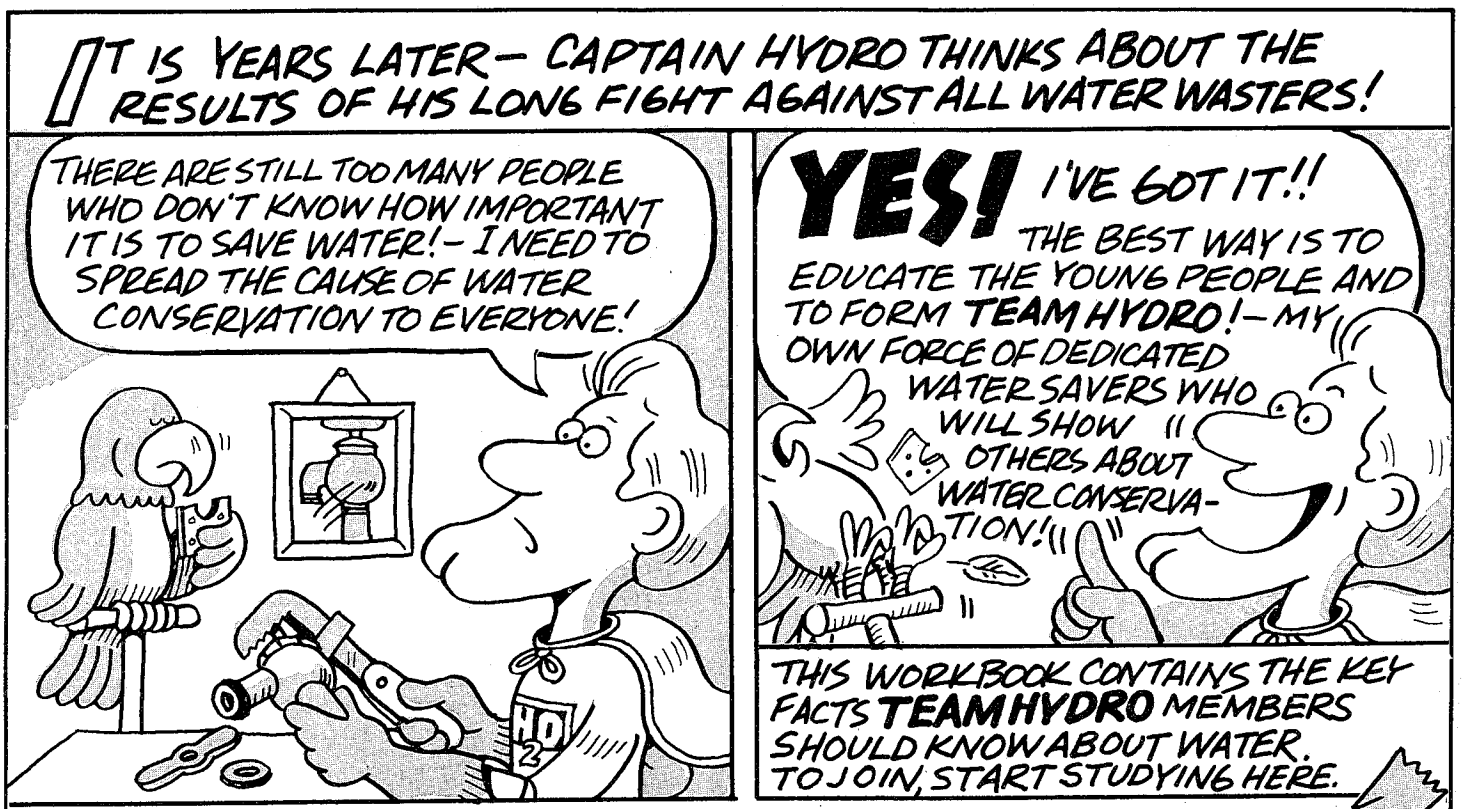




MEANWHILE- MARVIN IS AT HOME, GETTING READY FOR BED- BUT WHEN HE TURNS ON THE BATHROOM FAUCET, HE SENSES THAT SOMETHING IS **WRONG!!**




UPON ARRIVING AT THE WATER WORKS!
I KNEW YOU WERE COMING HYDRO! THIS TIME I'M READY AND WAITING FOR YOU!!
450 LB. PRESSURE
YI! AGAIN!
HOW DO YOU LIKE 450 LBS OF WATER PRESSURE HYDRO!!
VROOM
HAD ENOUGH HYDRO? YOU'VE BEEN GETTING IN MY WAY LONG ENOUGH! C'MON AND TRY AND GET ME!!
C'MON!! C'MON!!
BOY- AM I GETTING TIRED OF THIS!
NOW JUST A MINUTE, W.B. – NO NEED TO RAISE YOUR VOICE AND GET ANGRY – I REALIZE YOU MUST DO YOUR THING AND I MUST DO MINE - SOMEHOW WE CAN SETTLE THIS VERY QUICKLY IN THE HONEST, STRAIGHTFORWARD MANNER THAT IS THE INTELLIGENT WAY TO DISCUSS DIFFERENCES OF OPINION BETWEEN TWO ADULT HUMAN BEINGS – AND THAT SIMPLE MANNER IS---
THAT SIMPLE MANNER IS---
WRESTLING!!-NO HOLDS BARRED!!!
YIKES!
BAM!! CRASH!! SPLASH!
WHAM!
BOP!!
CRUNCH!!
YOU HAVEN'T SEEN THE LAST OF ME YET, HYDRO!!
AMBULANCE
HE'S RIGHT YOU KNOW..
I CAN'T STOP WATER WASTE ALONE---
CAPTAIN HYDRO NEEDS YOU!
THE END?



THE NATURAL WATER CYCLE

Where does water come from? All water comes from the glaciers, oceans, lakes and rivers that exist on earth. That water rises into the atmosphere as a vapor by **evaporation**. Plants and animals transfer water from their bodies into the atmosphere as vapor by **transpiration**. The water vapor changes back to water droplets by **condensation** when it is cooled at higher altitudes. Droplets then form clouds. When the clouds become too heavy with moisture, gravity causes the moisture to fall as **precipitation:** rain, snow, sleet or hail. The cycle repeats itself over and over.

DEMONSTRATION REPORT

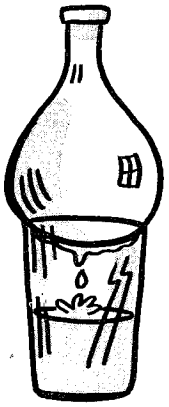
Define the terms given below. Note where each process occurs in the demonstration.

Evaporation: _____

Condensation: _____

Precipitation: _____

Transpiration: _____



Place each of the following words in the appropriate space to represent water as found in nature: **lake, cloud, rain**.

_____

_____

_____

Describe briefly what happens in the demonstration.

_____

_____

_____

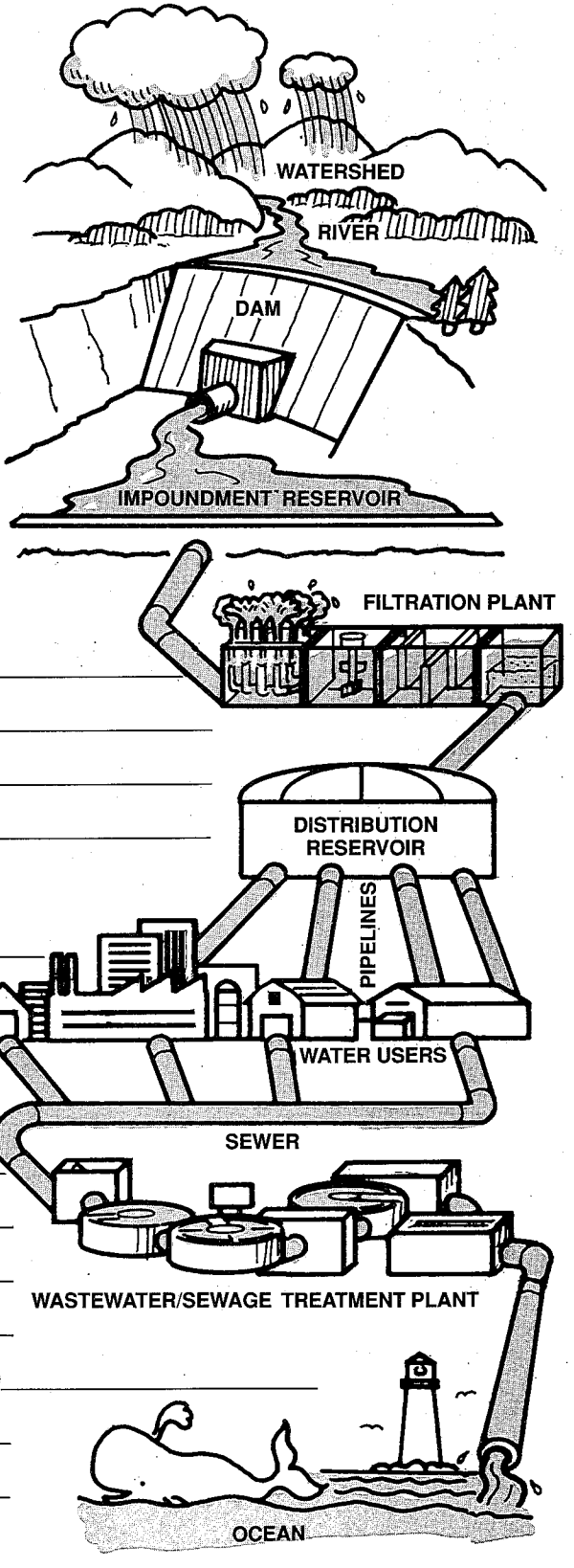
_____

_____

_____

THE BUILT WATER CYCLE

At the "top" of the natural water cycle, we step in and take the water we need for our use. To do that, we **build** a cycle of water use of our own. This built water cycle begins when precipitation **falls** from the sky as rain or snow. The natural water cycle "begins" when water **rises** from the earth as vapor. We build **dams** and **reservoirs** to collect and store water. We build **pumping station**s and **wells** to bring water that has soaked into the ground to the surface. We build **filtration plants** where we purify the water we collect. We build **storage tanks**, **distribution reservoirs**, **pumping** and **pipeline systems** to get the water to houses and offices and factories. We build **sewers** to carry our used (dirty) water and sewage to **treatment plants**, where the used water is cleaned before we dump it back into the oceans or rivers where it rejoins the natural water cycle. There it evaporates, forms clouds, condenses and falls as precipitation all over again.



ANSWER BRIEFLY:

1. Is your water cleaned before or after you use it?_____
2. Where does water go after you use it? _____
3. How does water you use reenter the natural water cycle? _____

_____

FIND OUT:

the source of the water you use at home _____

_____

what watershed land is_____

_____

where purification of your water takes place_____

_____

where your wastewater and sewage are treated _____

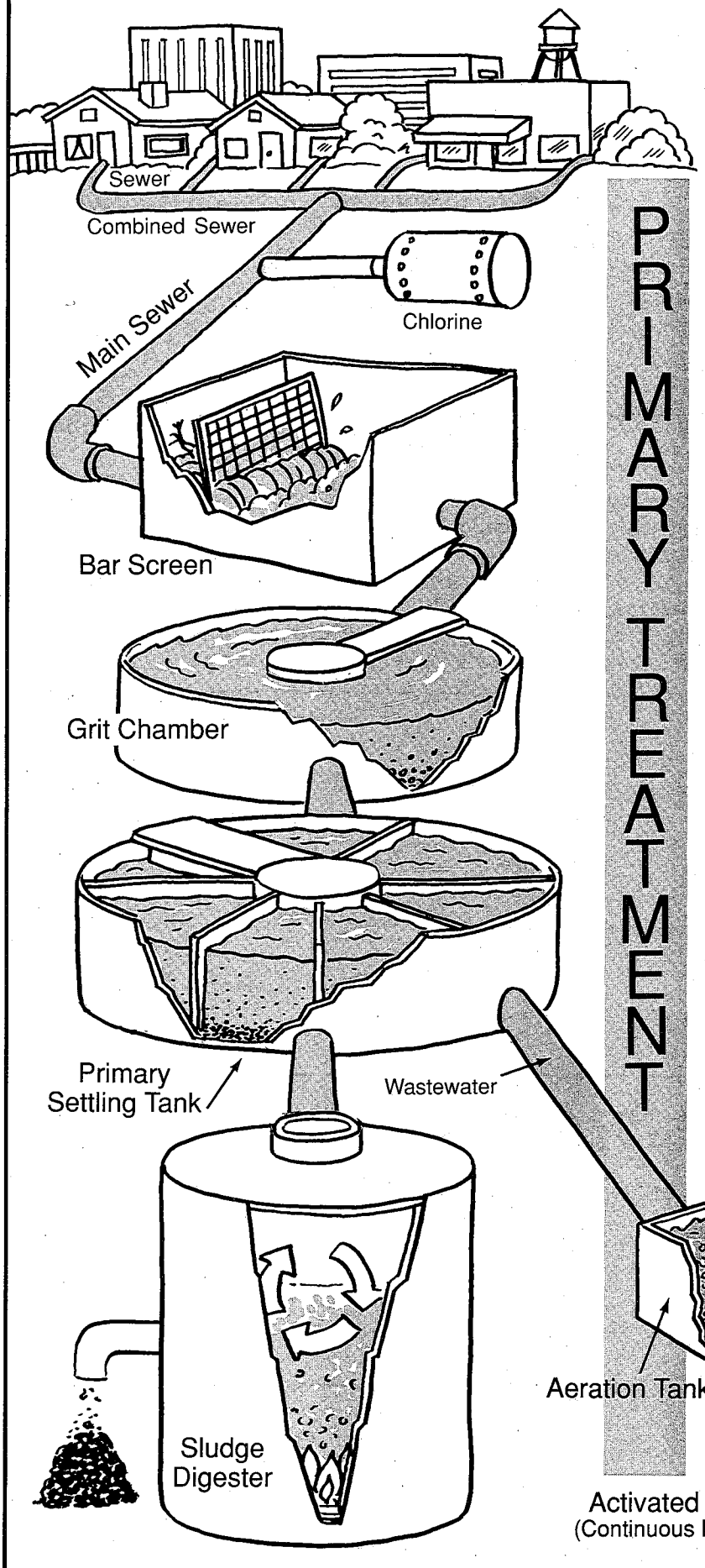
_____

where the water you use at home reenters the natural water cycle_____

how nature purifies water _____

_____

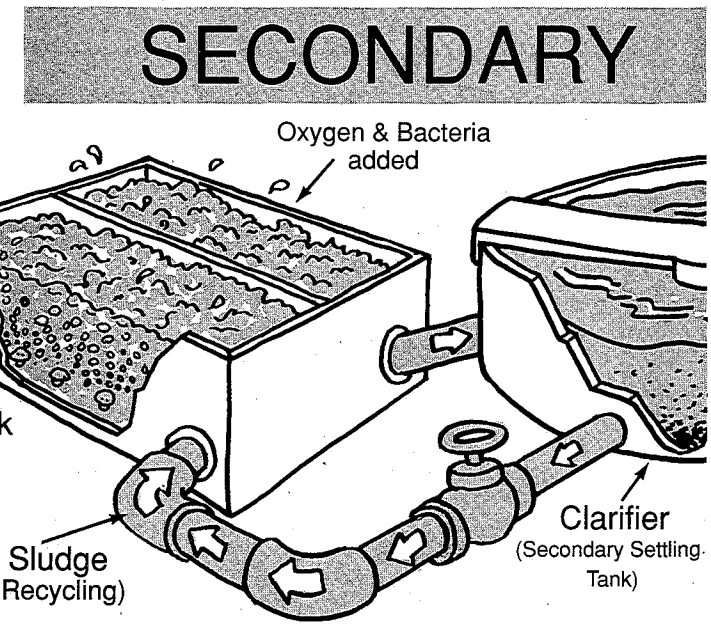
Wastewater



As you watch dirty water swirl down the drain in your sink or toilet after you've used them, where do you think this used water, or **wastewater**, as it's called, goes? It runs down to a **sewer**, a large pipe which connects the drain pipes in your house to a larger **combined** sewer, which collects the wastewater from many houses and storm drains in your neighborhood. These sewers connect to even larger **main sewers**, which collect wastewater from all parts of the city and send it to a **wastewater treatment plant** for cleaning and disposal.

We clean wastewater in two ways: (a) by screening and filtering out harmful substances and objects – we call this **primary treatment**; and (b) by treating the used water with chemicals or bacteria which destroy the harmful substances. We call this **secondary treatment**. Most large cities use at least these two steps in treating their wastewater. Many places add an **advanced treatment** after the first two. They add chemicals which neutralize ammonia and phosphorous, which encourage growth of plants like **algae** in the water. Too many algae would use up the oxygen needed by fish and other life forms in the water.

Primary Treatment. The first step in the process is to **screen** out and remove large solids as they flow past – sticks, rags, cans and such. The second step is to run the water through **grit chambers**, tanks in which particles like gravel, seeds, small stones and coffee grounds settle to the bottom and are removed. In another **settling** or **sedimentation tank**, smaller

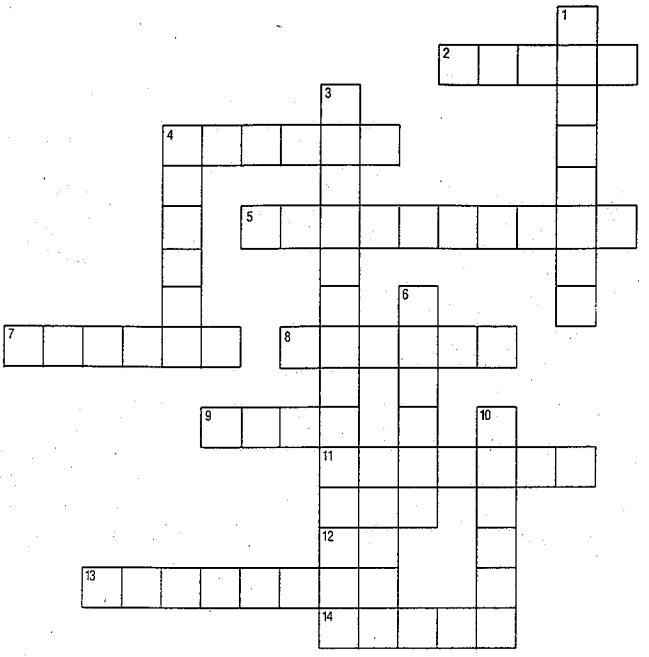


Treatment

solids are given time to sink to the bottom, where they form **primary sludge**, which is sucked out and sent to a sludge digester. Once the sludge from the primary settling tanks is removed, oil or other scum on top of the water is skimmed off and is burned, buried in the ground or sent to the digester. This is the point at which secondary treatment begins.

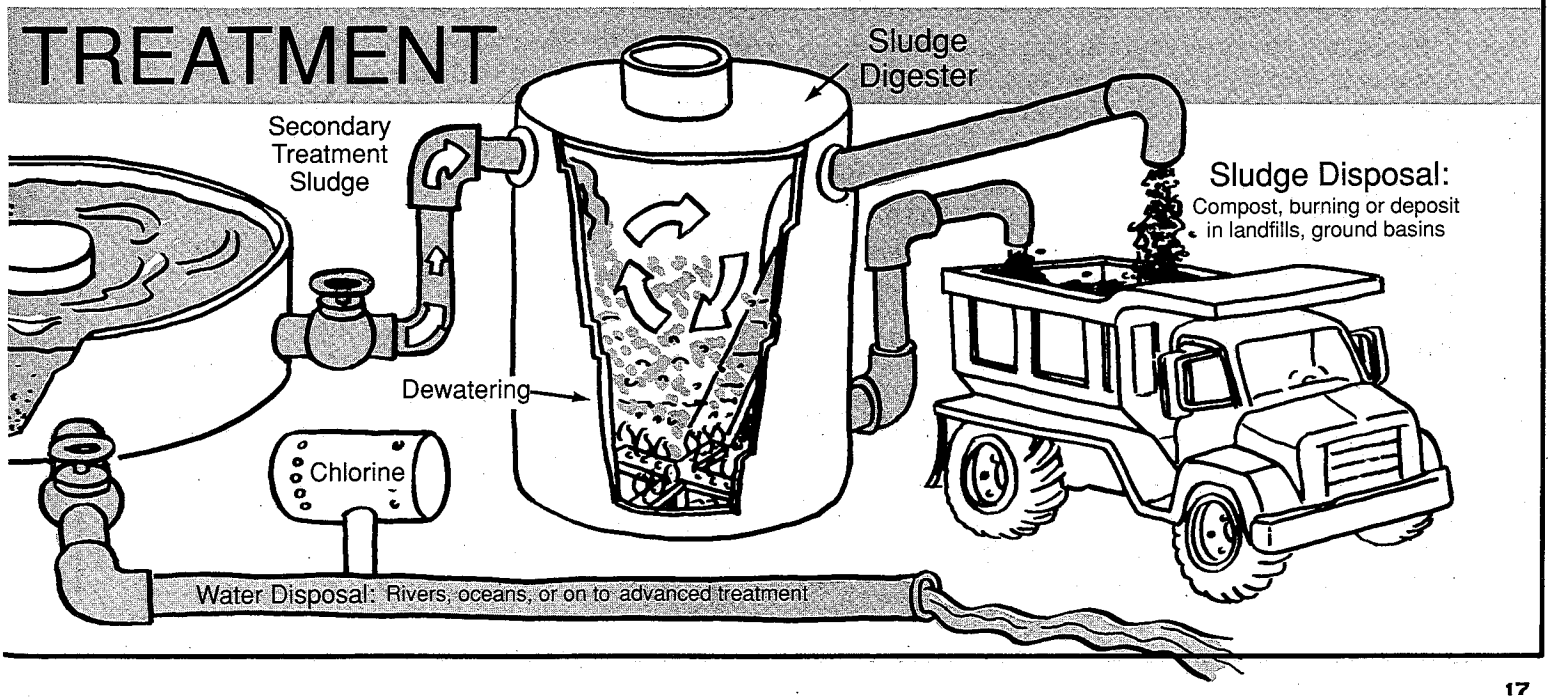
Secondary Treatment. The remaining wastewater travels to an **aeration tank**, where oxygen and bacteria are added. Oxygen feeds the bacteria which multiply and break up the wastes still in the water. The well-fed bacteria travel on to the **clarifier**, the secondary settling tank, where they sink to the bottom as **secondary treatment sludge**. Some of this sludge, now **"activated"** by the bacteria, is sent back to the aeration tank to be used over again. The excess sludge is sent on to the digester. Water from the clarifier is disinfected with chlorine, then the chlorine is taken out to protect marine life. Treated wastewater is then sent on to either **advanced treatment** and possible **recycling** or **reuse**, or else it is discharged into the sea, into rivers or on top of the ground, where it can percolate into the soil and build up the underground **water table**. The remaining sludge is dried out and stabilized (chemicals in it are made harmless). It then can be put in landfills, deposited in the ground or composted for use as fertilizer or soil conditioner.

The water cleaned in this way cannot be re-used like regular drinking water without additional "advanced treatment." It must get more cleaning before it can be used to wash cars, to irrigate farm crops or for taking showers.



Complete the crossword puzzle above, using the definitions below.

ACROSS	DOWN
2. A form of seaweed	1. Microscopic plant used to eat sewage
4. Pipes that carry wastewater	3. Place where wastewater cleaned (two words)
5. Secondary settling tank	4. Muck that settles after wastewater is left in a tank
7. Barrier that stops large objects from passing through it	6. What is removed from wastewater
8. To add oxygen to wastewater	10. Another name for wastewater
9. Sand, small rocks, coffee grounds	
11. To stop from happening	
12. Like	
13. Gas for disinfecting water	
14. Water level below the ground	



THE NEED FOR WATER

About 65% of your body is water. Water bathes all your body cells and tissues. It fills the spaces between bones. It flows through miles of arteries and veins along with the blood. A person five feet eight inches tall, weighing about 150 pounds, will have over 12 gallons (50 quarts) of water in his or her body at any given time.

Human beings can live for more than two months without food, but can die in a week or less without water. That is because solid foods also are **mostly water**, so a person can make up the liquids missed in food by drinking more water. At least for awhile.

Eventually, the body could not process water that comes only from food fast enough to do all the things it does in the body. It would need to get water directly to survive.

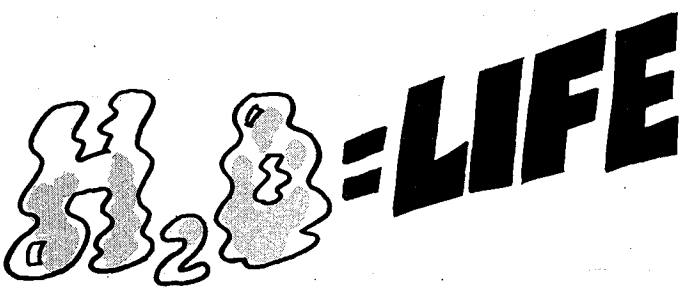
What are the ways the body uses water? It regulates the body's temperature. It keeps salt in the body from building up. It carries nutrients from food into the body organs and moves waste products out. It carries oxygen to body parts and helps remove carbon dioxide from them. And water is necessary to help digest all the food we eat.

The most important thing water does in the body, however, is cleanse the blood in the kidneys. About 15 times a day, all our blood passes through our kidneys, where water helps to "wash" it. When the kidneys fail, the human body cannot survive more than three weeks with unclean blood.

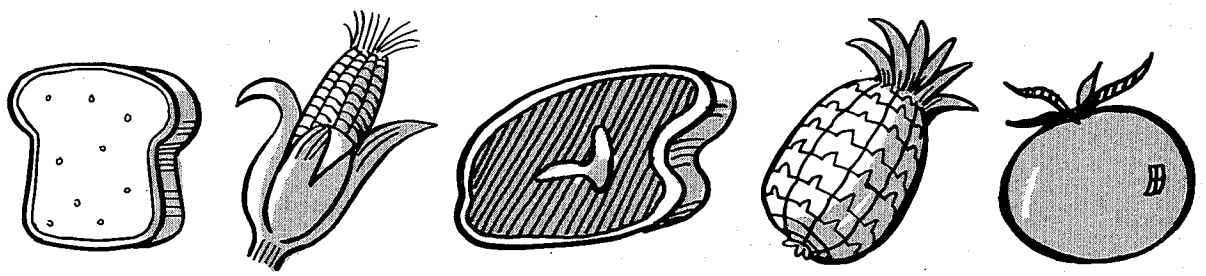
So it is important for us to drink lots of water. How much do we need to drink? About $2\frac{1}{2}$ quarts a day, one third of it by drinking, the other from the water in the solid foods we eat.

Animals use water in about the same ways we do. Most meats from animals contain 50 to 70 percent water. Plants use enormous amounts of water: most plants make food for themselves from air and water with the help of sunlight in a process called **photosynthesis**. In the same way, plants change water and carbon dioxide to make substances which become food for us, and by using the carbon dioxide, they clean up the atmosphere at the same time.

A continuous water supply is really a matter of life and death, not only for human beings, but also for all animals and plants. Without it, there would be no food. There would be no life.



CHARTING A COMPARISON



The bodies of human beings are 65% water. Most plants and animals depend upon water for 50% or more of their weight.

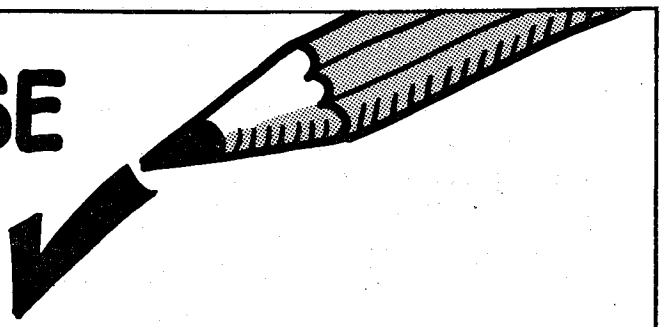
Here are some common food stuffs and their approximate water content:

BREAD - 35%
CHICKEN - 74%
CORN - 70%
HERRING - 67%
LOBSTER - 79%
MEAT - 70%
PINEAPPLE - 87%
POTATO - 80%
SUNFLOWER SEEDS - 5%
TOMATO - 95%

In the space below, make a bar chart which shows the percentage of water in each of these ten foods, placing the food with the highest percentage at the top and the food with the lowest percentage at the bottom.

	% of Water Content									
FOOD	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	
TOMATO										
PINEAPPLE										
POTATO										
LOBSTER										
CHICKEN										
CORN										
MEAT										
HERRING										
BREAD										
SUNFLOWER SEEDS										

HOME WATER USE SURVEY



Here is a chance for you to find out some information about your family's water use. You may be able to answer some questions yourself, but you will probably need to talk to the other members of your family in order to complete all items.

GENERAL INFORMATION

1. What type of home do you live in? (check one)
   _____ house _____ apartment/condominium _____ mobile home
2. How many people are living at home? _____
3. What are the ages of the children living at home?
   _____ _____ _____ _____ _____ _____
4. How many gallons of water were used in your home during the last billing period? (Ask your parent(s) to show you the latest water bill).
   _____
5. How many days were there in that billing period? _____

SPECIFIC WATER USE - Outside the House (Skip this section if you live in an apartment or condominium.)

1. What size is your lot compared with other lots on your street? (check one)
   _____ larger _____ the same _____ smaller
2. What type of plants do you have? (check all that apply)
   _____ lawn or ground cover _____ flowers and/or shrubbery
   _____ vegetable garden and/or fruit trees _____ none
3. Outside watering for the months April to September (estimate).
   _____ number of watering minutes per day (total number of minutes each hose is run every watering day).
   _____ number of watering days per week

SPECIFIC WATER USE - Inside the House

1. Dishwasher (answer only if you have one)
   a. How many times per week is the dishwasher run? _____
   b. How full is the dishwasher usually loaded?
   _____ full _____ ½ full _____ less than ½ full
2. Washing Machine (answer only if you have one)
   a. How many loads per week are usually washed? _____
   b, How full is the washer usually loaded?
   _____ full _____ ½ full _____ less than ½ full
3. How many of each of the following do you have in your home?
   _____ sinks _____ showers _____ bathtubs _____ toilets
4. How many showers per week are taken in your house? _____
5. How many tub baths per week are taken in your house? _____
6. How many minutes is your family's average shower? _____
7. How many times each day is a toilet flushed in your home? _____
8. Is there any other place where a significant amount of water is used in and/or around your home? (Examples: automatic sprinklers, hot tub, pool, etc.)

PERSONAL WATER USE ESTIMATE

Keep this sheet with you for at least one day so that you can mark the proper space with a check for *each* time you use water.

HOW YOU USE IT	NUMBER OF TIMES PER DAY
taking a bath	
taking a shower	
flushing a toilet	
washing face/hands	
getting a drink	
brushing teeth	
washing clothes	
watering outside	
other	

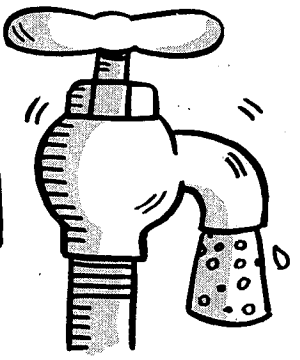
Now you can estimate the amount of water you use by taking the average amounts given below and multiplying each by the number of times you used water for that purpose. The average figures might seem high, but they are based on the assumption that you probably let the water run to get hot or cold. You don't drink ¼ gallon of water each time you have a drink, but you probably use ¼ gallon of water each time.

HOW YOU USE IT	AVERAGE AMOUNTS	X TOTAL NUMBER/DAY =	TOTAL
taking a bath	40 gallons (full tub)		
taking a shower	30 gallons* (water running)		
flushing a toilet	7 gallons**		
washing hands	2 gallons (water running)		
getting a drink	¼ gallon		
brushing teeth	10 gallons (water running)		
washing	40 gallons/load		
watering outside (by hand)	10 gallons/minute		
other	you estimate		

* 12 gallons if the shower has a low-flow head

** 4½ gallons if the toilet has a displacement device

WATER USE COMPARISON



The table below lists the amounts of water you use when you do a number of different household chores and perform several frequent acts of personal hygiene. One column shows the amount of water you will need if you use the regular way of doing these things. The other column shows the amount of water needed if you use the recommended conservation method. Figure out the savings between the two methods for each task and place the number of gallons saved in the far right-hand column headed "savings." Then total the combined savings from all tasks in the "Total" blank at the bottom of the table.

TASK	REGULAR USE	CONSERVATION METHODS	SAVINGS
SHOWER (5 minutes)	Water Running* 30 gallons	Wet & Soap, RinseOff 5 gallons	
TUB BATH	Full Tub 40 gallons	LowLevel 15 gallons	
BRUSH TEETH	Tap Running 10 gallons	Wet Brush, Rinse 1/2 gallon	
WASH HANDS	Tap Running* 2 gallons	Half-fill Bowl 1/2 gallon	
FLUSH TOILET	Regular Tank** 7 gallons	Ultra-low Flush 2 gallons	
WASH DISHES BY HAND	Tap Running* 30 gallons	Wash, Rinse in Dishpan or Sink 5 gallons	
AUTOMATIC DISHWASHER	Full Cycle 15 gallons	Short Cycle 7 gallons	
WASH CLOTHES	Top Water Level 40 gallons	Minimum Water Level 25 gallons	
SHAVING (5 minutes)	Tap Running 20 gallons	Half-fill Bowl 1 gallon	
* 12 gallons if the shower has a low-flow head **4 1/2 gallons if the toilet has a displacement device in the tank		TOTAL	

HOME WATER USE CONCLUSIONS

Now, read over your Personal Water Use Estimate and your Water Use Comparison and draw some conclusions about your own and your family's water use habits.

In comparison with the families of other students, I think my family's water use is (check one):

1. greater_____ 2. less _____ 3. about the same _____

The places where I think it is easiest for me to save water are:

1. _____
2. _____
3. _____

The places where I think it is pretty hard for me to save water are:

1. _____
2. _____
3. _____

I have definitely made up my mind to conserve water regularly in the following three ways:

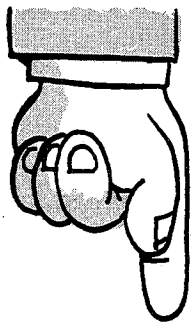
1. _____
2. _____
3. _____

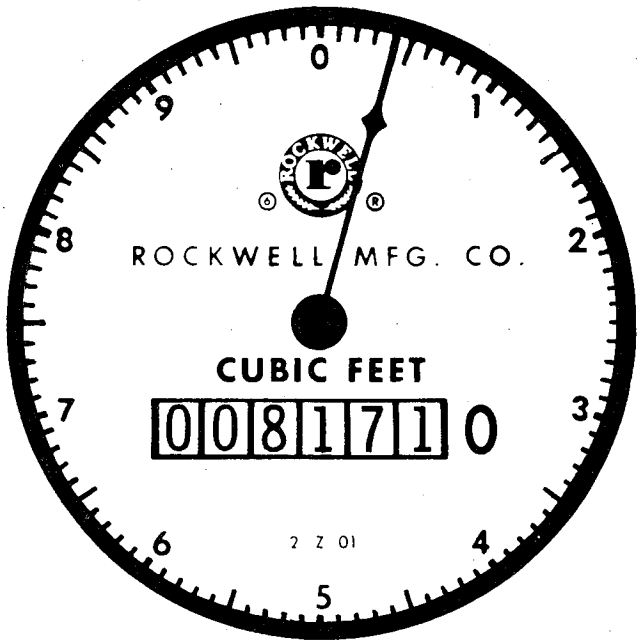
Measuring

Although Captain Hydro has the only Wrist Drip-O-Meter in the world, most houses have water meters. These meters measure all the water used inside and outside the home. That includes even the water used for washing cars and watering outside.

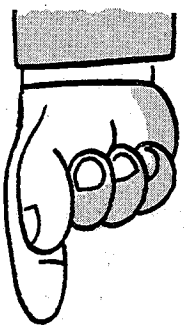
Everyone can learn to read a water meter and find out how much water is being used. Most meters record gallons much like your car records miles, but some show cubic feet of water used. For these meters you must multiply the figure shown by 7.5 to find the number of gallons used.

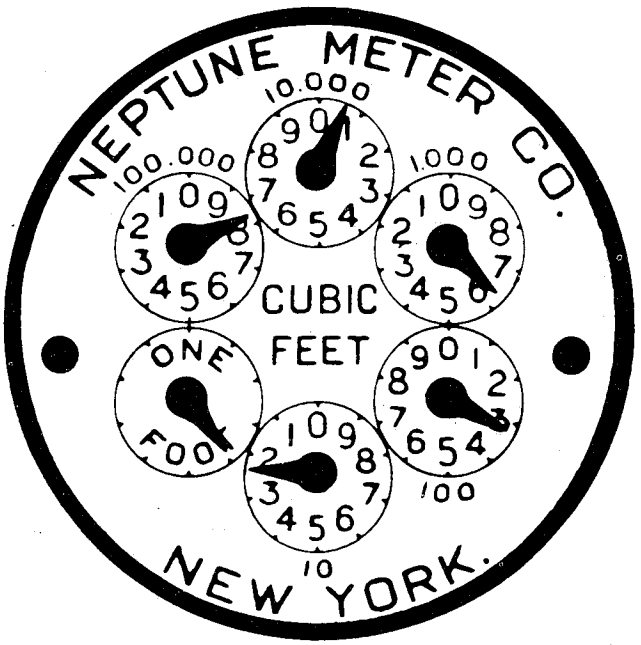
There are two basic types of water meters, the straight-reading meter that looks like this –





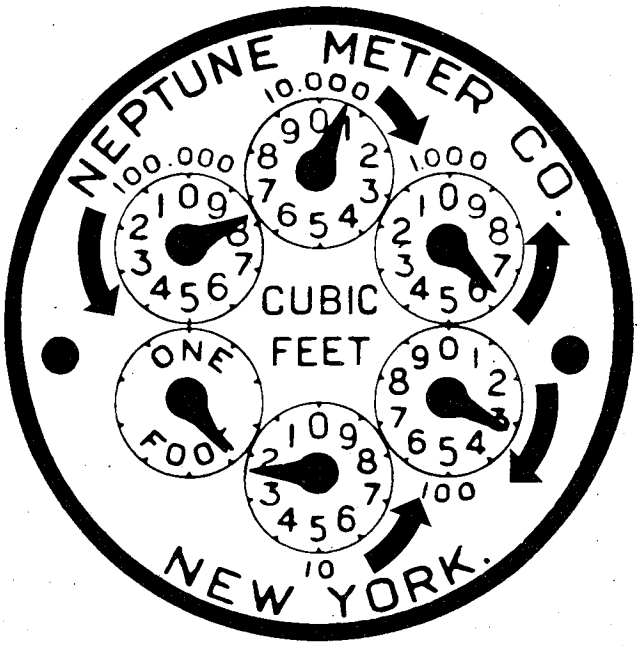
and the round-reading meter that looks like this –





Water Use

Here's how to read a round-reading meter. The meter has several dials which are marked off in units of ten. You read these dials much like a clock except some of the hands on the dials turn the opposite way from a clock (counter-clockwise). To tell which way the hands go, look to see which way the numbers are printed around the face of the dial. Each dial should be read in the direction that the numbers increase.



To check the reading on the meter, begin with the "100,000" dial and read each dial around the meter to the "10" dial. (Don't try to read the "one foot" dial; it just shows you whether or not the meter is working.) If any hand is between two numbers, use the lower number. The dials show 8, 0, 6, 3 and 2 (80,632 cubic feet). The charge for water is based on units of 100 cubic feet; so the meter reader doesn't use the last two numbers (3 and 2). The reader would only record 806: if you used 1200 cubic feet of water by the next reading, the meter reader would record 818 units:

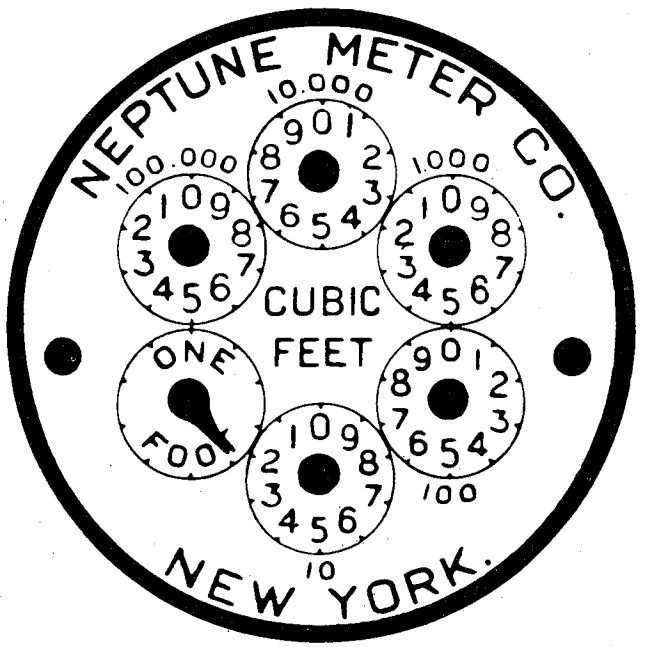
80,632
+ 1,200
81,832 = 818 units

Your bill would be based on the difference in the two readings, or 12 units (1,200 cubic feet or about 9,000 gallons):

Units	Cubic Feet
818 this reading	81,832 this reading
- 806 last reading	- 80,632 last reading
12 units used	1,200 cubic feet

Gallons
1,200 cubic feet
x 7.5 gal per cubic foot
9,000 gallons

Draw the hands on the dials of the meter to show a reading of 32,164 cubic feet.



Reading Your Water Bill

BAY WATER DISTRICT

ACCOUNT No. 0941718 2

THANK YOU FOR KEEPING YOUR WATER USE WITHIN YOUR ALLOTMENT

CURRENT ALLOTMENT 250 GPD 61 DAYS
NEXT ALLOTMENT 250 GPD 61 DAYS NEXT READING 09/12/91

MARVIN PRIMINSKY
NO. 1 HYDRANT LANE
BAY CITY, U.S.A.

FROM	TO	LINE
06/13/91	08/13/91	1

FOR: NO. 1 HYDRANT LANE
PRIVATE RESIDENCE 1

		AMOUNT	TOTAL	
WATER CHARGES				
WATER SERVICE CHARGE		9.60		2
WATER FLOW CHARGE	7 UNITS AT .91	6.37		3
CONSERVATION CREDIT		2.00-		4
TOTAL			14.95	5
WASTEWATER CHARGES				
WASTEWATER TREATMENT CHARGE		11.91		6
TOTAL			11.91	7
BAYLAND SEWER SERVICE			16.90	8
PLEASE SEE REVERSE SIDE FOR BILLING EXPLANATION	PLEASE PAY THIS AMOUNT NOW DUE		43.76	9

METER SIZE	ELEV BAND	METER READINGS CURRENT	PREVIOUS	UNITS	CONSUMPTION INFORMATION GALLONS	DAYS	GAL/DAY	LINE
5/8"	2	560	553	7	5,236	61	85	10
		LAST YEAR		8	5,984	61	98	11

Study the water bill shown above; then answer the following:

1. How many days' water use is this bill for? _____ How often does this water agency send a bill to customers? _____

2. Is this billing period normally a time when water use is high? _____ How do you know? _____

_____

_____

3. One unit for this agency's bills is 748 gallons. How many gallons are there in 7 units? _____ Where do you find this on the bill? _____ What is the average use (in gallons) per day in this house? _____ If there are three people living in the house, how many gallons does each person use per day? _____ Does that show that the family is conserving water? _____ How? _____

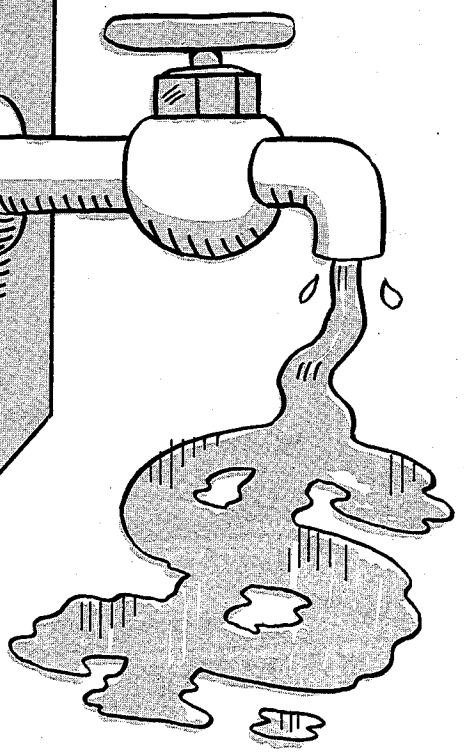
4. Conservation Credit (Line 4) is a discount of $1.00 for using less than 10 units in each of the two months, totaling $2.00. What is **not** shown is the rising scale for charges to provide water service, water flow, wastewater treatment and sewer service. **All** these charges are reduced when water use goes down, since all are tied to the amount of water used. More water used means more pumping, more wastewater, more sewage treatment is necessary. That costs more.

For seven units of water, this company charges $6.37 for water flow and $9.60 for water service. The wastewater treatment charge for 7 units would be $11.91, and the city's sewer service charge would be $16.90. And there would be a flat discount of $2.00 on the total bill for using fewer than 10 units of water.

For twelve units of water, this company charges $12.60 for water flow; $11.10 for water service; $14.10 for wastewater treatment; and $18.72 for the city's sewer service. And there would be no Conservation Credit discount .

On the table below, enter the separate charges for a bill for 7 units of water and a bill for 12 units of water.

CHARGES	7 UNITS	12 UNITS
WATER SERVICE		
WATER FLOW		
WASTEWATER TREATMENT		
CITY SEWER SERVICE		
SUB-TOTALS		
CONSERVATION CREDIT		
NET TOTALS		



AMOUNT SAVED FOR USING LESS WATER: $_____
A unit of water for this company is 748 gallons. How many gallons were saved in the 7-unit month? _____
How much money per unit was saved? $_____

WATER AND INDUSTRY

We know that we use a lot of water in and around our homes. We also know that farmers use lots of water. But water in the United States is used mostly in industry – in factories, mills, foundries, refineries, packing plants and shops, where things are made, put together, processed, packaged and shipped. Altogether, industry in the U.S. now uses about 1,500 gallons a day for every man, woman and child in the country. That's about 350 billion gallons, every day.

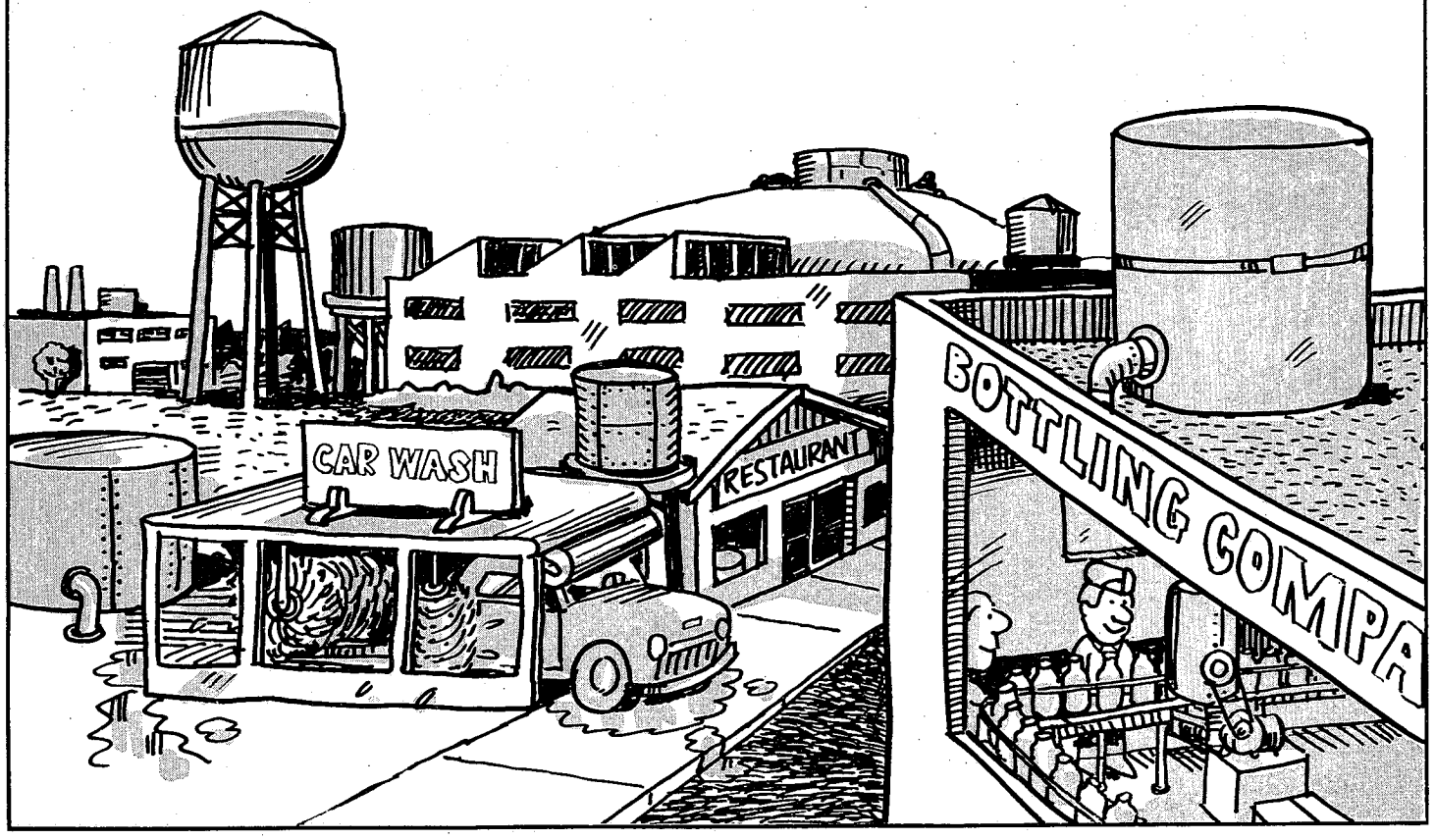
What does industry do with this water? Industry needs water for four specific purposes:

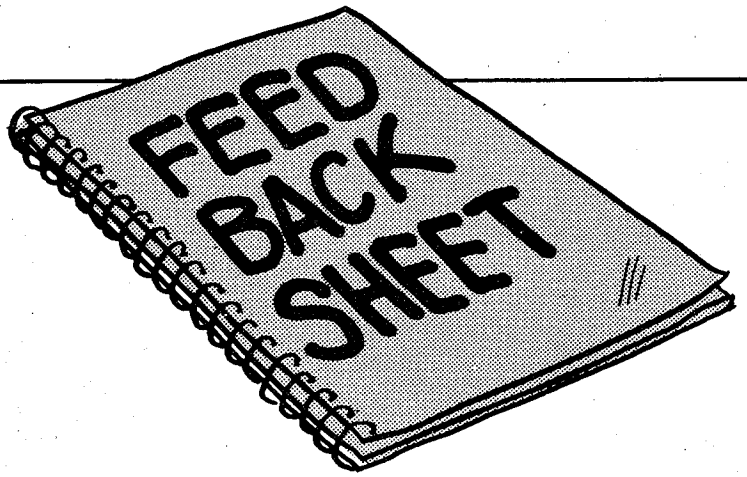
1. For cooling. About 90% of water used by industry is for cooling. This water is not mixed with materials being processed, such as steel, aluminum or plastics. It is needed only to keep machinery, tanks and piping cool while they are being used to make the many products which industry manufactures or assembles. Cooling water does not usually become contaminated and can often be used again.

2. For processing. Process water does come into contact or is mixed with the material or substances being processed. For example, fruits and vegetables are washed when they are sized, cut up and cooked before canning; water may also be used to cook them. This water needs to be treated before it can be used again or re-enter the natural water cycle.

3. For boiler feedwater. Feedwater is water that is used to replace water lost when boilers generate steam in factories. Steam is used to drive engines, heat factories and provide other energy needed in manufacturing.

4. For service water. Service water is water used for drinking, cleaning and sanitary purposes; to wash down equipment and buildings; for personal use in toilets, showers and washbasins; and in cafeterias and drinking fountains.





Use the sentence starters below to give your response to the lesson Water and Industry.

The idea in this lesson that most surprised me was _____

_____

Now I understand _____

_____

I am puzzled about _____

_____

Some of the ways that industry pollutes water are: _____

_____

_____

Some of the ways industry is helping to clean up its wastewater are: _____

_____

_____

Some possible results of the dumping of excessive amounts of industrial waste into water sources are: _____

_____

_____

_____

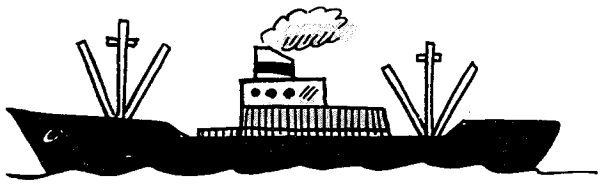
Someday I hope _____

_____

_____

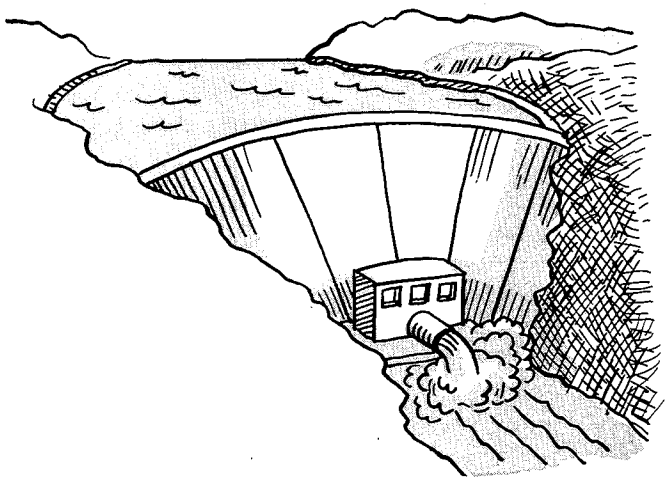
WATER AT WORK

We have already begun to appreciate that without water, all living organisms would die. We also understand that most of our necessities (food, for instance) and conveniences (like automobiles) would be impossible to have without water. What we also need to be aware of is that we need water to move people and goods from place to place, to supplement dwindling energy resources and to make our leisure time more abundant.



Transportation – If you look at the map of any country, it is hard to find any large or important city that is not on or near the water. Civilization began near the water and the growth of societies and nations has always depended on the ease with which water was available to move goods and people or even be moved itself.

Canals today carry more traffic than ever before. The cheapest way to move bulk freight is by water. Germany, France, Belgium and Holland owe much of their booming economies to almost 15,000 miles of barge canals and rivers. United States ports on the Great Lakes handle 70 percent as much cargo as all other U.S. ports together, mainly because the St. Lawrence Seaway allows large ships to travel from the Atlantic to the middle of the country. And great sections of the U.S. and other countries, such as Israel, would have remained deserts had not water been transported by aqueducts and canals from plentiful sources to dry areas.

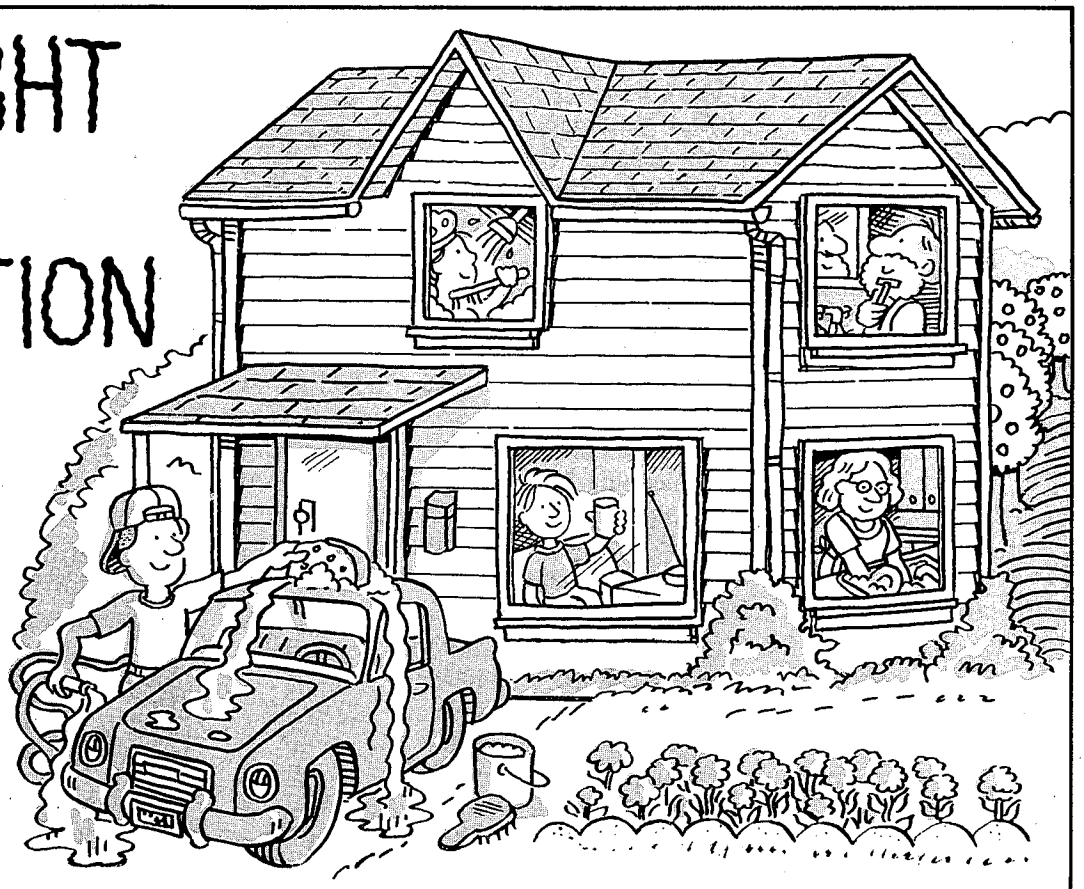


Energy – One-fifth of all the electricity used in the United States comes from water held in dams and almost all of the rest comes from water that is heated for steam generators. Hydroelectric power is created when water falling from the top of a dam turns turbine blades at the bottom; the turbines are connected to generators which whirl electromagnets which in turn produce electric current. Remember, however, that while water saves energy because it generates power in hydroelectric plants, much water is needed to produce other kinds of energy. Nuclear plants use great amounts of water for cooling, for instance.

Hydroelectric power is so important that one major dam is completed every month somewhere in the world. Among the greatest man-made structures are dams. Besides producing electric power, they also serve to store water, improve navigation, control floods and push back bodies of water to provide people with more land. Actually, there is a trade-off when a dam is built on a river. In some cases the best farm land is along river bottoms. This land is lost to farming, and people are moved from their homes. The trade-off comes when other land that was not practicable to farm is now able to be brought under cultivation, and the people who were forced to move end up with newer homes, recreation opportunities, and probably better living conditions. The great dams in Nevada, Washington, California, Arizona and the Tennessee Valley have contributed more to the health and well-being of those states than can be measured.

Recreation – It is hard to evaluate what beaches, lakes and rivers have contributed to the health and enjoyment of people the world over, in terms of providing facilities where rest and relaxation can restore tired and nervous bodies. But it must be considerable. There is practically no one who thinks of a vacation spot which is not blessed with water nearby. The Grand Canyon, Yellowstone Park, the lakes of Wisconsin and Minnesota, Warm Springs, Georgia, Niagara Falls – almost all the great vacation locations in this country and elsewhere are immediately associated with bodies of water. Hunting, fishing, camping and all the other activities we think of when we think of recreation would be all but impossible if there were no water.

DROUGHT DAYS SIMULATION



SITUATION: You are in a family of 5 persons: 2 adults and 3 children – a boy 17, a girl 15, and a boy 12. Your house has two bathrooms, a dishwasher and a washing machine. There is a lawn in front of your house and the yard in back is planted with 4 fruit trees and a variety of flowers and vegetables. Your family has a car which is usually washed every week. Typically, the average per capita (per person) amount of water used each day is 150 gallons.

TASK 1: You have just been notified by your local water supplier that because of the continuing drought, each person will be allowed to use only 100 gallons of water per day. Hold a family conference to decide how you will deal with this situation. Below, list 5 changes you and your family could make in your water use habits to limit your water use to 100 gallons per person. (Use the Water Use Comparison on page 22 as a guide.)

_____

_____

_____

_____

_____

TASK 2: It is now two months later. The water company has notified all customers that because of the severe water shortage, each person will be limited to using only 50 gallons of water per day. Below, list at least 5 additional changes you and your family could make in your water use habits.

_____

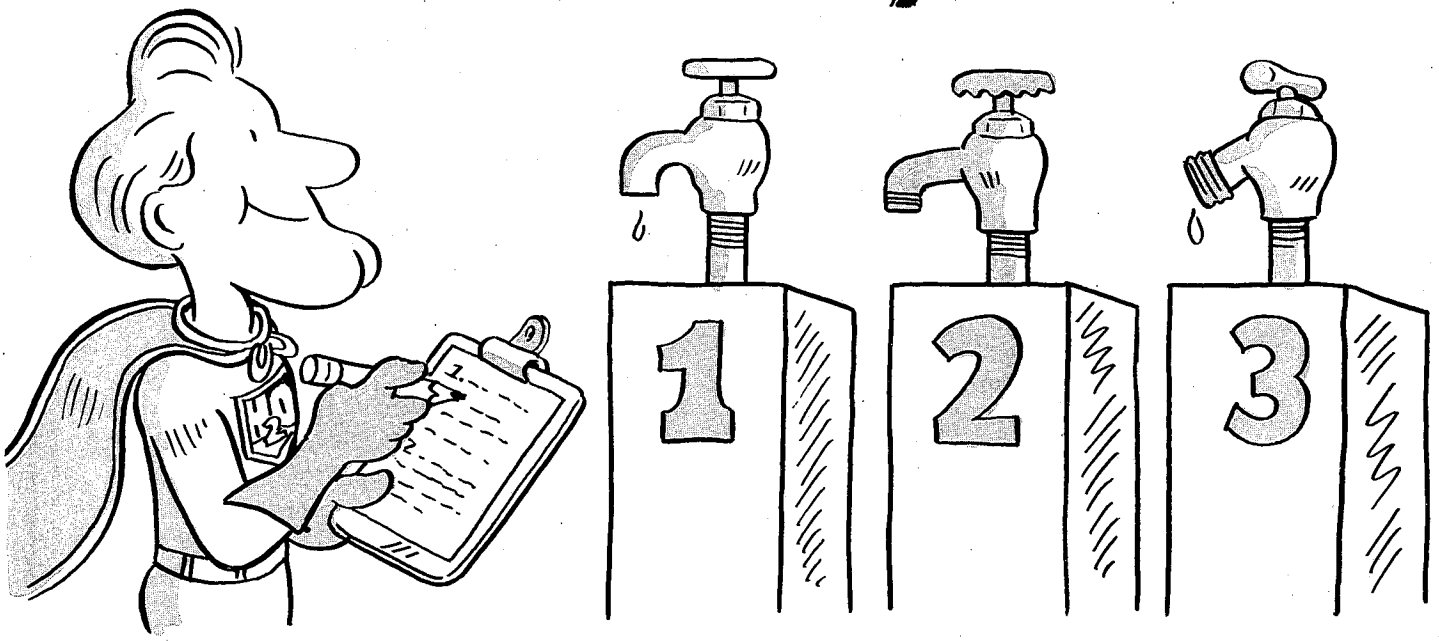
_____

_____

_____

_____

WATER QUALITY/ TESTING



H_2O is pure water. We don't find pure water very often. Most water, including rain water, usually contains many other minerals in addition to the two parts hydrogen and oxygen. When there is a large concentration of calcium and magnesium in water, we call it **hard water**. It is not easy to make suds with soap in water that is hard. Water with a lot of salt in it is also hard. It doesn't suds up well with soap, and has other undesirable features, too. It can seep into groundwater basins or invade river deltas where farmers get their water for irrigation. It then makes farm crops very hard to grow.

Besides salt, other natural chemicals and human-caused pollutants can get into underground and surface water supplies. That is why we have testing laboratories to check the quality of our drinking water. Both state and federal governments have enacted laws to insure safe water. These have been very effective. Most drinking water in the United States is as good or better than the best spring water you can buy in bottles in the grocery store. Even when your drinking water is not 100% H_2O, some foreign substances which may still be in it are there in such microscopic amounts that the chances of health being affected are truly one in a billion! Some tests on water supply samples are performed as often as 380 times per month, and all water providers meet or surpass federal standards for water safety. It is this continuous monitoring and testing that protects the water from the many hazards that can cause it to become polluted or contaminated.

WATER QUALITY SCENARIO

THE PROBLEM

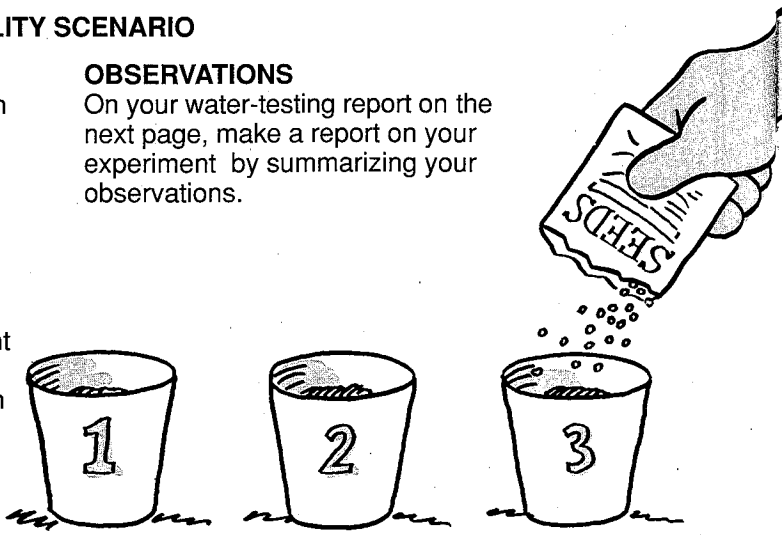
You are a water quality engineer. You have been given 3 water samples gathered by a farmer. The farmer had three places where he could buy water to use on his crops. You are to test the water samples and determine which water would grow plants the best.

THE TEST

Set up 3 containers (growing cups) two-thirds full of soil. Be sure each cup has the same kind of soil. Plant 75 seeds in each cup. Label the cups 1, 2, 3. Water them using the 3 samples of water labeled 1, 2, 3 from the farmer. Be sure the number on the water sample bottle always matches the number on the growing cup. Put 1 tablespoon of water in each cup every other day for 2 weeks.

OBSERVATIONS

On your water-testing report on the next page, make a report on your experiment by summarizing your observations.



Lab Report

1. Which sample grew the most? _____

2. Which sample grew the least? _____

3. Summarize your observations of the appearance of the plants

	END OF WEEK 1	END OF WEEK 2
SAMPLE 1		
SAMPLE 2		
SAMPLE 3		

4. Rate the water from best to worst.

SAMPLE ☐ SAMPLE ☐ SAMPLE ☐

Best ◄----------► Worst

A CHALLENGE

The farmer took his samples from 3 different locations. Which sample do you think goes with these locations?

A) A bay near the ocean _____

B) A stream where it enters the bay which is near the ocean _____

C) The stream 10 miles from where it enters the bay _____

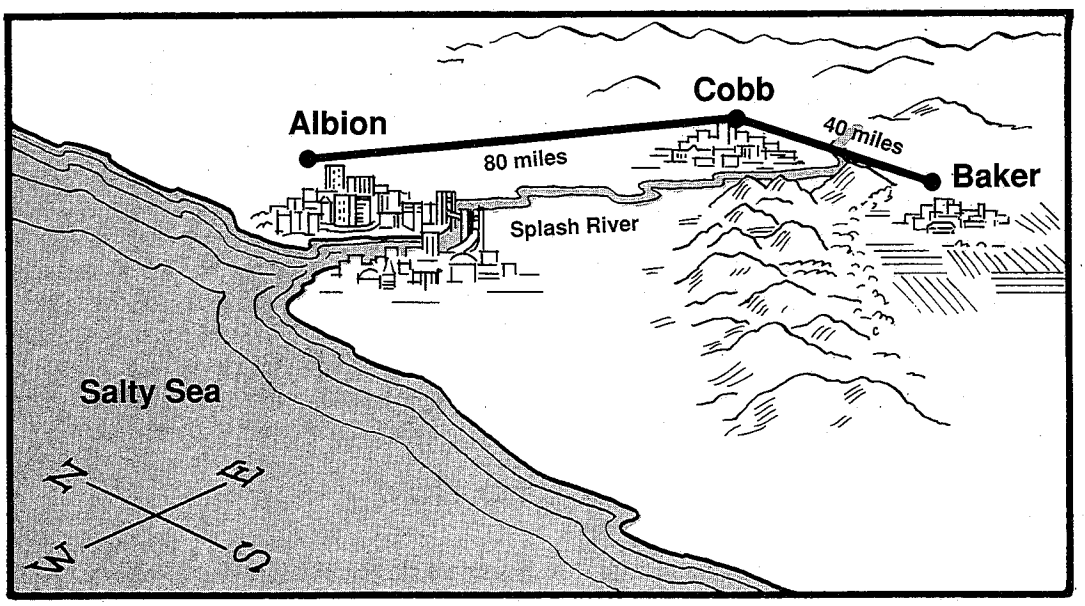
WATER and CITIES

The map below shows three cities which are having different kinds of problems with their water supply. Albion is a big city, a center of banking and international trade. Cobb is a smaller city. It has a lot of industries, with several large lumber, steel and manufacturing companies. Baker is the medium-sized hub of a growing agricultural area in a dry, but fertile, valley. It rains heavily on the west side of the mountains in winter and in the mountain range itself, but very little on the east side.

Both Albion and Cobb get their water from Splash River. Baker gets its water mainly from underground, pumped up through wells. Only Cobb has as much water as it needs.

Albion is the only one of the three cities with a wastewater treatment plant big enough to handle its sewage. Cobb has a sewage treatment plant too small for its needs; when it rains heavily, raw sewage spills into the river. Baker is still on a septic tank system. It collects its sludge, dewaters it and puts it in a landfill. The water that is left is dumped on open land.

Cobb depends on Albion for raw materials shipped by sea to keep its industry going. Both Albion and Cobb depend on the farmers in the valley for food products. Baker depends on Albion and Cobb for goods and services which it does not produce for itself. How can the three cities provide good, clean water for themselves and prevent continuing pollution so that they will all prosper?

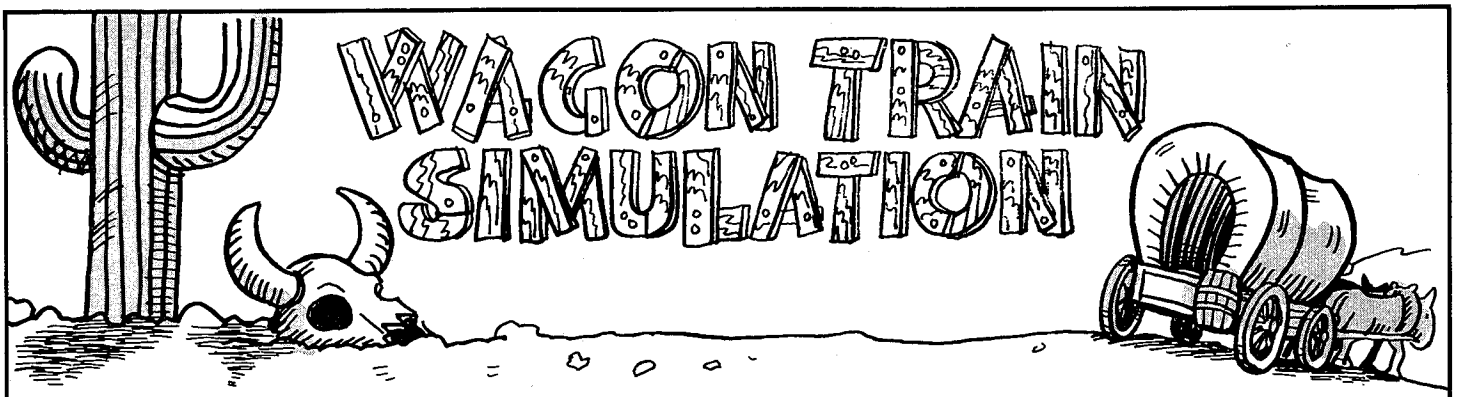


EXERCISE

On a separate sheet of paper, indicate two (2) ideas you think would help to solve each of the following problems for the cities described above:

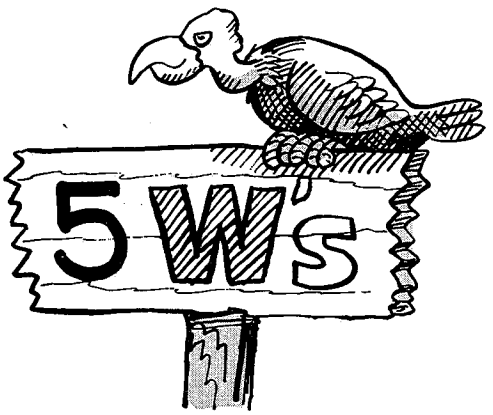
1. Clean up the river between Albion and Cobb
2. Bring more water to Albion
3. Bring more water to Baker
4. Maintain the water supply Cobb now has
5. Encourage all the cities to conserve water

(Be sure to take into consideration such ideas as dams, aqueducts, desalination plants, etc.)



SITUATION: Two weeks ago your wagon train left Ft. Independence and began the trip west toward Prairie Wells. Normally, the wagon train stops there to water the stock and fill the water barrels with fresh well water. Since there has been little rain this spring, most streams have also been dry and water has been scarce. You and the rest of the members of your train have been looking forward to Prairie Wells' water because the last water supply was 2 days back and the next available water supply is 4 days away at Prairie Crossing.

Even though you were all tired when you finally reached Prairie Wells, you went directly to the wells to fill your water barrels and water your stock. But you were shocked to find a group of armed men guarding the wells. These residents of the small community of Prairie Wells informed you and the others that the water level was low and that they needed water for themselves and their own range cattle and crops. With water so scarce the once free water was now going to cost you $10 a barrel. Several people on the train said they could not afford $10 for even 1 barrel, but most people need 4 barrels (2 for themselves and 2 for their stock). Tired and discouraged, you return to your encampment just outside Prairie Wells to decide what to do.

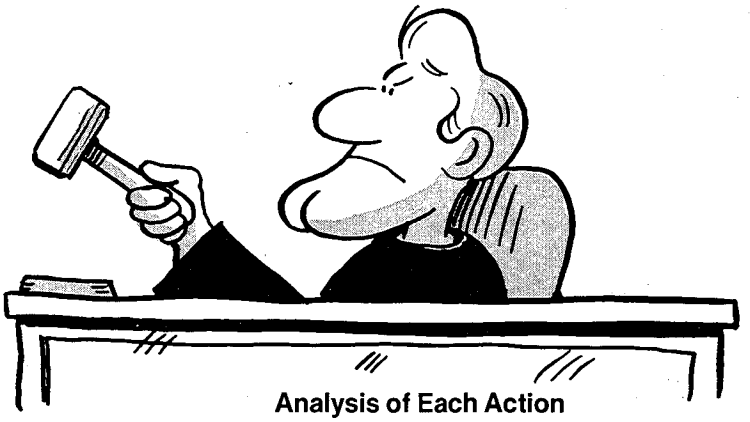


WHO is involved, **WHERE** the action took place, **WHEN** the action took place, **WHAT** the problem is, **WHY** it is a problem)

WHO
WHERE
WHEN
WHAT
WHY

Adapted from PIONEERS

TRAIL DECISION



Possible Actions	Analysis of Each Action
1. Because you need water and because you will not likely find much water between here and Prairie Crossing, you should agree to pay the $10 a barrel. You will share the water with those that cannot afford the $10.	
2. Since you need the water and can afford to pay the $10 per barrel, you want to pay. Those who cannot afford it will have to try to find their own water along the trail.	
3. You should not pay the ridiculously high price for the water. You should plan to move on the first thing in the morning and hope to find enough water along the trail to get you safely to Prairie Crossing.	
4. You want the water but cannot afford to pay $10 a barrel. You and the others should wait until dark, attack the guards and take the water.	
ANOTHER ACTION	
BEST ACTION	

Adapted from PIONEERS

Glossary

Acre foot of water – the amount of water it takes to cover an acre of land to a depth of one foot — about 326,000 gallons. An acre-foot covers an area about the size of a football field.

Aeration – the addition of air to water.

Alum – aluminum sulfate, used to help make impurities "clump up" during water purification.

Aqueduct – an artificial conduit used to transport water, usually a pipeline or canal.

Aquifer – a layer of rock, sand and gravel beneath the surface of the soil that contains water in large amounts.

Arid – dry and barren, like a desert.

Bacteria – microscopic organisms that can cause disease; germs.

Canal – an artificial waterway for transporting water or irrigating farmland.

Chlorine – a gas that is used to disinfect water before use.

Clarifier – a tank where sludge is made to settle in the process of treating wastewater.

Coagulation – clotting or clumping; the process by which dirt or other particles are made to stick together so they can be removed from water.

Condense – to turn from a vapor into a liquid, usually by cooling.

Conduit – pipe or channel to carry water.

Desalination – removing salt from water, especially ocean water.

Dew – moisture which condenses on cool surfaces, especially at night.

Dewatering – removing moisture from sludge in wastewater treatment plants.

Disinfectant – a chemical that destroys harmful microorganisms.

Drought – dryness; a long period of little or no rainfall.

Evaporation – changing a liquid into a gas, usually by heating.

Feedwater – water which is used to feed boilers to generate steam for industrial use.

Filter – a device to remove solids from a mixture.

Filtration – the process of straining out impurities from a liquid.

Floc – flocculation, or clumping, of impurities during the purification of water; the clumps of impurities.

Glacier – a large mass of ice formed on land by the compacting and recompacting of snow.

Grit – sediment taken out of wastewater in sewage treatment; sand, gravel, small rocks, coffee grounds, etc.

Grit chamber – a tank in which grit is allowed to settle so it can be removed from wastewater.

Groundwater recharge – addition of water to an aquifer to replace water taken from it.

Groundwater – water held in underground basins.

Hail – layered balls of frozen water, formed from raindrops bouncing up and down in the atmosphere, alternately freezing, melting and refreezing as they fall.

Hydraulic – operated by the force of moving water or other liquid.

Hydroelectric power – electricity produced when water is forced to turn turbine/generators in a magnetic field.

Hydrologic cycle – the water cycle, the constant movement of water to the atmosphere by evaporation; to the earth again by condensation and precipitation; and to the sky again by evaporation, over and over again.

Ice – water in a solid state.

Iceberg – a large chunk of a glacier near the ocean that breaks off and floats away.

Intake – the place where a pipe or vessel takes in fluids.

Irrigation – controlled watering of the soil to grow crops.

Meter – a measuring device.

Mulch – a covering of bark chips, compost or leaves to retard evaporation.

Organism – any living thing, plant or animal.

Overdraft – taking more water out of the ground than is replaced.

Ozonation – disinfection of drinking water in the final stages of the water purification process.

Ozone – a form of oxygen which is used to disinfect and deodorize drinking water.

Percolation – the flow of water into the soil and then to lower levels of rocks beneath the earth's surface.

Photosynthesis – the making of food by green plants from chemicals in their tissues by exposure to sunlight.

Pipeline – a line of connected pipes that carries water, oil or other liquids.

Precipitation – water falling toward earth in the form of rain, sleet, hail or snow.

Primary treatment – the first stages of cleaning wastewater; disinfection, screening of large solids; settling and disposal of grit; and sedimentation and removal of sludge.

Process water – water that comes into contact with an end-product or material and becomes itself part of the end product, like tomato juice or hair shampoo.

Pumping plant – a station where pumps lift water up and over mountains, hills and other elevated places.

Purification – the process by which one gets rid of impurities in water, especially drinking water.

Reclaim – to treat something, like water, so that it can be re-used.

Recycle – same as **reclaim** above; to restore something so it can be used again.

Refinery – a factory where crude oil is made into gasoline and other products.

Reservoir – a place where water is stored.

Runoff – water that travels downward over the earth's surface due to the force of gravity. Includes water running in streams as well as over land.

Salinity – saltiness; the level of concentration of salt in a liquid.

Secondary treatment – the second stages of cleaning wastewater: aeration; treatment with activated sludge; settling and removal of sludge; disinfection.

Sedimentation – settling of small particles in a liquid.

Septic tanks – underground tanks used to hold domestic wastes when a sewer line is not available to carry them to a treatment plant.

Sewage – used water that cannot be re-used before treatment and cleaning.

Sewage treatment – a process by which wastewater is cleaned for re-use or return to the water cycle.

Sleet – raindrops that freeze while falling through a layer of cold air.

Sludge – solid dirt and grit produced by settling or sedimentation of wastewater.

Snow – frozen crystals formed directly from water vapor.

Soil – sediment formed on the earth's surface by the weathering of rocks and decay of living matter.

Spring – a place where water from an underground basin seeps out onto the earth's surface.

Stream – a river, brook, creek, rill or rivulet.

Toxic – poisonous; a poisonous substance or material.

Transpiration – a process by which living things give off water through pores.

Turbine generator – a piece of equipment with rotary blades which are turned by the force of water or steam to draw off electric current from an electro-magnetic field.

Vapor – the gaseous form of water or any substance that is also liquid or solid.

Wastewater – used water that cannot be returned to the water cycle without being treated; sewage.

Water table – the level of water underground.

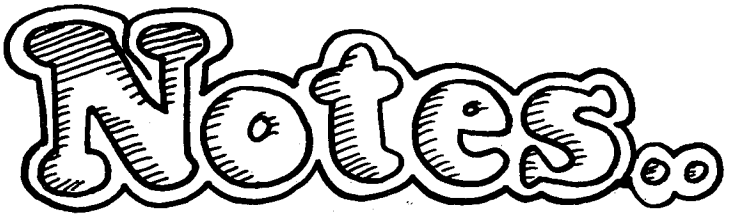
Water cycle – the continuous movement of water from the earth's surface to the atmosphere and back again.

Watercourse – any natural or artificial channel through which water flows.

Watershed – land area that drains rain or snow into a stream, river system, or other large body of water.

Well – a hole drilled into the ground to tap an underground supply of water.

Wetlands – lands under water much of the time, like tide pools or swamps.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