Know Your Water Supply
"The person that solves the water problem deserves two Nobel prizes for their contribution to improved health and food production."

J. F. KENNEDY
First Published 2001

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Water is probably in three distinct states at the given time.

Although it is well known that water has become fairly common, water is a precious commodity.

Water can impinge on the health of Barbados, as a result of its potential to cause illness.

It is for this reason that the Barbados government must be vigilant in its efforts to maintain its water resources.

As you read through this book, you will become more aware of water's importance and how it is used in everyday life.

- appreciate
- play an active role
- share the responsibility of protecting our water resources.
Foreword

Water is probably the most widely distributed substance on the earth. It is found naturally in three distinct forms. These forms are solid, liquid and gas, depending on the temperature at the given time.

Although it is widely distributed, it is not evenly distributed. This results in some countries having a surplus, whilst others have a scarcity of that precious resource. Consequently, we have become familiar with the terms flooding and drought as the weather decides who would be wet or dry. This affects agriculture and some areas of manufacturing. Since water can impact on our lives in different ways, we should strive to learn more about it.

Barbados, as a relatively small country without large catchments of surface water for drinking purposes, must concern itself with the conservation of its water reserves. We must endeavour to eliminate wastage, since our underground supply is not limitless; and must be vigilant to maintain a water supply free from chemical and biological pollutants.

It is for this reason that we have set out to share the information in this book with you to make you more aware of the workings of our water supply, as we move from the old system of simply using fresh water from aquifers, to the more advanced technology of reverse osmosis for desalination of brackish water.

As you read through this book, it is our desire that you:
- become aware of the importance of water to human survival
- appreciate the efforts of the workers of the BWA in maintaining a regular supply
- play an active role in water conservation
- share this information with your neighbours.
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WATER

“OUR FRESH WATER RESOURCES ARE LIMITED”

SOURCE

The source of all of Barbados’ fresh-water resources is rainfall. Some of this water is either trapped above the ground in surface impoundments (surface run off), or infiltrates deep into the coral rock to become groundwater.

AVAILABLE WATER RESOURCES

Water and climate are intimately related. The climate of Barbados, to a large extent, determines the water supply situation, as it controls the rainfall patterns and amounts. Predicted changes in climate could therefore impact on the water supply either by increasing or decreasing it.

The amount of groundwater available for use is dependent on a number of climatic and hydrologic conditions. The temperature, wind speed, the number of sunshine hours, type of ground cover and the amount of storage spaces (voids) in the rock (coral for Barbados) forming the ground.

The smaller the amount of rain that falls, the smaller the amount of water available. Some of

Fig. 1

Coral limestone
the rain that falls is lost through evaporation from the ground, ponds and plant surfaces and some is used up by plants and lost through transpiration (by the plants). Some is also lost through surface run-off, directly into the sea.

The fact that some water goes into the ground does not mean that it automatically becomes groundwater, **until it goes beyond the root zone**, since it could still be taken up by the plants and **lost through transpiration**.

On average in Barbados, 80% of the rain is lost through surface run-off and a combination of evaporation and transpiration (i.e. **Evapotranspiration**). Of the remaining 20%, not all of it can be pumped out of the ground, since some of it attaches itself to the coral particles or is held in isolated spaces within the coral rock and cannot be retrieved.

These percentages will vary according to the conditions of the ground before the rainfall, and from one location to another.

An estimate of the volume of available groundwater can, therefore, be obtained from the following equation.

**Volume of water = 20% of Rainfall(depth) x Area of Barbados**

If it were possible to pump out all of this water, this would be the amount available. It could be pumped out through one well or through a million wells, but it would still be limited to this available amount.

The amount of water in storage varies on a seasonal and yearly basis. The recharge of aquifers in wet years (above average) allows for storage of excess water (carry-over storage) for use in dry years (below average). This may allow for higher withdrawals in **drier years**, depending on the corresponding water budget with variations in **Inflow-Outflow**. For **Maximum Leakage Retention**:

- **Waste water Ret:**
- **Amount Available:**
  \[ R_f \times E - L_s - R_0 + \]
  \[ R_f \times E - L_s - R_0 + \]
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drier years, depending on the storage capacity and characteristics of the aquifer as well as the corresponding levels of abstraction for the period.

Water budgeting and control within a given year should, therefore, take account of these variations in available water. See Figure 2 for a schematic for water budgeting used to determine the available freshwater resources.

**Fig. 2 Simplified Typical Water Balance Equation**

For Maximum Sustainable Use
Inflow-Outflow=Change in Storage=0

\[
\text{Rainfall, } R_F \quad \text{Evapotranspiration, } E_T \\
\text{Leakage Return, } L_R \\
\text{Waste water Return, } W_R \\
\text{Amount Available for Abstraction} \quad R_F - E_T - L_S - R_O + W_R + L_R - A_B = 0 \\
R_F - E_T - L_S - R_O + W_R + L_R = A_B
\]

Losses to the Sea, } L_S \\
Run off, } R_O
Fig. 3 shows the amount of water that can be allocated per person per year in a number of Caribbean islands.

**Fresh Water Estimate**
*Annual per Capita Allocation*

<table>
<thead>
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<th>Countries</th>
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<td>Barbados</td>
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Fig. 4 SIMP
In Barbados th

1. Groundv
   sponge ho quantities
   water or s they may I
Fig. 4  SIMPLIFIED HYDROGEOLOGICAL CROSS SECTION OF BARBADOS

In Barbados the available water occurs in three modes. (See Figure 4)

1. **Groundwater** occurs in tiny spaces between the coral rock particles much like a sponge holds water. The underground areas of the coral rock where substantial quantities of water are found are called **aquifers**. The groundwater occurs as **sheet water** or **stream water**. Both of these terms are Barbadian terms. In other countries they may be called by different names. When it occurs as sheet water, which is close
to the coastline, it occurs as a thin layer of freshwater floating on top of sea water. In the stream water mode (further inland) it may sometimes create, or find and flow through a cave (e.g. Harrison’s, Coles or Bowmanston Caves) as a stream of water, but not at every location. This is how the term “stream water” originated.

2. **Surface run-off** refers to water running over the ground surface.

3. **Spring water** is essentially groundwater which eventually runs out of the ground naturally at points along the surface (interface) at which the bottom of the coral rock meets with the material (oceanic rock) below it. This is seen at the bottom of Hackleton’s Cliff or where the ground-surface level falls below the water table. (e.g. Graeme Hall Swamp)

Normally when a well is being pumped, there is a drop in the water level in and around the well. A well pumping from sheet water at too high a pumping rate may draw sea water into the well. Unfortunately, the sea water level below the sheet water tends to rise approximately forty (40) times faster than the drop in the fresh-water level.

The amount of water that can be pumped out of a given well varies from point to point, according to the character of the coral rock at that particular point and the amount of water held in the rock. This essentially means that to get a “good” well, you have to find the best location to excavate it.

*Note:* **NOT ALL THE WATER THAT GOES INTO THE GROUND/AQUIFER CAN BE SAFELY AND ECONOMICALLY TAKEN OUT.**
Figure 5 shows the contours of the base of the coral constructed from information obtained by drilling 4" diameter exploratory boreholes across the island. These contours are also used to approximate the potential groundwater flow directions.

**Legends**

- Scotland District
- Contours (ft above sea level)
- Catchment Boundary
- Sheet water zone
- Public Supply Well

...
WATER QUALITY

"PROVISION OF A CONTINUOUS SUPPLY OF POTABLE WATER IS ESSENTIAL FOR GOOD HEALTH"

Water quality is defined in terms of the chemical, physical and biological content of water. There is no single measure that constitutes good water quality. Different uses may require different qualities of water; e.g. water suitable for drinking can be used for irrigation; but some water used for irrigation may not be suitable to drink or meet drinking water guidelines. Water becomes unsuitable for a specific purpose when either the chemical, physical or biological constituent levels exceed certain predetermined allowable levels or standards.

Water is a very good solvent (i.e. it will dissolve a lot of material that it comes in contact with) and as a result can be very easily contaminated.

The quality of the water in Barbados has been maintained through a number of factors and measures.

1. **SOIL COVER** is the thin layer of soil on top of the coral rock which supports a number of water purification activities. These are:
   - **filtration** - the removal of suspended sediments.
- **adsorption** - the removal of some of the contaminants dissolved in the water, by attracting them and holding them onto the soil particle surfaces (especially clay and carbon particles).

- **ion exchange** - this occurs when clays, hydroxides, and organic matter in the soil take up some of the contaminants through chemical action.

- **bacterial activity** - the process of bacteria within the soil acting on some of the contaminants dissolved in the water and breaking them down into less harmful constituents.

2. **CORAL ROCK COVER** (with few impurities) will generally support two activities:
   - **filtration** - the removal of suspended sediments.
   - **bacterial activity** (above the water level) - the process whereby bacteria within the soil act on some of the constituents dissolved in the water and break them down into less harmful constituents.

3. **ZONING POLICY**: The island has been sub-divided into five groundwater protection zones: (See Figure 6).

   A very conservative approach was chosen in deciding on the Zone 1 boundaries. However, it should be noted that the required zone boundaries had to be reduced at implementation stage, in a lot of cases, to accommodate pre-existing development structures and physical...
boundaries. Therefore, some of the lands in Zone 2 for example, should actually have been within the theoretical Zone 1 boundaries. Also, recognizing the fact that the basic criteria used in determining the zone boundaries was bacteriological protection, chemicals applied in non Zone 1 areas upstream of the wells within the recharge areas may still get to and contaminate the water.

Just by looking at the number of activities supported by the thin soil cover, it can be observed that we need to seriously protect it, in order to protect our water quality and health.

Barbados Water Authority
Water Protection Zones

Produced By The:
Barbados Water Authority

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   aquifer rech
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   Mining may

   Whereas it ri
   pumps to acc
   capital and c

   This situatio
WATER POLLUTION

In spite of the above factors and measures, the groundwater quality can be adversely affected by human activities, as well as by naturally occurring factors.

1. OVERPUMPING

The most common problems produced by overpumping are:

a. Aquifer Mining

This happens when water abstractions through a specified period of time exceed aquifer recharge for the same period resulting in depletion of groundwater. This is normally evidenced by falling water levels and the drying up of some wells. Mining may also result in impaired water quality.

Whereas it may be possible for some users to deepen their wells and/or change their pumps to accomplish these higher lifts resulting from falling water levels, the resultant capital and operating costs requirements may be too high for other users.

This situation should therefore be avoided wherever feasible.
b. Encroachment on the Water Rights of Others

This is caused when the areas of influence (area from which the well gets its water) of the individual wells interfere with each other by overlapping and producing higher drawdowns. *(See Figure 7).* This can lead to legal disputes as evidenced by the situation with the two private water supply companies at Bowmanston that were subsequently taken over by government to create the Water Works Department. It is also possible that this encroachment can be on the public supply wells as a result of private well pumping and vice-versa.

![Schematic Diagram of impact of overpumping or interfering wells either due to overpumping or wells too close to each other.](image)

*Fig. 7*

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c. Salt-water

In the sheet wa abstractions ce water or upco neighbouring West Coast due

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Saline intrusion example, the u to the build up

Unfortunately, problems asso wells. The pro existing privat
c. Salt-water Intrusion

In the sheet water section of the groundwater system in Barbados, heavy groundwater abstractions can lead to salt water intrusion evidenced by inland movement of the sea water or upconing beneath the pumping well. This intrusion can expand to affect neighbouring wells. (See Figures 8a and 8b). Salinity problems are experienced on the West Coast due to the reduced thickness in the layer of sheet water in that area.

This can only be reversed by either discontinuing pumping and resting the well or by reducing pumping at these wells or other upstream wells whose resultant overflow passes through these well locations.

Saline intrusion can cause the groundwater to become unsuitable for its intended use. For example, the use of saline water for irrigation has been known to create barren lands due to the build up of salts in the soil. Salt water intrusion is therefore a serious problem. Unfortunately, most private abstractors do not have a clear understanding of the potential problems associated with overpumping, nor do they monitor for salinity levels in their wells. The problem may therefore go unnoticed until it is too late. Approximately 60% of existing private water abstraction wells are located in the sheet water zone.
Schematic Diagram of Salt-water Intrusion - Lateral Inland Movement

- Upcoing of freshwater/saltwater interface

- Ground Level
- Original freshwater water level
- Original fresh/salt-water Interface
- New position of fresh/salt water interface
A. Discolouration of Water

Water flowing continuously through a main will deposit some of the suspended sediments it may be carrying at the bottom of the main. Agitation of these sediments due to stop and start actions in the flow will make water quality appear discoloured and unpalatable. This may also occur due to iron in the water or rusting pipes.

B. Chemical Pollution

The groundwater may become polluted due to leachate from septic tanks, landfill sites, illegal dumping in quarries, gullies and on land, inappropriate agricultural practices (excessive application of fertilizers and pesticides) and accidental spills. In addition, naturally occurring sucks or fissures in the coral rock may allow water to pass through the coral rock without any cleansing, much like through a pipe conduit. This water can be conducted straight into the water-table, depending on how well the suck or fissure is developed. Therefore, to maintain the quality of water available to us now, there is a strong need for a well structured water quality monitoring and protection programme. The following programmes are in place at present.

1. Zoning Policy to control/minimize bacteriological contamination;

2. Sampling of source and distribution system waters; (World Health Organization [WHO] Drinking Water Guidelines are used to assess the acceptability of the water quality for drinking purposes.)

3. Disinfection through chlorination.

White, milky or gaseous water is due to water mixing with air. White deposits in kettles and other hot-water systems are due to coral rock dissolved in the water.
QUALITY OF PRESENT WATER SUPPLIES IN BARBADOS

Based on an analysis of water quality monitoring data collected by the Barbados Water Authority’s Environmental Engineering Division and the Water Resources Management & Water Loss Studies, (chemical, bacteriological as well as physical) from the well sources as well as the distribution system, the present water quality meets all the World Health Organization (WHO) Drinking Water Guidelines.

Contamination Due To Land Use Practices

The levels of nitrates in some groundwater units, even though still below the 10 mg/l (milligrams per litre) maximum allowable unit, have been noted to have risen over the years and this will be kept under constant review. The levels of Atrazine noted in the water are also below the United States Environmental Protection Agency (USEPA) maximum allowable limit for drinking water.

A structured long-term National Water Quality Monitoring Programme has been developed and implemented by The Barbados Water Authority in collaboration with the Ministry of Agriculture and Rural Development, Ministry of Health (Environmental Engineering Division) and Coastal Conservation Management Unit. Some aspects of the programme were implemented from January 1998.
WATER SUPPLY AND DISTRIBUTION

BACKGROUND

In the early days, the water supply of Barbados was entirely derived from ponds, springs, private water wells and rainwater tanks, some of which used blocks of coral rock to purify the water by filtration.

However, as the population of Bridgetown grew, the need for a better water supply was recognised. As a result, a joint stock company called Bridgetown Waterworks Company was formed in 1857 and went on to develop Benn Spring at Newcastle, St. John, as their first source of supply for Bridgetown.

In 1886, another joint stock company called Barbados Water Supply Co., was formed with a view to supplying water to the rural parts of the island up the 750 ft above sea level elevation, taking water from Cole’s, Harrison’s and Barker’s caves and from the Edgehill and Plumtree gullies.

As a result of drought problems experienced in 1885, both companies ended up looking in the Bowmanston area to supplement their supplies and conflict ensued, due to their wells interfering with each other, resulting in reduced outputs. To solve this problem and stabilize the water supply situation, the government decided to buy both companies and thereafter formed its own Waterworks Department, in 1895.

The Barbados Water Authority was created through the Barbados Water Authority Act of 1982, to try to improve and expand on the scope of the works and activities undertaken by the Waterworks Department.
HYDROLOGY

The topographic relief of the island consists of a terraced area covered with coral and a more rugged area where the coral cover has been removed by erosion (Scotland District). (See Figure 9)
Also, approximately fifty (50) percent of the land mass lies below the 300ft ground surface contour and so does most of the population.

To compound these topographic features, the hydrology (mode of occurrence of the water) of the island dictates that most of the well sources should be located in the area below the 300 ft. contour, (sheet water area) forcing the BWA to have to pump water from the lower to the higher elevations.

Fig. 9

Fig. 10

Topography Contours
(m)
Physiographic Areas

Legend

1. St. Lucy Plain
2. Below the First High Cliff
3. Below the Second High Cliff
   a. Leeward Coast
   b. Lowand Plateau
   c. Lowands
4. St. George Valley
5. St. Phillip Plain
6. Above Second High Cliff
   a. Upland Plateau
   b. St. John Valley
7. Christ Church Ridge
8. Scotland District
9. Below Cliff Area

Average annual rainfall (mm) 1937 - 1970
SOURCES AND LOCATIONS

At present, BWA utilizes 16 sheet water wells, 5 stream water wells and 2 spring sources. Figure 13 shows the location of the BWA wells, reservoirs and groundwater unit boundaries, as well as sheet water boundaries.

As a result of the above considerations, the island's water supply system has been subdivided into 19 sub-systems, based on ground surface elevations, the locations of the well and spring sources and the top water levels of the reservoirs. The implication of this is that certain sources (wells), trunk mains and reservoirs are by design (carrying capacity, water pressure, route, etc.), meant to be associated with only certain sub-systems. At present, there are 26 reservoirs and tanks in the distribution system with a total capacity of 32.5 MG (Imperial).
The extraction of groundwater has been substantial. The current extraction capacity is 32.5 million cubic meters per year. At present, there is a need to expand the extraction capacity of the well field to meet the demand. Figure 13 shows the distribution of the current and proposed well field expansions.
Figure 14 depicts a system taking water from a well through a large diameter water main and sending it to a reservoir. Between the well and the reservoir, customers are connected to, and take water out of the water main.

A pumping station designed to service a particular area or sub-system, could not be used to adequately supply water to another area, without upgrading the pumping facilities at source and/or in conjunction with re-pumping or transfer stations located at strategic points in the distribution network.

There are twelve (12) re-pumping stations in the distribution system; the majority of these are not meant to transfer water from one sub-system to another, but are intended to boost the pressure within their assigned sub-system.

Also, most of the reservoirs have been designed to “float” on the system. This means that the reservoirs can only receive water when the customers serviced by the water mains leading to these reservoirs are using less water than that being pumped into the system.

Therefore, in a drought situation, in case of excessive usage of water by some users or during peak demand hours, areas mostly serviced by water stored in the reservoirs, will inadvertently suffer from water shortages and outages if little water gets into the reservoirs.
meters are connected

ping facilities at strategic points

majority of these intended to boost

This means that the water mains into the system.

by some users or reservoirs, will into the reservoirs.

Fig. 14
SUMMARY OF SOME CHARACTERISTICS OF THE WATER SUPPLY SYSTEM

Groundwater:

- Requires digging of suitably located wells
- Safe yield of wells confirmed by test pumping
- Pumps are needed to take water out of the well and to push it through distribution mains to user points

Surface Water:

- Presently not in use
- Only available during rainy season
- Needs dams to catch and store it for later use
- Would require treatment before putting into supply
- Pumps are needed to send water to user points

Distribution System:

- Consists of a network of interconnected pipes plus service reservoirs
- Most of the reservoirs only receive water after the demand in the area is satisfied, during off-peak hours of the day.
- Pipe sizes dependent on demand
- Island subdivided into several sub-systems
Note: Existing public water supply system consists of:

- Twenty-one (21) well sources plus 6 boreholes
- Two (2) spring sources
- Twenty-nine (29) reservoirs; twelve (12) re-pumping stations
- Over 2000 miles (in length) of mains
Storage Tank for Desalinated Water

Housing, commercial and industrial developments increased the demand for water, and a study in 1995 and 1996 showed a fairly substan...
Desalination in Barbados

Housing, commercial and industrial development in Barbados over many years have increased the demand for water to the point where there is no more water available from the traditional sources for further development or to provide domestic water for the new houses being constructed. It was therefore necessary to investigate alternative sources of water, and a study into the feasibility of desalination in Barbados was conducted during 1995 and 1996. It concluded that brackish water desalination could be utilized to produce a fairly substantial quantity of additional water for drinking at very reasonable cost.
Brackish water is groundwater found near the coastline. This is fresh water that is mixed with sea water as the sea ebbs and flows into the coastline continuously. Since there is not much salt in this brackish water, it is less expensive to remove salt from this water than from seawater. Consequently, removing the salt from available brackish water would result in additional supplies of potable water for the island.

The island’s first desalination plant has been constructed at Freshwater Bay at Brighton, St. Michael. Water produced at this plant complements the general supply of the BWA.

The process of producing desalinated water involves five steps as listed below.

1. **Water Intake**: the pumping of brackish water from ten eighty foot wells located on the compound into the desalination plant

2. **Pre-treatment**:
   - (a) the process which involves filtration to remove suspended solids from the water.
   - (b) the addition of an antiscalant, which prevents build up of bacteria and mineral deposits in the machinery.

3. **Desalination**: the separation of incoming water into a desalted stream and a concentrated stream. This is done by applying pressure to water as it passes through a semi-permeable membrane. The process is called **reverse osmosis**.

4. **Post-Treatment**:
   - (a) the addition of lime to the water to improve its taste.
   - (b) the addition of sodium hypochlorite that acts as a chlorinating agent.

5. **Distribution**: the pumping of desalinated water to the St. Stephen’s reservoir, where it is distributed in the general supply.
WATER CONSERVATION

- Reducing demand for selected uses/users in order to make water available for other uses/users (unserved populations/new developments).

- Reducing demands on limited resources (results in postponing time to reach resource limits)

- Actions by BWA: (timely repair of burst mains, leak detection, pressure reduction/ control, legislation, public education.)

- Actions by users: (use of efficient plumbing fixtures, changes in water use habits, advocacy based on understanding the issues.)

At present, available alternative sources of water are all more expensive than groundwater.

SEVERAL WAYS CONSUMERS CAN CONSERVE WATER IN AND AROUND THE HOME

- Repair faulty taps. Close taps properly and replace worn washers promptly.
  A tap dripping at the rate of one (1) drip per second is equivalent to about four (4) gallons wasted daily. It can be deduced that many dripping taps will add up to a relatively large quantity of water wasted. Depending on the volume and the pressure of the water, a faulty tap could result in daily losses ranging from 10 to about 2000 gallons.

- Mend broken pipes on premises promptly.
  Daily loss could be from 1000 gallons up.
Report broken pipes off premises promptly to the Authority.
Report the nature of the problem in as detailed a manner as possible. For example, don’t say the leak is causing a flood when it is relatively minor. This detail facilitates prioritising.

Turn the water off while brushing teeth. Use a glass of water for rinsing. Running taps while brushing teeth (assuming twice daily) can result in a daily loss of about six (6) gallons.

Shower rather than bathe in a full bathtub. When showering turn off the tap while soaping body. Running water while soaping can result in a daily loss of about 15 gallons. Also lengthy showers (10 minutes) with an open tap could result in at least 40 gallons daily loss. A three-minute shower at a medium spray should be adequate.

Wash your car with a bucket of water and sponge or chamois instead of a running hose. Using a running hose while washing your car (assuming washing twice weekly) can result in a loss of about 75 gallons weekly.

When collecting water, pay attention. Alternatively, install self-regulating taps. Ignoring a running tap while collecting water could result in a daily loss of 15 gallons or more.

Use a basin or sink rather than a washing machine to wash small items or tiny loads. When handwashing clothes, dishes, fruit and vegetables, never run water continuously. Wash household utensils in bulk. Wash them in a partially filled sink, then rinse them under the tap. Running the tap continuously while performing these chores could result in 100 gallons daily loss.
Reduce water use by 40% to 50% by installing low flush toilets. With existing toilets, water use can be reduced by about 20% by placing, for example, a two-litre plastic bottle filled with water in your toilet tank. This will cause the water level in the tank to rise to the maximum level faster, thereby using less water. Generally, toilets use about 2 to 3 gallons of water per flush.

Install water-saving shower heads and spray nozzles for kitchen and bathroom taps.

Farmers and gardeners should install drip irrigation systems rather than water-guzzling sprinklers. Some growers could create makeshift drip systems using a “stopped-up” hose with tiny holes punctured along its length. Reference should be directed to the Ministry of Agriculture regarding the recommended quantity of water per crop. It should be noted that the policy of the Authority is not to provide potable water for irrigation. Farmers should use private wells.

Wet plants using a watering can instead of a hose. Collect rainwater (for e.g. from roofs) for irrigating gardens etc. Where possible, recycle water used for washing to water plants.

If your yard is dusty do not “wash down” with a hose. Yards should be swept and then sprinkled with a watering can.

Collect cold water which is normally run off to waste from hot water systems.
MISCELLANEOUS

Why is the water from Bowmanston Pumping Station muddy after heavy rains?
The problem is due to sucks or fissures connected to the cave feeding Bowmanston well. No filtration is provided to the muddy runoff going into the sucks. This only occurs with high intensity rainfalls.

Is spring water purer than well water?
No. In some cases it may be worse. e.g. due to the shorter period of time within the coral rock the water may be heavily contaminated with live bacteria.

Can you tell when the water contains too much chlorine?
Yes, but only by taste and smell. You cannot see chlorine in the water.

What causes discoloured/brownish water?
Rust, stagnant water in dead-end mains or deposits at the bottom of a pipe which has been disturbed by opening and shutting off of the water are the main causes of discolouration of water coming through the pipes.

How do pollutants (e.g. chemicals) get into the groundwater?
Rainfall washes down and dissolves some of the pollutants in its way, as it travels along the ground surface, through the soil and the coral rock to reach the groundwater.

Is it possible to remove these pollutants from the water?
Yes. This may require more than one treatment process to remove all. However, the treatment is generally expensive.

What is
This is ground water

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What is
Leak detector
water is for the users

What is
Locating sound of

Is the age
No, but it doesn't affect the pipes factors though

What is
The BW, Studies etc. and deal with
What is the bluish/greenish deposit sometimes seen on plumbing fixtures? This is generally due to the copper in the plumbing fixtures. The bluish deposit, copper sulphate, could come from the hot water system; it is not from the water.

Does boiling of the water eliminate pollution? No, boiling water kills germs, but will not remove chemicals.

Are night-time shutoffs used to allow wells to recover? No, they are intended to force water to go into the reservoirs in order to meet peak demand water requirements.

What is involved in leak detection? Leak detection involves isolating a given water main at night, checking how much water is going through it and comparing this with the amount required to service the users connected to it. Locating the position of the leak is done by using sounding equipment (listening for sound of escaping water during the daytime) or noise correlators.

Is the age of the main the major cause of burst pipes? No, but it is a factor. Some bursts are due to increased traffic load since most of the pipes are laid in the road. Bursts may also occur due to corrosive environmental factors that attack the pipes.

What is BWA doing to correct these water problems? The BWA has carried out the Water Resources Management and Water Loss Studies to assess the existing situation and prepare the plans necessary to implement and deal with the situation.
The other measures taken include:

a  tariff and organisational strengthening study

b  the metering of domestic consumers

c  the implementation of a water conservation programme including the distribution of low-flow shower heads and kitchen tap aerators

d  effecting an intensified leak detection and mains replacement programmes

e  making modifications to the distribution system to increase water transfer capabilities

f  carrying out investigations for locating and excavating wells to optimise groundwater extractions

g  reviewing of the feasibility of treated waste-water reuse

h  the establishment of desalination

i  coordinating public education programmes

♦  **What are our other possible sources of water?**
Other options include brackish water, sea-water, treated waste-water and imported water.

♦  **Why were water outages not experienced on such a large scale during previous dry seasons prior to 1993/94?**
We were not extracting more water than was in the ground, therefore, it was possible to increase pumping during these periods, without adversely affecting the ground.
the groundwater supply.

- **How long does it take for the rain water to reach the groundwater stage?**
  On average, it takes ninety (90) days. Water from rain falling closer to the well will take a shorter time.

- **Is Barbados going to run out of groundwater?**
  No. As long as there is rain, there will always be groundwater. However, if and when demand exceeds the available groundwater resources, other water supply sources would need to be sought to meet demand.

- **What is a drought?**
  A drought is an occurrence when the annual rainfall total falls below the long-term annual average rainfall. This definition, however, is dependent on the use of the water. (e.g. in agriculture a drought occurs when there is less than one inch of rainfall in a given week.) Droughts are natural events that have occurred throughout history. Droughts will have different frequencies or probabilities of occurrence, duration and magnitude. To properly define a drought, all three of the above parameters need to be determined.

- **Why do we have to pay to use water?**
  Even though water is a naturally occurring substance, it has to be managed in order to safeguard it. The quantities available have to be assessed and there are administrative costs attached to these activities. In addition, the water supplies have to be pumped, stored, moved and treated (disinfected in this case) to make it available and safe for use. All of these services cost money.

- **How does the cost of tap water compare with the cost of other drinks?**
  Tap water is inexpensive when compared with other drinks. For example, 1,000 litres of water cost $1.50, while the same amount of pet drink would cost $2,000.00 and bottled water would cost $2,800 or more, depending on the brand name.
What is El Niño and what will be its impact on Barbados?
El Niño refers to the anomalous increase in sea surface temperatures from the coasts of Peru and Ecuador to the Central Pacific. This phenomenon is irregular; but on average occurs once every four years and usually lasts for about eighteen months after its onset.


Based on available data, El Nino’s impact on Barbados cannot be accurately predicted, but it is anticipated that it will result in reduced rainfall below the long-term average.

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5. A guide to Providing a Mwansa, et al
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GLOSSARY OF TERMS

AQUIFER ......................... a natural underground area where water collects

HYDROLOGY .................... anything pertaining to the study of the water cycle

EVAPORATION .................. the changing of water into water vapour by heating

TRANSPARATION .................. the process by which water vapour escapes from leaves into the atmosphere

EVAPOTRANSPIRATION .......... a combination of the process of evaporation and transpiration

GROUNDWATER .................. the water that seeps through the pores in the rock

SHEET WATER ................... the fresh water that collects in an aquifer

POTABLE WATER ................ water that is safe for drinking

BORE HOLES ..................... small vertical holes dug to find water

FILTRATION ....................... the removal of suspended particles from the water

ADSORPTION ...................... the removal of particles by attraction

ION EXCHANGE ................... the exchange of ions between compounds

DRAW-DOWN ....................... the removal of water from a well (by pumping)

UPCONING .......................... the upward movement of salt water into a well
ABSTRACTION .................. the removal of water from an aquifer
OVERPUMPING .................. removal of too much water from a well so as to cause salt water intrusion
AGITATION .................... the shaking of the body of water
DISINFECTION ................. the use of chemicals to kill germs in the water
CHLORINATION ................ the adding of chlorine to water to kill germs
DESALINATION ................. the action of removing salt from the water
BRACKISH WATER ............. groundwater that contains a high level of salt