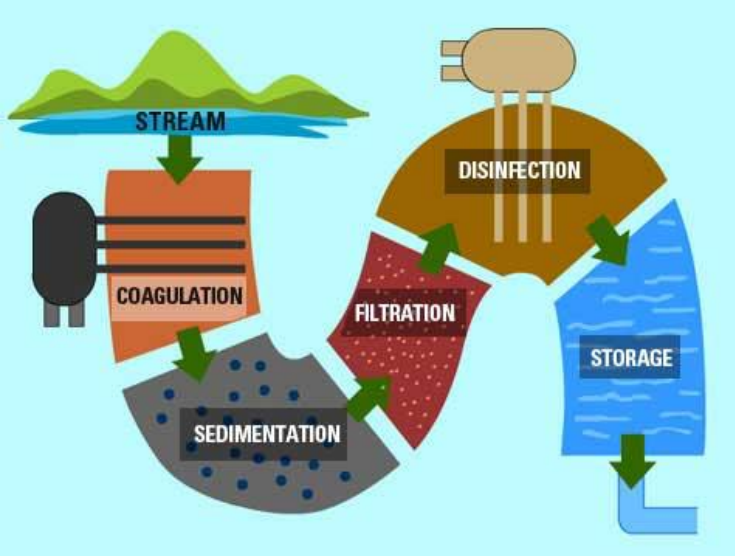


Chapter 5

Water Treatment Concepts

What is Water ?

Water is a transparent, tasteless, odorless, and nearly colorless chemical substance that is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms.

Density	: 1000 kg/m^3
Boiling point	: 100 °C
Freezing Point	: 0 °C
Chemical Formula	: H_2O

Water Sources

In the urban environment Source has the ability to represent a wide variety of water sources such as:

- River extractions
- Groundwater extractions
- Alternative sources such as Storm water Harvesting and Waste Water Treatment
- Desalination
- Decentralized Sources such as rainwater tanks

Drinking Water Standards – World wide

1. WHO Guidelines for Drinking Water Quality
2. European Drinking Water Directive
3. USEPA standard — National Primary Drinking Water Standard. EPA 816-F-02-013 dated July, 2002
4. Indian Standard Drinking Water – Specification (IS:10500-2012)

What is Drinking Water ?
(as per IS:10500-2012)

Definition of Drinking Water as per, IS:10500-2012 ;

Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

Drinking water shall comply with the requirements given in Tables 1 to 4.

Drinking Water - Specification
(as per IS:10500-2012)

Table 1 Organoleptic and Physical Parameters
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, *Max*	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	*p*H value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, *Max*	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, *Max*	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Drinking Water - Specification

(as per IS:10500-2012)

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l

Drinking Water - Specification
(as per IS:10500-2012)

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, *Max*	0.5	No relaxation	Clause **6** of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO_3), mg/l, *Max*	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C_6H_5OH), mg/l, *Max*	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, *Max*	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO_4) mg/l, *Max*	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30

Drinking Water - Specification

(as per IS:10500-2012)

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
xxi)	Sulphide (as H_2S), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, *Max*	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as $CaCO_3$), mg/l, *Max*	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, *Max*	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Drinking Water - Specification

(as per IS:10500-2012)

Table 3 Parameters Concerning Toxic Substances

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Cadmium (as Cd), mg/l, *Max*	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, *Max*	0.001	No relaxation	IS 3025 (Part 48)/ Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, *Max*	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, *Max*	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, *Max*	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, *Max*	0.000 5	No relaxation	ASTM 5175*	— or APHA 6630
ix)	Polynuclear aromatic hydro-carbons (as PAH), mg/l, *Max*	0.000 1	No relaxation	APHA 6440	—
x)	Total arsenic (as As), mg/l, *Max*	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes:				
	a) Bromoform, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	b) Dibromochloromethane, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	c) Bromodichloromethane, mg/l, *Max*	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
	d) Chloroform, mg/l, *Max*	0.2	No relaxation	ASTM D 3973-85* or APHA 6232	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Drinking Water - Specification
(as per IS:10500-2012)

Table 4 Parameters Concerning Radioactive Substances
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 14194	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Radioactive materials:				
a)	Alpha emitters Bq/l, *Max*	0.1	No relaxation	Part 2	—
b)	Beta emitters Bq/l, *Max*	1.0	No relaxation	Part 1	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Drinking Water Quality Standards

(Organoleptic and Physical Parameters)

Colour, Hazen Units		
IS:10500-2012	Acceptable : 5Hz	Permissible : 15Hz
Risk or Effects	Visible tint, acceptance decreases	
Sources	Iron, Copper, Manganese, Natural Deposits	
Treatment	Filtration, Distillation, Reverse osmosis, Ozonisation	

Drinking Water Quality Standards

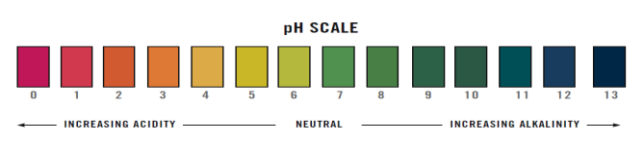
(Organoleptic and Physical Parameters)

Odour	
IS:10500-2012	Water should have agreeable odour
Risk or Effects	Rotten egg, Musty, Chemical
Sources	Chlorine, Hydrogen sulphide, Organic Matter, Septic contamination, Methane
Treatment	Air stripping, Oxidation, Activated carbon, Filtration

Drinking Water Quality Standards

(Organoleptic and Physical Parameters)

pH		
IS:10500-2012	Acceptable : 6.5-8.5	Permissible : No relaxation
Risk or Effects	Low pH : Corrosion, metallic taste High pH : bitter / soda taste	
Sources	Natural	
Treatment	Increase pH by soda ash Decrease pH with white vinegar / citric acid	



Drinking Water Quality Standards

(Organoleptic and Physical Parameters)

Taste	
IS:10500-2012	Agreeable
Risk or Effects	Unappetizing mustiness when you fill a glass with water may be caused by bacterial growth. A salty aftertaste in water could be caused by chloride ions and/or sulphates.
Sources	Natural formation Intrusion of waste, landfills
Treatment	Bad taste is indicator of contamination. Hence test the water and treat accordingly.

Drinking Water Quality Standards

(Organoleptic and Physical Parameters)

Turbidity, NTU (Nephelometric Turbidity Unit)		
IS:10500-2012	Acceptable : 1 NTU	Permissible : 5 NTU
Risk or Effects	Turbidity indicate the presence of high bacteria levels, pathogens, or particles that can shelter harmful organisms.	
Sources	Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky.	
Treatment	Ultra filtration, Reverse Osmosis	

Drinking Water Quality Standards

(Organoleptic and Physical Parameters)

Total Dissolved Solids (TDS)		
IS:10500-2012	Acceptable : 500 mg/l	Permissible : 2000 mg/l
Risk or Effects	Hardness, scaly deposits, sediment, cloudy coloured water, staining, salty or bitter taste, corrosion of pipes & fittings	
Sources	Landfills, nature of soil Hazardous waste landfills Dissolved minerals, iron & manganese Livestock waste, septic system	
Treatment	Reverse Osmosis, Distillation, Deionization	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Total Hardness (as $CaCO_3$)		
IS:10500-2012	Acceptable : 200 mg/l	Permissible : 600 mg/l
Risk or Effects	Scale in utensils and hot water system, soap scums	
Sources	Dissolved calcium & magnesium from soil and aquifer minerals containing limestone or dolomite.	
Treatment	Water Softener Ion Exchange, Reverse Osmosis	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Total Alkalinity (as Calcium Carbonate)		
IS:10500-2012	Acceptable : 200 mg/l	Permissible : 600 mg/l
Risk or Effects	Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the chance for many heavy metals in water are present in pipes, solder or plumbing fixtures.	
Sources	Pipes, landfills Hazardous waste landfills	
Treatment	Neutralizing agent	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Iron, (as Fe)		
IS:10500-2012	Acceptable : 0.3 mg/l	Permissible : No relaxation
Risk or Effects	Brackish colour, rusty sediment, bitter or metallic taste, brown-green stains, iron bacteria, discoloured beverages.	
Sources	Natural deposits Leaching of cast iron pipes in water distribution systems.	
Treatment	Aeration Oxidizing Filters, Green-sand Mechanical Filters	

Drinking Water Quality Standards
(General Parameters Concerning Substances)

Manganese, (as Mn)		
IS:10500-2012	Acceptable : 0.1 mg/l	Permissible : 0.3 mg/l
Risk or Effects	Brownish colour, black stains on laundry and fixtures at 0.2mg/l, bitter taste, altered taste of water mixed beverages.	
Sources	Natural deposits in rock and soil Landfills	
Treatment	Aeration, Oxidizing Filters, Green-sand Mechanical Filters, Chlorination	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Sulphate, (as SO_4)		
IS:10500-2012	Acceptable : 200 mg/l	Permissible : 400 mg/l
Risk or Effects	Bitter, medicinal taste, scaly deposits, corrosion, laxative effects, rotten-egg odour from H_2S gas.	
Sources	Sewage intrusion, septic system By-product of coal mining, industrial waste Natural deposits or salt	
Treatment	Ion Exchange, RO, Distillation	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Nitrate, (as NO_3)		
IS:10500-2012	Acceptable : 45 mg/l	Permissible : No relaxation
Risk or Effects	Methemoglobinemia or blue baby disease in infants	
Sources	Sewage intrusion Manure/fertilizer water intrusion Natural deposits	
Treatment	Ion Exchange, RO, Distillation	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Chloride, (as Cl)		
IS:10500-2012	Acceptable : 250 mg/l	Permissible : 1000 mg/l
Risk or Effects	High blood pressure, salty taste, corroded pipes, fixtures, appliances, blackening and pitting of stainless steel.	
Sources	Industrial wastes intrusion Fertilizer intrusion Minerals, seawater	
Treatment	Activated Carbon, RO, Distillation	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Fluoride, (as F)		
IS:10500-2014	Acceptable : 1.0 mg/l	Permissible : 1.5 mg/l
Risk or Effects	Brownish discoloration of teeth, bone damage	
Sources	Industrial wastes intrusion Minerals from geological formation	
Treatment	Activated Alumina, RO, Distillation, Ion Exchange	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Copper, (as Cu)		
IS:10500-2012	Acceptable : 0.05 mg/l	Permissible : 1.5 mg/l
Risk or Effects	Anaemia, digestive disturbances, liver & kidney damage, gastrointestinal irritations, bitter or metallic taste, Blue-green stains on plumbing fixtures.	
Sources	Leaching from copper water pipes and tubing, algae treatment, Industrial & mining waste, wood preservatives. Natural deposits	
Treatment	RO, Distillation, Ion Exchange.	

Drinking Water Quality Standards

(General Parameters Concerning Substances)

Zinc, (as Zn)		
IS:10500-2012	Acceptable : 5 mg/l	Permissible : 15 mg/l
Risk or Effects	Metallic taste	
Sources	Leaching of galvanized pipes and fittings, paints, dyes. Natural deposits	
Treatment	Water softening, RO, Distillation.	

Drinking Water Quality Standards

(Parameters Concerning Toxic Substances)

Total Arsenic, (as As)		
IS:10500-2012	Acceptable : 0.01 mg/l	Permissible : 0.05 mg/l
Risk or Effects	Weight loss, depression, lack of energy, skin & nervous system toxicity.	
Sources	Intrusion of pesticides Improper waste disposal or product storage of glass or electronics, mining, rocks	
Treatment	Activated Alumina filtration, RO, Distillation, Ion Exchange, Lime softening, chemical precipitation	

Drinking Water Quality Standards

(Parameters Concerning Toxic Substances)

Total Chromium, (as Cr)		
IS:10500-2012	Acceptable : 0.05 mg/l	Permissible : No relaxation
Risk or Effects	Skin irritation, skin & nasal ulcers, lung tumours, gastrointestinal effects, damage to the nervous system and circulatory system, accumulated in the spleen, bones, kidney and liver	
Sources	Industrial discharges, mining sites, septic system Geological formation	
Treatment	RO, Distillation, Ion Exchange.	

Drinking Water Quality Standards

(Parameters Concerning Toxic Substances)

Cyanide (as CN)		
IS:10500-2012	Acceptable : 0.05 mg/l	Permissible : No relaxation
Risk or Effects	Thyroid, nervous system damage	
Sources	Fertilizer Electronics, steel, plastics, mining	
Treatment	RO, Ion Exchange, chlorination	

Drinking Water Quality Standards

(Parameters Concerning Toxic Substances)

Lead, (as Pb)		
IS:10500-2012	Acceptable : 0.01 mg/l	Permissible : No relaxation
Risk or Effects	Reduces mental capacity (mental retardation), interference with kidney and neurological functions, hearing loss, blood disorders, hypertension, death at high levels	
Sources	Paint, diesel fuel combustion Pipes and solder, discarded batteries, paint, leaded gasoline, Natural deposits.	
Treatment	RO, Ion Exchange, Activated Carbon, Distillation	

Drinking Water Quality Standards

(Parameters Concerning Toxic Substances)

Mercury, (as Hg)		
IS:10500-2012	Acceptable : 0.001 mg/l	Permissible : No relaxation
Risk or Effects	Loss of vision and hearing, intellectual deterioration, kidney and nervous system disorders, death at high levels.	
Sources	Fungicides Batteries, Mining, electrical equipment, paints, paper and vinyl chloride. Natural deposits	
Treatment	RO, Distillation.	

Drinking Water Quality Standards

(Pesticide Residual Limits & Test Methods)

Endosulfan (alpha, beta, and sulphate)		
IS:10500-2012 (USEPA)	Limit : 0.4 micro-gram / l	No relaxation
Risk or Effects	Exposed to high levels of endosulfan, in contaminated water or food, suffered tremors and seizures and some died.	
Sources	Contaminate during spraying fields which enter water course.	
Treatment	Adsorption. If still persist need to abandon the water.	

Drinking Water Quality Standards
(Bacteriological Quality)

Total Coliform Bacteria or E.coli	
IS:10500-2012	Shall not be detectable in any 100 ml sample.
Risk or Effects	Gastrointestinal illness
Sources	Livestock facilities, septic system, manure lagoons Household wastewater Naturally occurring
Treatment	Chlorination, UV, Distillation, Iodination

Water Treatment Process

The basic types of water treatment shall depend on the quality of water from the Source

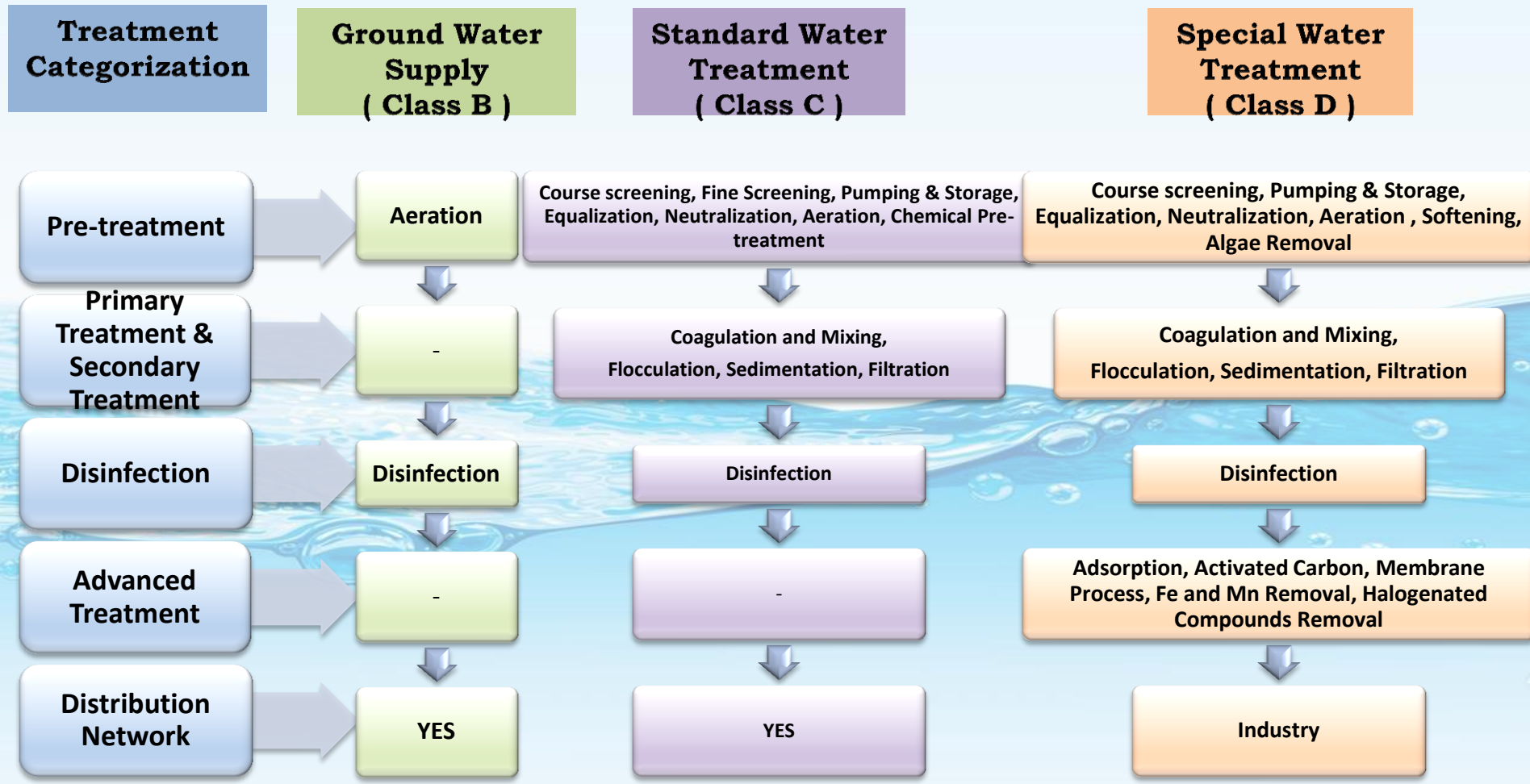
- **Class A-** No Treatment
- **Class B-** Only Disinfection
- **Class C-** Standard Water treatment
- **Class D-** Special water Treatment

Water Treatment Categorization

The categorization of water treatment shall depend on the source of water is as follows ;

- **Pre-Treatment :** Course Screening, Fine Screening, Equalization, Neutralization, Aeration, Chemical pre-treatment
- **Primary Treatment :** Coagulation & Mixing, Flocculation, Sedimentation
- **Secondary Treatment :** Filtration
- **Disinfection**
- **Advanced Treatment :** Adsorption, Iron & Magnesium removal, Fluoridation

Water Treatment Categorization



Selection of Treatment Process

Pollutants	Treatment Process
Floating Matter	Coarse screens, Fine Screens
Suspended Matter	Micro screens
Algae	Micro screens, Pre-Chlorination, Carbon, Adsorption, Rapid Filtration
Turbidity	Coagulation, Sedimentation, Post chlorination
Color	Flocculation, Coagulation, Filtration
Taste & Color	Activated Carbon
Hardness	Coagulation, Filtration, lime softening
Iron & Manganese	> 1mg/lit : Pre Chlorination < 1mg/lit : Aeration, Coagulation, Filtration
Pathogens	> 20 : Post Chlorination 20 to 100 : Coagulation, Filtration, Chlorination >100 : Pre-Chlorination, Coagulation, Filtration, Post Chlorination
Free Ammonia	Post-Chlorination, Adsorption

Water Treatment Processes

Clean, safe water is vital for every day life. Water is essential for health, hygiene and the productivity of our community.

The water treatment process may vary slightly at different locations, depending on the technology of the plant and the water it needs to process, but the basic principles are largely the same. This section describes standard water treatment processes.

Coagulation / Flocculation

During coagulation, liquid aluminium sulfate (alum) and/or polymer is added to untreated (raw) water. When mixed with the water, this causes the tiny particles of dirt in the water to stick together or coagulate. Next, groups of dirt particles stick together to form larger, heavier particles called flocs which are easier to remove by settling or filtration.

Sedimentation

As the water and the floc particles progress through the treatment process, they move into sedimentation basins where the water moves slowly, causing the heavy floc particles to settle to the bottom. Floc which collects on the bottom of the basin is called sludge, and is piped to drying lagoons. In Direct Filtration, the sedimentation step is not included, and the floc is removed by filtration only.

Filtration

Water flows through a filter designed to remove particles in the water. The filters are made of layers of sand and gravel, and in some cases, crushed anthracite. Filtration collects the suspended impurities in water and enhances the effectiveness of disinfection. The filters are routinely cleaned by backwashing.

Iron and manganese removal

In groundwater, iron is usually present as dissolved ferrous compounds.

To remove iron in this form, it is necessary to oxidise ferrous iron, usually by aeration, to the insoluble ferric hydroxide and to remove the precipitated material in a subsequent filtration stage.

It is important to ensure that oxidation does not give rise to colloidal species which may pass through the filters.

Fluoridation

Water fluoridation is the treatment of community water supplies for the purpose of adjusting the concentration of the free fluoride ion to the optimum level sufficient to reduce dental caries.

The typical concentration of fluoride in drinking water supplied by Hunter Water is one milligram per litre.

Disinfection

Water is disinfected before it enters the distribution system to ensure that any disease-causing bacteria, viruses, and parasites are destroyed.

Chlorine is used because it is a very effective disinfectant, and residual concentrations can be maintained to guard against possible biological contamination in the water distribution system.

The concentration of chlorine in drinking water supplied with ranges from 0 to about 1.5 mg/L.

pH Correction

Lime is added to the filtered water to adjust the pH and stabilize the naturally soft water in order to minimize corrosion in the distribution system, and within customers' plumbing.

To control corrosion in water distribution networks the methods most commonly applied are adjusting pH, increasing the alkalinity and/or hardness, or adding corrosion inhibitors such as sodium polyphosphates or silicates and orthophosphate.

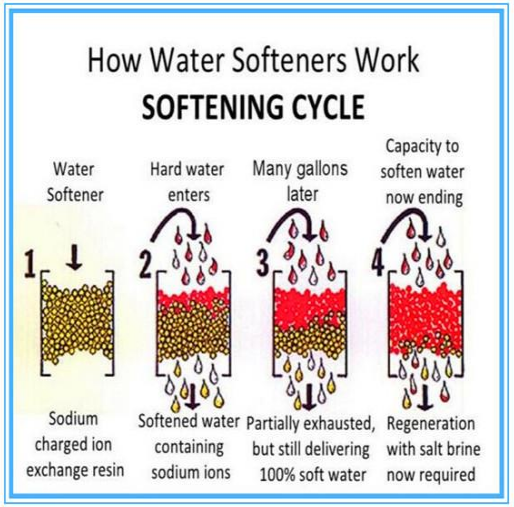
Ion-exchange softeners

Although not a necessary treatment to provide safe drinking water, it is sometimes beneficial to remove calcium and magnesium in order to prevent scaling and encrustation with limescale from very hard waters.

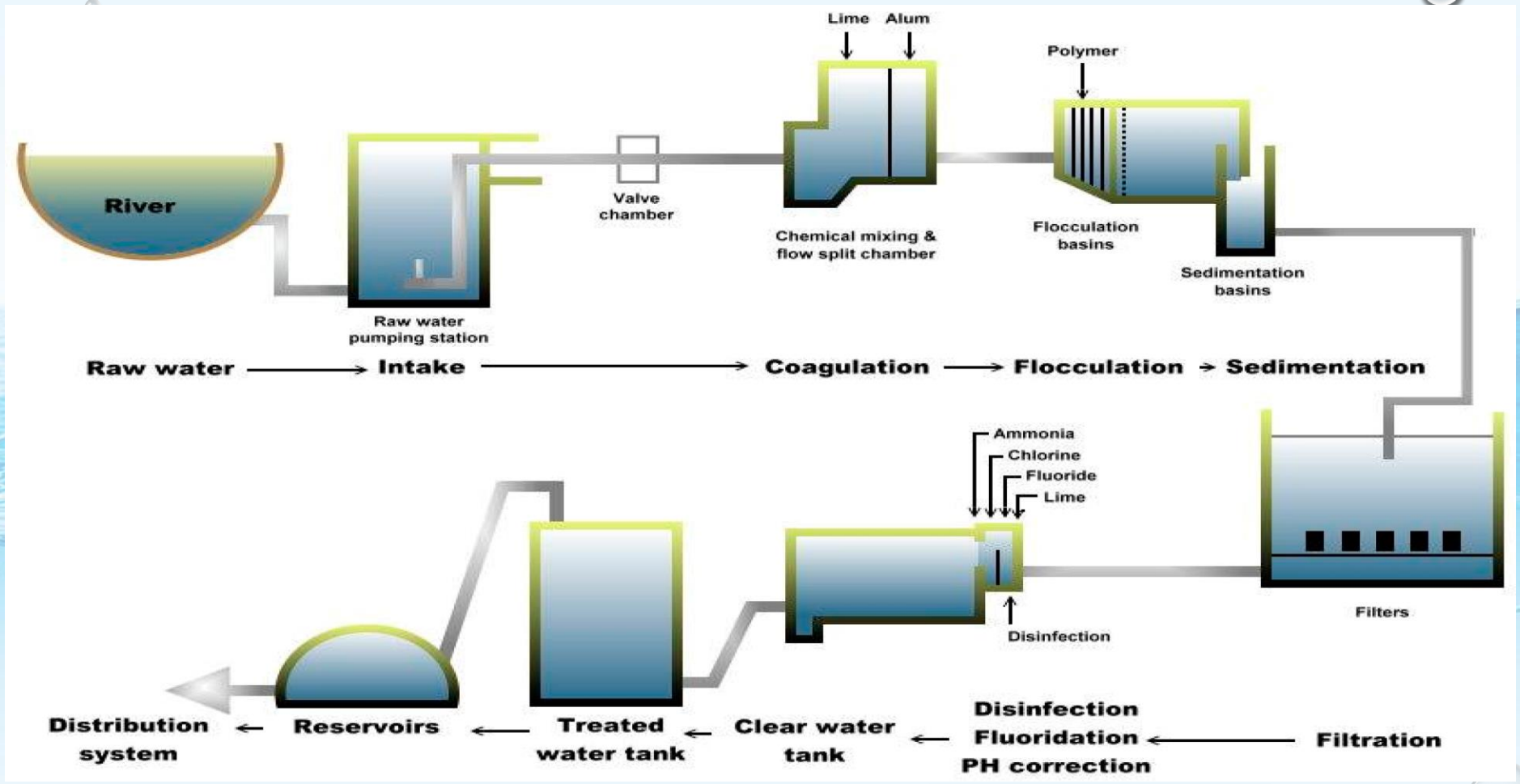
Softening is achieved by cation exchange, whereby water is passed through a bed of cationic resin and the calcium ions and magnesium ions in the water are replaced by sodium ions.

Ranges of hardness, usually expressed in units of milligrams per litre (mg/L) of equivalent Calcium Carbonate ($CaCO_3$) are rated by the National Health and Medical Research Council (NHMRC) Australian Drinking Water Quality Guidelines as follows:

<60 mg/L	Soft but possibly corrosive
60-200 mg/L	Good quality
200-500 mg/L	Increasing scaling problems
>500 mg/L	Severe scaling

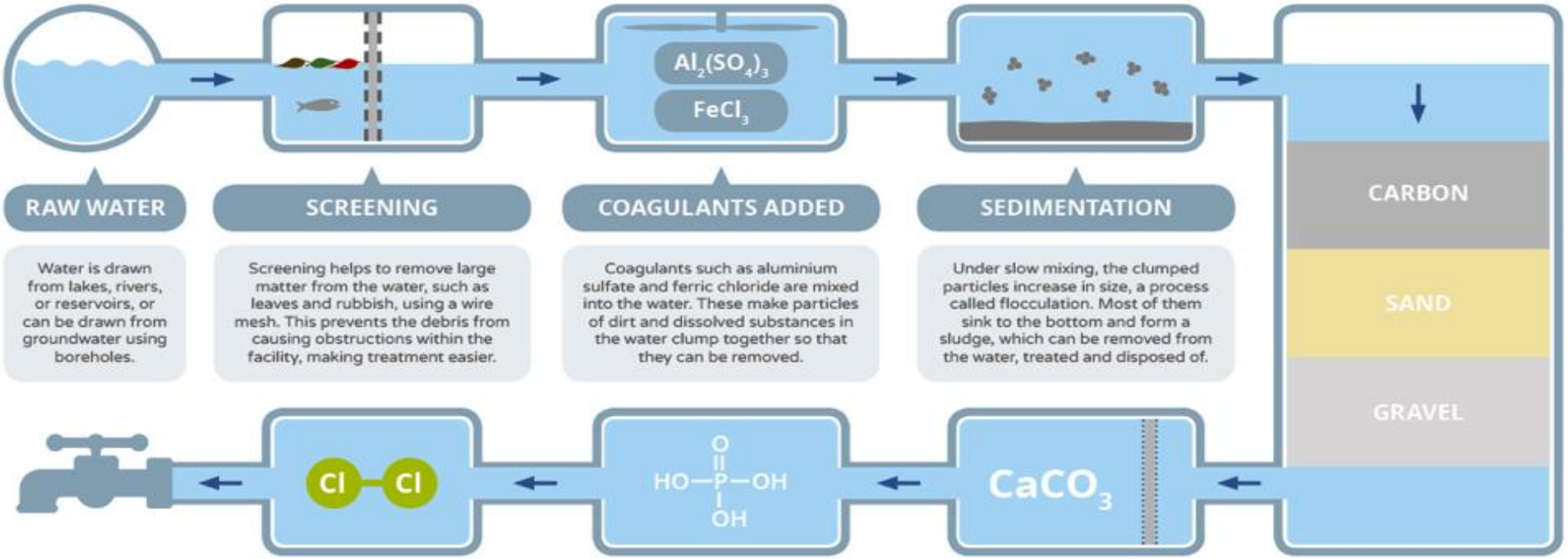


Water Treatment Process : River Water



Water Treatment – Reservoir to Home

We take the water coming from our taps for granted – but what happens to it before it gets there? Here's how chemistry helps!



RAW WATER

Water is drawn from lakes, rivers, or reservoirs, or can be drawn from groundwater using boreholes.

SCREENING

Screening helps to remove large matter from the water, such as leaves and rubbish, using a wire mesh. This prevents the debris from causing obstructions within the facility, making treatment easier.

COAGULANTS ADDED

Coagulants such as aluminium sulfate and ferric chloride are mixed into the water. These make particles of dirt and dissolved substances in the water clump together so that they can be removed.

SEDIMENTATION

Under slow mixing, the clumped particles increase in size, a process called flocculation. Most of them sink to the bottom and form a sludge, which can be removed from the water, treated and disposed of.

FILTRATION

Some particles remain in the water after sedimentation; these are removed by filtration through coal, sand, and gravel beds. They are cleaned by pumping air and water backwards through them.

pH CORRECTION

Water that is too acidic can lead to water pipe corrosion. It can be passed through a filter containing crushed limestone (mainly calcium carbonate) to raise pH. Acids can be added if the pH is too high.

ANTI-CORROSION AGENTS

Agents such as orthophosphates can be added to the water, particularly in areas with lead pipes. These agents form lead-phosphate complexes on the inside of the pipes, stopping lead getting into the water.

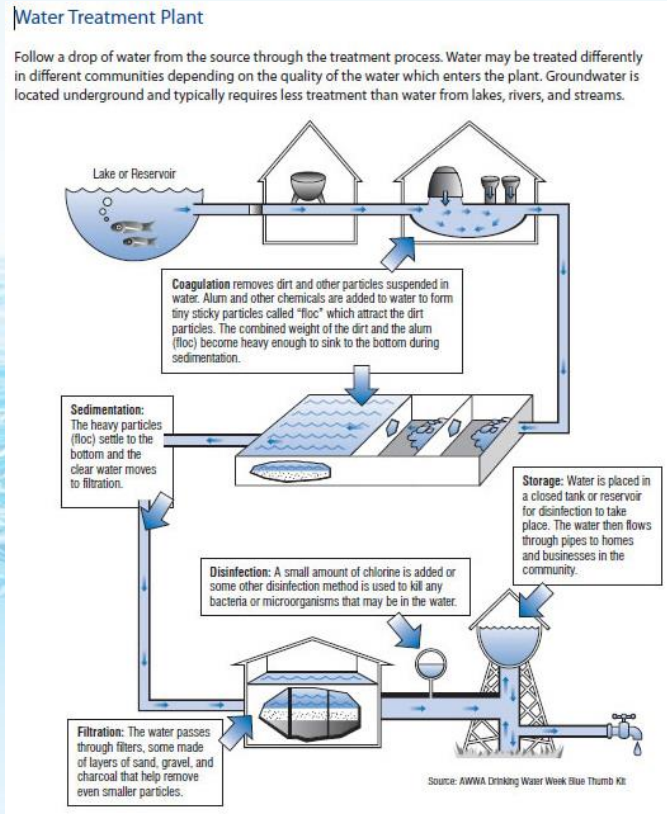
CHLORINATION

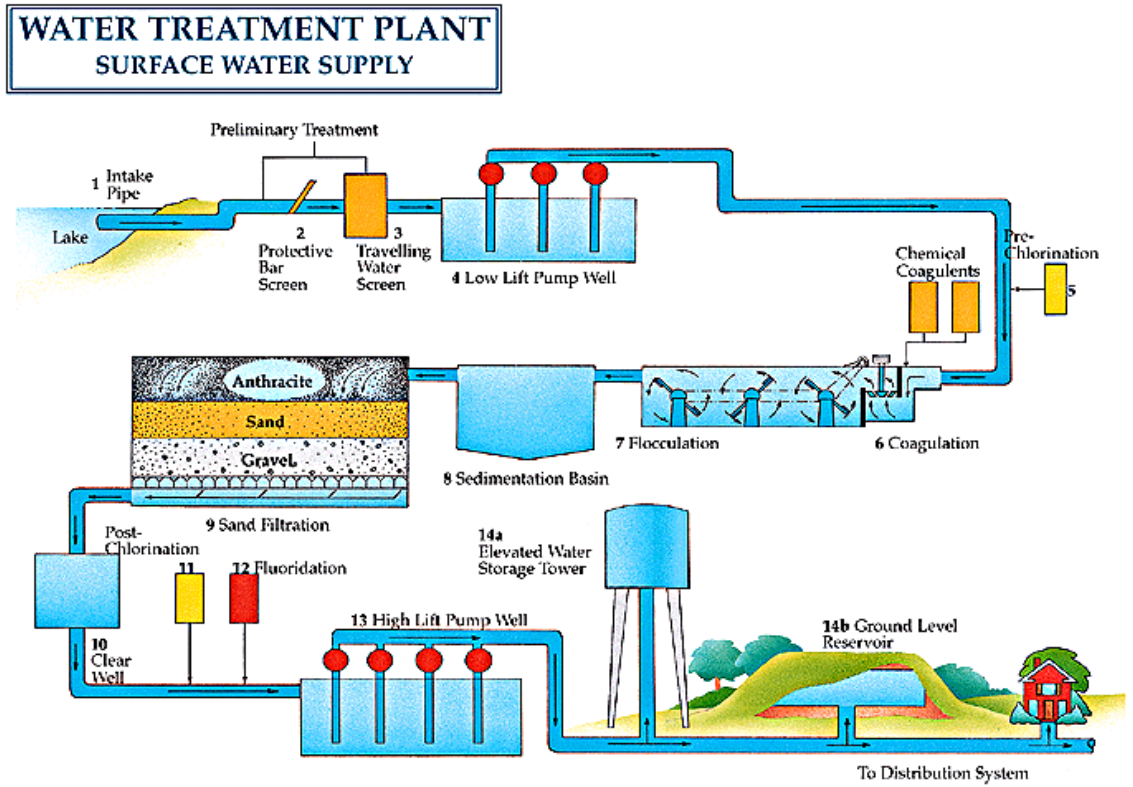
Chlorine is added to water to kill bacteria and viruses, preventing water-borne diseases like cholera and typhoid. Ozone can be used instead of chlorine, and avoids disinfection byproducts.

TO HOMES

Residual chlorine in the water safeguards against pathogens. Fluoride can be added after chlorination to help to prevent tooth decay.

Water Treatment Process : Lake Water





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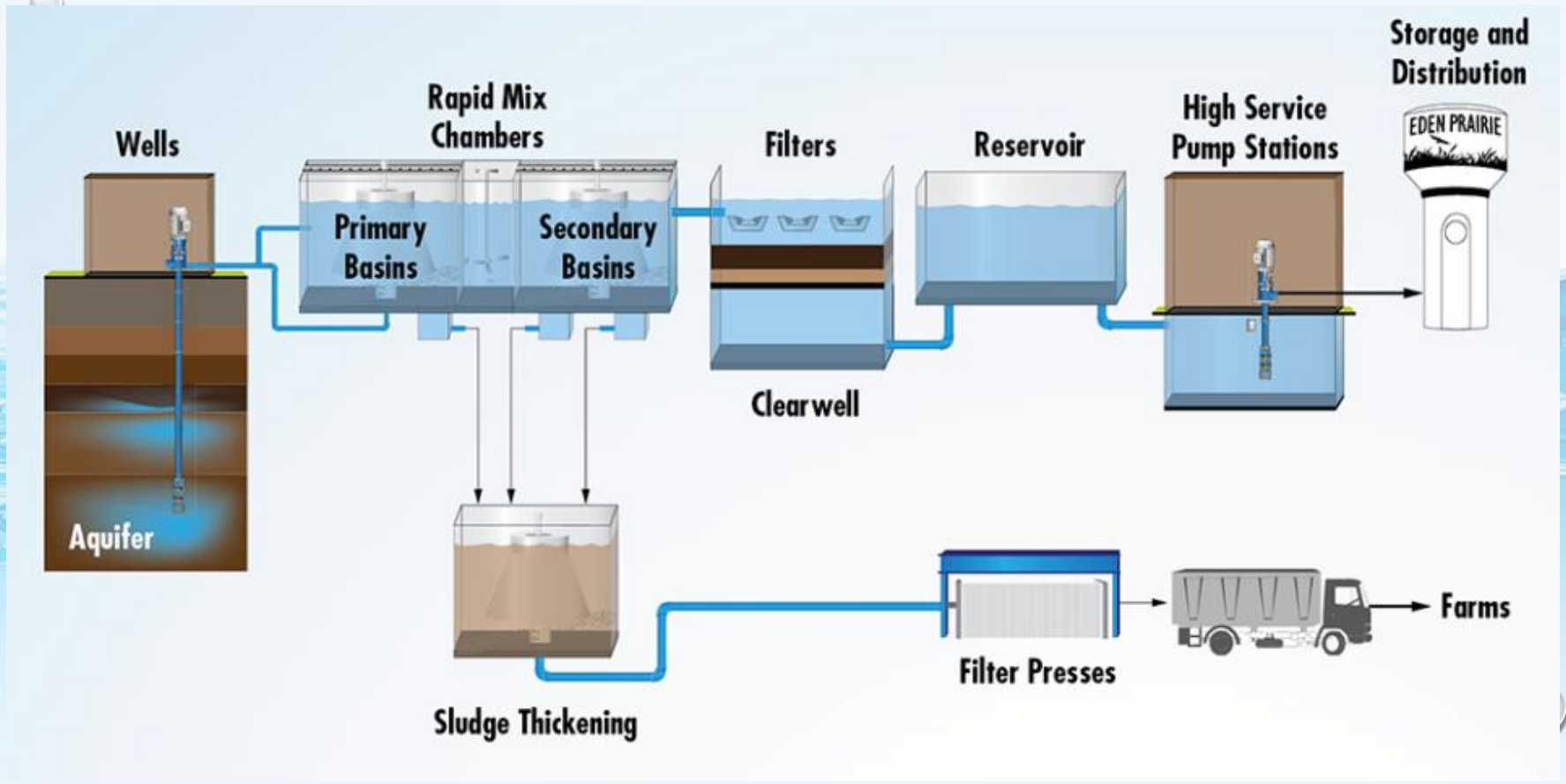
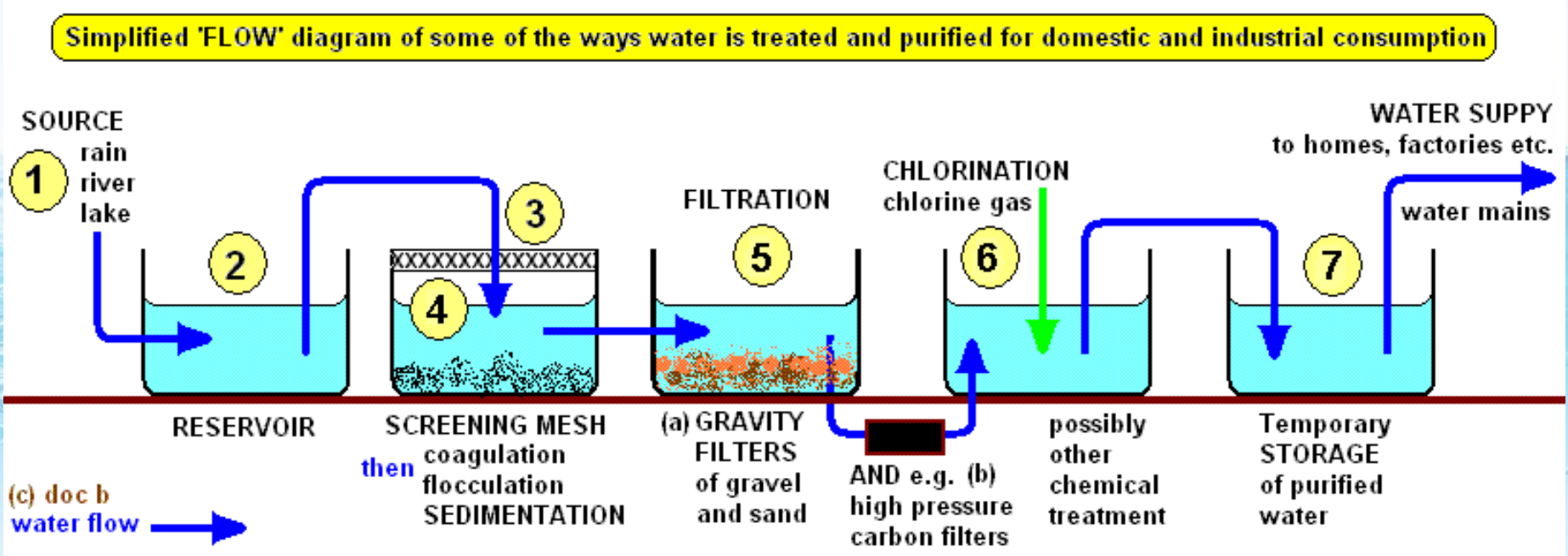
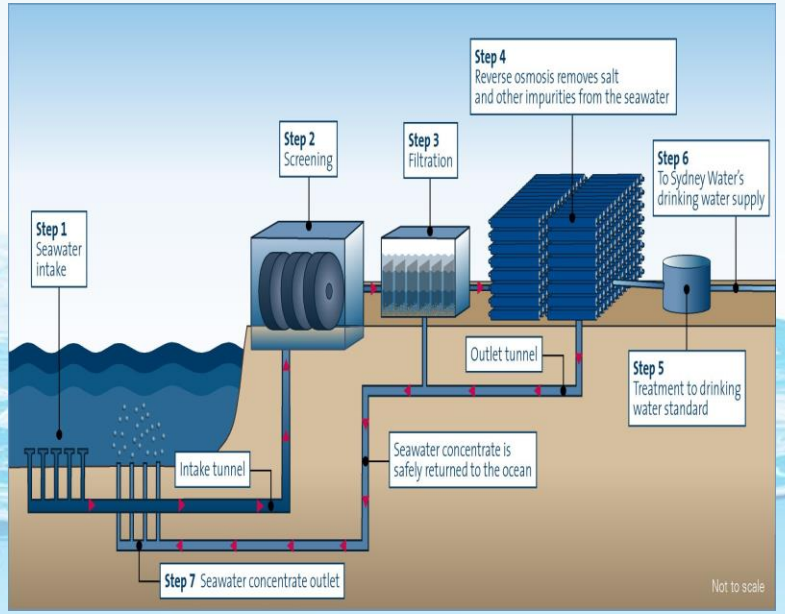
Water Treatment Process : Wells

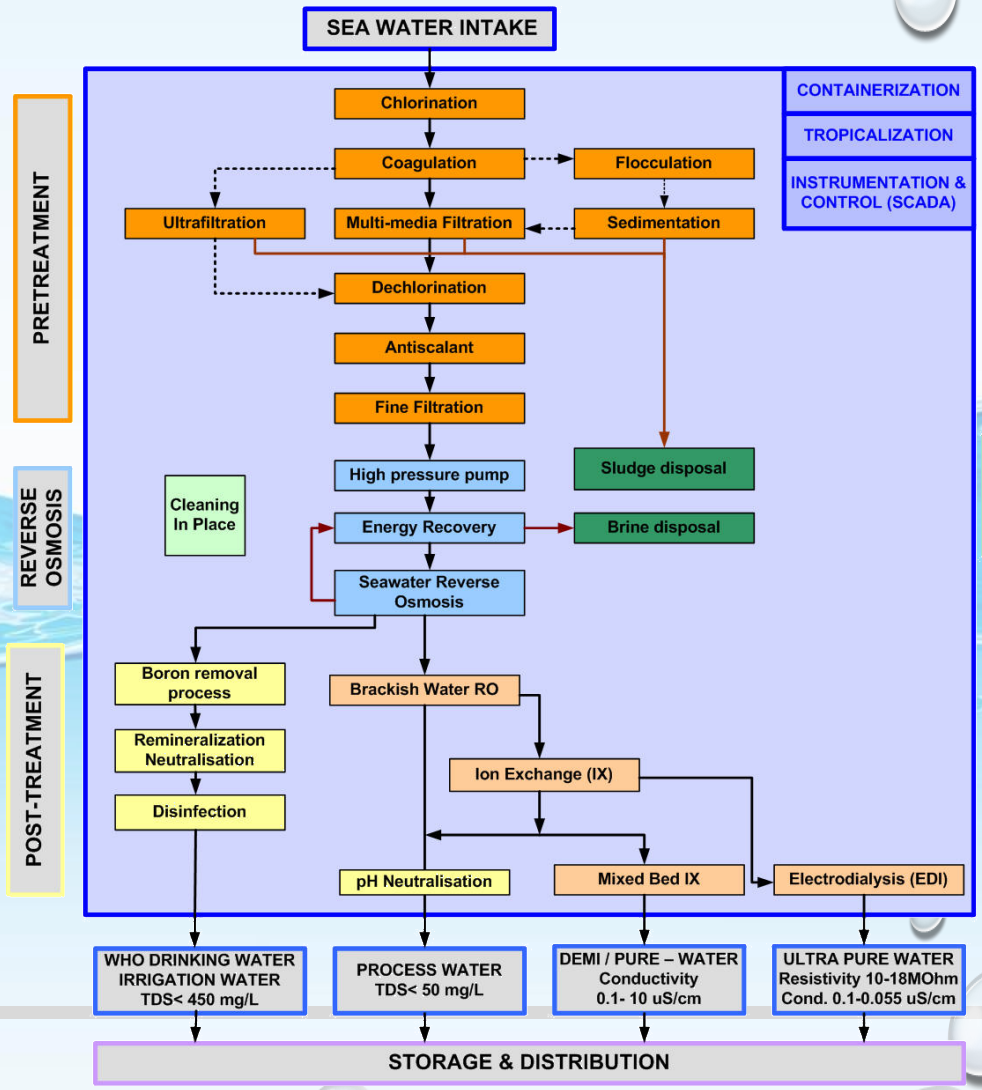


Water Treatment Process : Rain Water



Water Treatment Process : Sea Water





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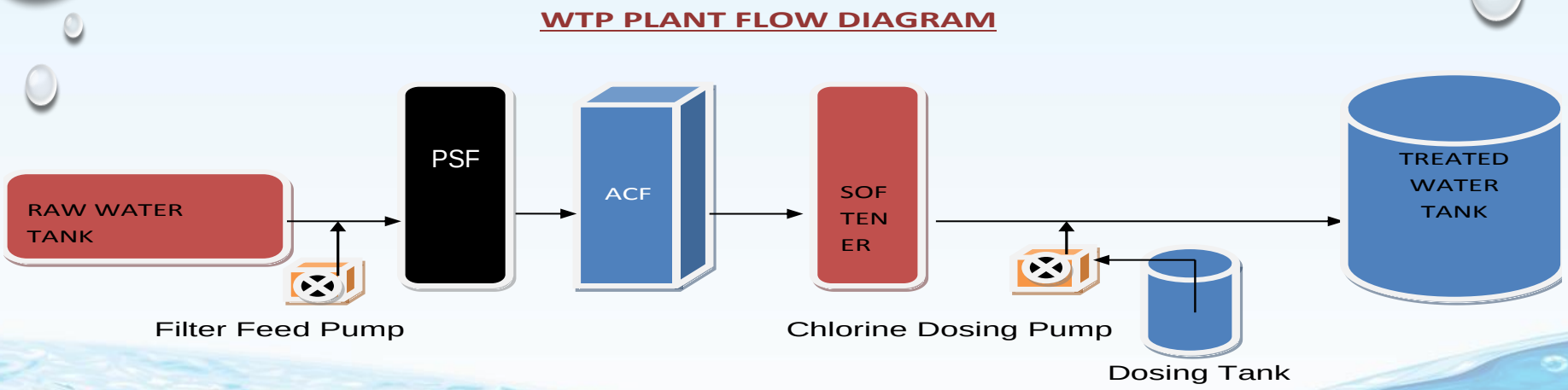
Basic Water Treatment Process



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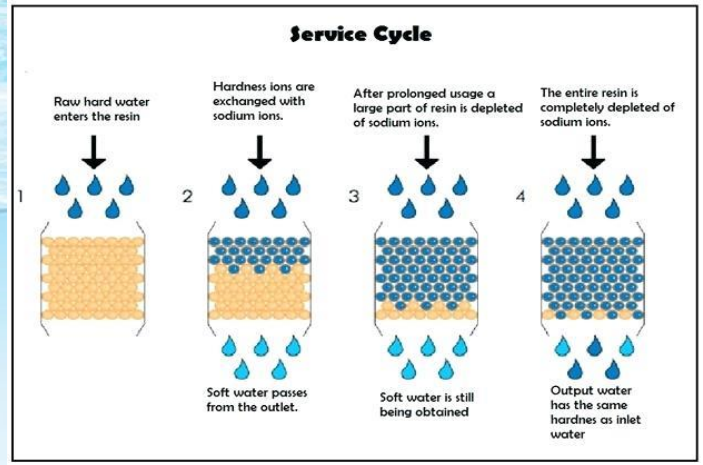
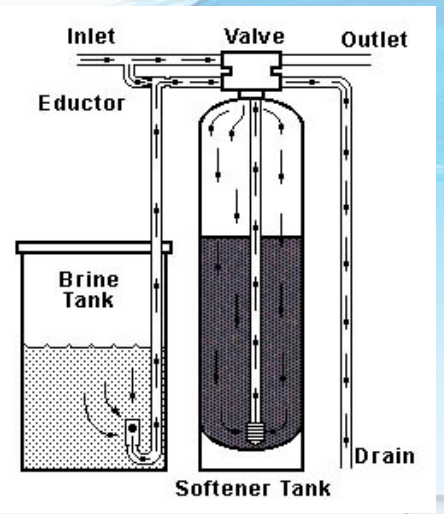
ACF





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Thank you

- Any Questions?

Compiled by Technical Committee - IPA