betterment tax on all premises and properties which can avail of the services though the facility may not be actually used by such premises and properties. Such a betterment tax could be related to the fixed charge component of the financial burden caused by the scheme.

For recovery of variable charges, rates based on consumption of water may be charged and these rates can be different for various categories and slabs of consumption. These charges would be payable by only those who actually consume water.

Authorities such as water supply boards generally do not own water works. The functions of these boards are generally restricted to planning, designing and constructing facilities on behalf of local bodies and then to transfer the works to the owners who have the responsibility to operate the works and also to collect water charges. The boards receive only the agency charges to cover the cost of their establishment, these agency charges being treated as a part of the capital cost of work, planned and constructed by the boards.

There are, however, a few boards, who besides carrying out the functions of planning, designing and execution of works also own water works. These boards operate the water works and also collect water charges directly from the consumers they serve.

While concluding, it is to be stated that a water supply system has to be created since it is essentially required for sustenance of life. It may be initially uneconomical but the water supply project may be evaluated on social cost-benefit analysis method. It is difficult to quantify the social benefits and relate them to the capital cost. The following factors which are likely to get developmental impetus due to creation of water supply system and incidentally a waste water disposal system should be identified:

- Industrial and agricultural development;
- Improvement in living habits, health and hygiene; and
- Increased productivity.

Water supply being a community service, the economical analysis and the financial analysis should be done prudently and judiciously.

CHAPTER 18
LEGAL ASPECTS

18.1 GENERAL

In India, laws related to use of water date back to the period when the CODE OF MANU was prescribed, over 3000 years ago. Water was considered public property, subject to public administration, several penalties were prescribed for unauthorised use and for causing harm to water holding structures and for causing pollution of water. Upstream points along a river were reserved for drawl of drinking water and in-situ uses of water such as washing clothes, bathing etc., were permitted only at the downstream.

The establishment of priorities in the use of water for multiple purposes and among several users for the same purpose is one of the longest established features of water law.

18.2 SYSTEM OF ACQUISITION OF WATER USE RIGHTS

There are currently three major systems of acquisition of water use rights. These are:

(i) The riparian rights system;

(ii) The prior appropriation system; and

(iii) Administrative disposition of water use rights.

18.2.1 RIPARIAN RIGHTS SYSTEM

The riparian rights belong only and equally to those who possess access to water through ownership of land abutting on a stream. A person having riparian right can initiate use of water at any time and insist that his right be accommodated with other user, or that a share of the water be allotted to him. Riparian right is a form of real property, and is a part of land law. Thus this right is appurtenant to the land, in the sense that a person who purchases or inherits riparian land automatically acquires the water right, although it may not be specifically mentioned. The riparian does not own the water, but owns only the right to use it on his riparian land, and to have it flow to his land so that it may be used.

As a rule only the natural flow of a stream is subject to riparian rights. Water added artificially to a stream i.e. the so called "developed" water is not subject to riparian rights. It belongs to whoever developed it, unless the increased flow was caused by mere clearing of obstacles. Riparian rights do not attach either to waste water which seeps or escapes from ditches or reservoirs, or to foreign waters drained artificially from a different water shed. They do attach to a spring when it is the source of the stream and also to the under flow of a stream.

Under this system there are two operating doctrines, viz. (i) Natural flow Doctrine, and (ii) Reasonable use Doctrine.

18.2.1.1 Natural Flow Doctrine

Under the natural flow doctrine the riparians have the right to use water on riparian lands, in as much quantity as they need, without consideration of the needs of their downstream users, if their use is confined to so called "Natural" or domestic purposes, i.e. drinking, washing. cleaning and the watering of live stock. However., when they make use of the water for other than domestic purposes even though still within riparian land, they may become subject to action by the lower riparian if he sustains harm in the use of water to which he is entitled; since he has the right to expect the water to flow to him, in its natural and undiminished state. Also any use not connected with riparian land, which affect the flow of water, even though it does not cause any harm, is considered subject to action.

18.2.1.2 Reasonable Use Doctrine

Because of the limitation of the natural flow doctrine in the use of water law as a tool for purposes of social engineering, the trend is away from, "Natural Flow Doctrine" and towards acceptance of the "Reasonable Use Doctrine".

As a rule, in determining reasonableness, such factors as social utility, capacity of the stream, benefit to the use and suitability to the purpose of the stream are taken into account, mostly retaining the fundamental right of the riparian to the reasonable use of the water of the stream, but free from unreasonable interference with other uses.

A number of uses have received judicial approval and their limits have been defined to some extent. Domestic use includes water for drinking, cooking, laundry, sanitation and other household purposes. A substantial quantity of water may be necessary to fulfil domestic uses where people gathered in hotels, apartment houses or resorts. Even military camps are given the privilage of taking water for domestic use. But domestic use does not include municipal uses in nonriparian areas of cities. A city situated on the banks of a stream is not a riparian right holder in any sense that would permit it to divert water and sell it to inhabitants who live on lands not adjacent to the stream.

The reasonableness of a particular use of water by a riparian is a question of fact and each case must be determined with reference to its own facts and circumstances. The use of water by one riparian that causes substantial harm to another, can generally be said to be unreasonable unless the utility of the use out weights the gravity of the harm. Wasteful uses or wasteful method of use may be unreasonable.

A prescriptive right may be described as a power to take water without reference to the rights of riparian owners. The right obtained by the prescription is absolute there being no corrective rights between the riparian and the prescriptive user.

18.2.1.3 Loss Of Riparian Rights

Generally a riparian right cannot be lost by abandonment or simply by non-use of water. Since use does not create the right, non-use cannot destroy it. However, there are some exceptions to this in some places when a riparian may lose his right.

(i) When a non- riparian or excessive use has been made continuously and adversely for the period of the status of limitations.

(ii) When prescriptive rights to the use of water have been acquired for such adverse use.

(iii) When the legal doctrine known as "estopple" is operative [e.g. when a riparian has permitted a non-riparian to construct a dam on his land at great expenses he is "estopped" (prevented) from revoking the license and destroying the value of the irrigated non-riparian land].

(iv) When there has been silent acquiescence by a riparian in respect of an upstream use of water, for which large sums of money have been spent for the public benefit; though he may still have the remedy for damages to compensate him for the rights he has lost.

(v) When a public or quasi-public agency needs water, it has the power to take it as long as it pays just compensation for the use it causes. (Any government authority, has this "right of eminent domain", and quasi-governmental bodies such a Water Supply Boards, may be given a similar power by grant from the state that creates them.)

18.2.2 PRIOR APPROPRIATION SYSTEM

The two cardinal principles of the doctrine of prior appropriation are:

(i) That beneficial use of water and not land ownership gives the basis of the right to use water; and

(ii) That priority of use and not equality of right is the basis of the division of water between appropriators when there is not enough for all.

18.2.2.1 Elements Of An Appropriation

An appropriation is the right to use a specific quantity from water from a public source of supply for a beneficial purpose, if that quantity is available free from the claims of prior appropriators. An appropriation requires:

(i) The diversion of water from a stream or other source;

(ii) The intent to appropriate;

(iii) Notice of appropriation to others;

(iv) Compliance with state procedural requirements; and

(v) The application of water to a beneficial use.

Once the appropriation has been established, prior appropriator has the right to exclusive use of the amount of water of his appropriation and all subsequent junior users take subject to his right. The appropriation may be obtained only for beneficial uses, which include domestic, agricultural and industrial uses. It lasts as long as water is beneficially used and is limited to the amount that can be so used.

18.2.2.2 Beneficial Uses

A number of uses of water have been approved as beneficial by courts and legislatures. Domestic use is everywhere recognised such. Cities and towns may appropriate water for municipal purposes. A city may appropriate more water than it presently needs in order to provide for future growth.

18.2.2.3 Quantity Of Water

An appropriation is always stated in terms of the rights to take a definite amount of water. Direct flow rights are stated in terms of the maximum current or flow that may be diverted from the stream. Storage rights are expressed in terms of the total volume of water that may be stored.

An appropriation acquired, by building a reservoir and storing water in it, is measured by the storage capacity of the reservoir, that it will hold as a result of a single filling each year. If the reservoir is to be filled more than one time, it can be done only after paying the compensation for the additional quantity of water stored.

18.2.2.4 Place Of Use

With few exceptions, an appropriation can be made in order to use the water at any place where it is needed. Diversions out of water-shed have been permitted, but not between interstate.

18.2.2.5 Preferences

Preferences are exceptions to the rule of priority. A preference allocates the water to what has been legislatively deemed to be a higher or better use regardless of the time of initiations of use. There is wide variation as to what uses shall be preferred. There is general agreement that man's personal needs come first so that domestic and municipal water supply head every list. A true preference exists when a junior right to a preferred use is placed at the top of the priority list, so that in times when water is short, senior non-preferred rights are cut-off while the preferred uses still draw water. Stated another way, a true preference exists when the preferred use may be initiated without regard to the fact that the supply is already fully appropriated for other purposes. The authorities have to prefer some uses over others when several applications for appropriation of water are pending and the available water is insufficient for all. These preferences should go first for domestic and municipal water supply, then to agriculture, then to power.

18.2.2.6 Changes In Appropriation

A water right is private property and, in most cases, it can be sold or used by its owner at any-place of use, but in the case of diversion type of use, at any time of use, or place of storage also. But the privilege of making such changes is subject to the rule that a change must not injure the vested water rights of the other appropriators. The agencies and courts that regulate the appropriation and distribution of water are given the power to approve or forbid changes on this ground, after proceeding at which all interested parties are represented.

The restriction on changes that cause damage is not merely on application of the rule of priority; it is applicable to any person senior or junior who will suffer as a result of the change. A change from non-consumptive use to consumptive one will obviously injure downstream appropriators. The loss of benefits from return flows is the most common type of damage that will prevent a change, but the appropriator may be permitted to change the place of use or the amount of this consumptive use, though not of his total diversion and other conditions may be imposed to permit a change to as great an extent as possible, and yet prevent infliction of damage.

18.2.2.7 Transfers Of Appropriation

An appropriation is regarded as real property and where it can be sold to a person who will use it at a different place or for different use, the transfer is ordinarily made by a deed. Water rights for the irrigation of land are generally regarded as appurtenant to the land, hence a sale of the land will carry the water right with it, although the water right was not specifically mentioned in the deed.

18.2.2.8 Loss Of Appropriation

An appropriation is a property right and its ownership, like that of land, is held in perpetuity although same may be granted for a limited period. However, it may be terminated if it is not used. It has been recognized that the non-use of water, coupled with an intent not to resume the use, amounts to an "abandonment" that terminates the water right and makes the water available for use and appropriation by others. No particular period of time is required for an abandonment, but long un-explained nonuse will often cause a court to say that the right is abandoned although there is no direct evidence of the intent of the appropriator.

18.2.3 System of Administrative Disposition of Water

The riparian rights doctrine and the prior appropriation systems, as a rule, are appropriate either in humid countries in which there is an abundance of water, or in circumstances in which the government organisation is weak and under-developed. As water becomes scarce, government tends to assume a more active role in the disposition of the available supply. This trend can be plainly seen in arid regions of the world where demand outstrips supply even at a primitive level of economy. When supply exceeds demand there is little need for desire for control; but where demand outgrows supply administrative control intensifies. The

administrative authorisation system has become the main feature of the water codes of new countries, such as Israel. These systems envisage authorisation by government for using any water declared public. Usually two kinds of authorisation are given:

(i) A permit which is less permanent and easily revoked; and

(ii) A concession which sets up reciprocal rights and obligations between granter and grantee.

In administrative law, "permits" are distinguished from "concessions", in as much as the former are revocable and create obligations only for the grantee, where as concessions are for a fixed period or perpetual, create reciprocal obligations and their revocation is governed by law. Consequently procedure for obtaining them is different, since a concession has a certain condition of stability which a permit lacks.

18.3 SURFACE WATER

18.3.1 POWER OF LEGISLATION REGARDING WATER

According to the Constitution of India water is in the "State list". Therefore, the States can enact any legislation regarding water that is to say, water supplies, irrigation and canals, drainage, embankments, water storage and water power excepting the regulation and development of inter-state rivers and river vallies. The parliament thus has no legislative competence in the matter.

18.3.2 NATIONAL WATER POLICY

Water is a prime natural resource, a basic human need and precious national asset. Therefore, planning and development of water resources need to be governed by national perspectives.

The Government of India have therefore formulated a National Water Policy in 1987; according to which, in the planning and operation of systems water allocation priorities shall be broadly as follows:

- Drinking
- Irrigation
- Hydro-power
- Navigation
- Industrial and other uses

However these priorities can be modified, if necessary, in particular regions with reference to area specific consideration. The National Water Policy has directed that adequate drinking water facilities should be provided to the entire population both in urban and rural areas by 1991; that irrigation and multipurpose projects should invariably include a drinking water component wherever there is no alternative source of drinking water; and that

drinking water needs of human beings and animals should be the first charge on any available water.

In order to provide for use and control by the state, the water of all rivers and streams flowing in natural channels and of all lakes, and to that end to amend and consolidate the existing laws relating to irrigation and drainage and assessment and levy of water rates and betterment contributions, a Model Canal Irrigation and Drainage Bill is being formulated by Union Government for the guidance of the States.

18.4 GROUND WATER

The existing Irrigation Acts or any other Acts do not define the ownership of such surface or ground water which is considered as belonging to the owners of the land. But in view of the vital importance of ground water to the nation; for water supply and irrigation it is essential for government to extend control over it and to provide for the methodical and systematic regulation in conjunctive use with surface water. The National Water Policy has directed that exploitation of ground water resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity; and that ground water recharge projects should be developed and implemented for augmenting the available supplies.

The Union Government has prepared and circulated to the State a Model Ground Water (Control and Regulation) Bill to regulate and control the development there with. The salient features of the Bill are as under:

- Ground water has been defined as the water which exists below the surface of the ground at any particular location.
- Ground Water Authority shall be constituted by the State Government.
- The State Government, on a report received from the Ground Water Authority may declare areas as notified areas; where, extraction and use of ground water will be regulated in the public interest.
- Any person desiring to sink a well in the notified area for any purpose other than exclusively domestic use, either on personal or community basis, shall apply to the Ground Water Authority for the grant of a permit for the purpose and shall not proceed with any activity connected with sinking unless a permit has been granted by the Ground Water Authority.
- In granting or refusing a permit the Ground Water Authority shall have regard to:
  - (a) the purpose or purposes for which water is to be used;
  - (b) the existence of other competitive users;
  - (c) the availability of water; and
  - (d) any other relevant factor.

- Every existing user of ground water in the notified area, shall apply to the Ground Water Authority for the grant of a certificate of registration recognising his existing use in such forms and in such manner as may be prescribed.
- No person shall himself or by any person on his behalf, carry on the business of sinking wells or any other activity connected with the sinking of wells in any notified area except under and in accordance with a licence granted in this behalf.
- Any person desiring to carry on the business of sinking of wells in the notified area may make an application to the Ground Water Authority for the purpose.
- The Ground Water Authority or any person authorised by it in writing in this behalf shall have power to enter on any property with the right to investigate and make any measurements concerning the land or the water located on the surface or underground, inspect the well, sunk or being sunk, take specimens of such solid, or other materials or of water extracted from such wells, and obtain such information and record as may be required.
- Any user of ground water who contravenes or fails to comply with any of the provision of the Act, will be penalised and/or punished according to the provision of the Act.

18.5 PREVENTION AND CONTROL OF POLLUTION

Though the conservation of available water sources free from pollution is of paramount importance now, even the early law regulating pollution says that the riparian owner may make such reasonable use of the water as he can while it passes his land; but he cannot make such use of water as to pollute it unreasonably or so as to create nuisance. The early law regulating pollution was enforced almost entirely through the process of individual suits for what was termed a private nuisance.

The concept of public nuisance has also been used to some degree to control pollution. A public nuisance is an act which causes inconvenience or damage to the public as distinguished from one or a few individuals and includes any interference with the public health, safety, or inconvenience. Thus the pollution of a stream which merely inconveniences several riparian owners is a private nuisance only, but may become public one, if it kills fish or creates a menace to the health of the community. A public nuisance is subject to abatement at the behest of state officials. It may also constitute a crime.

In our country until recently the pollution was regulated through state factory acts and rules, and also by some sections (section 28) of the Indian Easement Act. As the scope of these acts is limited in its extent and does not provide much guidance in respect of water pollution prevention, the Union Government enacted the Water (Prevention and Control of Pollution) Act, in 1974; which is applicable to all Union territories, and has been adopted by all the States, by resolution passed in that behalf under clause (i) of Article 252 of the Constitution. Under the provision of this Act no discharge of waste water can be made in the environment without obtaining consent from the State Pollution Control Board (from the Central Pollution Control Board, in respect of Union Territories). A consent prescribes the

volume and quality of waste water in terms of concentration of various pollutants, which can be permitted for discharge in the environment. In 1986, the Union Government enacted the Environment (Protection) Act, 1986, for protection and improvement of environment, and the prevention of hazards to human beings, other living creatures, plants and properties. The Act empowers the Union Government to make rules providing standards in excess of which environmental pollutants shall not be discharged or emitted in the environment.

APPENDIX A
ABBREVIATIONS AND SYMBOLS

atm	Atmosphere	emf	Electromotive force
BOD	Biochemical oxygen demand	Eq	Equation
ci	Curie	Fig	Figure
°C	Degrees centigrade	g	Gram
cal	Calorie	ha	Hectare
cc	Cubic centimetre	I.D	Internal diameter
CCE	Carbon-chloroform extract	JTU	Jackson turbidity unit
cgs	Centimetre gram second	k cal/kg	Kilocalorie per kilogram
C.I	Cast iron	kg/cm^2	Kilogram per square centimetre
cm	Centimetre	kg/m^2	Kilogram per square metre
cm/min	Centimetres per minute	kL	Kilolitres
cm/sec	Centimetres per second	kLd	Kilolitres per day
cm^2	Square centimetres	km	Kilometre
COD	Chemical oxygen demand	kw	Kilowatt
Col	Column	kwh	Kilowatt hour
cum	Cubic metres	L	Litre
cumec	Cubic metre per second	Lpcd	Litre per capita per day
		lpd	Litres per day
deg	Degree	lph	Litre per hour
DO	Dissolved oxygen	lph/m^2	Litres per hour per square metre
EDTA	Ethylenediaminetetraacetic acid	lpm	Litre per minute

lpm/m^2	Litres per minute per square metre
m	Metre
m^3	Cubic metre
m^3/hr	Cubic metres per hour
me	Milliequivalent
mg	Milligram
mg/l	Milligram per litre
ml	Millilitre
mL	Million litres
mLd or mld	Million litres per day
mm	Millimetre
mps.or m/s	Metre per second
min	Minute
mole	Gram molecular weight
mol wt	Molecular weight
mph	Metres per hour
m^3/d/m	Cubic metres per day per metre
m^3/d/m^2	Cubic metres per day per square metre of area
m^3/mL	Cubic metres per million litre
MPN	Most probable number
mμ	Millimicron
μ	Micron
μc_i	Microcurie
μg	Microgram
N	Newton
NPSH	Net positive suction head
No	Number
NTU	Naphelometric turbidity units
OTA	Orthotolidine arsenite
N_R	Reynold's number
P	Page
PP	Pages
pCi	Picocurie
ppb	Part per billion
ppm	Part per million
rpm	Revolution per minute
s	Second
sq	Square
Vol	Volume
wt	Weight

APPENDIX B
CONVERSION FACTORS

LENGTH

1 In	=	25.4 mm	1 mm	=	0.0394 in
1 ft	=	0.3048 m	1 cm	=	0.3934 in
					0.0328 ft
1 yd	=	0.9144 m	1 m	=	3.2808 ft
					1.0936 yd
1 mile	=	1.6093 km	1 km	=	0.6214 mile

AREA

1 sq in	=	645.163 sq mm	1 sq mm	=	0.00155 sq in
	=	6.4516 sq cm	1 sq cm	=	0.1550 sq in
1 sq ft	=	0.0929 sq m		=	0.00108 sq ft
1 sq yd	=	0.8361 sq m	1 sq m	=	10.7639 sq ft
1 sq mile	=	2.59 sq km		=	1.1960 sq yd
1 acre	=	0.4047 ha	1 ha	=	2.4710 acre
		4046.86 sq m		=	0.00386 sq mile
			1 sq km	=	0.3861 sq mile
				=	247.105 acre

CAPACITY

1 gal (UK)	=	4.54609 l	1 l	=	0.0353147 cu ft
	=	0.00454609 cum		=	0.001308 cu yd
	=	0.160544 cu ft	1 l	=	0.2200 gal(UK)
1 gal (US)	=	0.00378541 cu m	1 l	=	0.264172 gal(US)
	=	3.78533 l			
	=	0.832675 UK gal			
	=	0.133681 cu ft			

1 US Pint (Liquid)	=	0.4732 l			
1 fluid oz (US)	=	29.5729 ml			
1 fluid oz (UK)	=	28.4123 ml			

VOLUME

1 cu in	=	16.8871 cu cm	1 cu cm	=	0.061024 cu in
1 cu ft	=	0.0283 cu m	1 cu m	=	35. 815 cu ft
1 cu yd	=	0.7646 cu m		=	1.60795 cu yd
1 acre ft	=	1233.48 cu m		=	0.00081071 acre ft

WEIGHT

1 grain	=	0.0648 g	1 g	=	15.45254 grains
1 oz	=	28.3495 g		=	0.0352740 oz
1 lb	=	0.4536 kg	1 kg	=	2.20462 lb
1 ton	=	1.01605 tonnes	1 tonne	=	0.98421 ton

DENSITY

1 lb/ft^3	=	16.0185 kg/m^3 or g/L	Kg/m^3	=	0.0624 lb/ft^3

PRESSURE AND STRESS

1 lb/in^2	=	0.0703 kg/cm^2			
1 lb/ft^2	=	4.88243 kg/m^2	1 kg/cm^2	=	14.223 lb/in^2
1 ton/in^2	=	1.5749 kg/mm^2		=	10 m H_2O
				=	0.96784 atm
1 atm	=	101325.0 N/m^2	1 kg/m^2	=	0.204816 lb/ft^2
	=	760.0 mm Hg	1kg/mm^2	=	0.6850 ton/in^2
	=	1.01325 bar	1 atm	=	68087.0 pdl/ft^2

	=	14.6959 lbf/in^2			(Where 1 pdl = 0.138255N)
	=	33.8984 ft H_2O			
	=	29.9213 in Hg			
	=	10332.2 kg/m^2			
	=	1.03322 kg/cm^2			
	=	10.3322 m H_2O	1 mm Hg	=	2.78450 Lb/ft^2

FORCE

1 lbf	=	4.44822 N	1N (or 10^5 dynes)	=	0.101972 kgf
	=	0.453592 kgf		=	0.224809 lbf
1 tonf	=	9.96402 kN			
1 pdl	=	0.138255 N	1 kgf	=	2.20462 lbf

g(acceleration due to gravity) = 32.1740 ft/sec^2

= 980.665 cm/sec^2

ENERGY AND POWER

1horse-power	=	0.745700 kW	1kW	=	1.34102 Horse-power
1 ft.lb f/s	=	1.35582 W	1kWh	=	3.6 MJ
1 b.t.u	=	1.05506 KJ	1 J	=	0.737562 ft lbf
1 therm	=	105.506 MJ	1 kJ	=	0.277778 Wh
1 ft lbf	=	1.35582 J			

VELOCITY

1 fps	=	0.0348 m/s	1 m/s	=	3.2808 fps
	=	1.0973 km/h		=	2.2369 mile/h
1 mile/h	=	0.4470 m/s	1 km/h	=	0.9113 fps
	=	1.6093 km/h		=	0.6214 mile/h

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TREATMENT LOADING RATES

1 in/h	=	0.00705555 mm/s	1 mm/s	=	141.732 in/h
1 UK gal/ft^2/h	=	0.0135927 mm/s		=	73.5689 UK/gal/ft^2/h
1 UK gal/ft^2/h	=	1.17441 m^3/m^2/d		=	76.9130 Million UK gal/acre/d
1 million UK gal/acre/d	=	0.0130016 mm/s	1m^3/m^2/d	=	0.851491 UK gal/ft^2/h
	=	1.12336 m^3/m^2/d		=	0.890187 million UK gal/acre/d
1 UK gal/day/ft	=	14.915 lpd/m	1m^3/day/m	=	67.466 UK/gal/day/ft
	=	0.014915 m^3/day/m			
1 ft^3/s/1000 acres	=	6.99724 l/s/km^2	l/s/km^2	=	0.142915 ft^3/s/1,000 acres
1 ft^2/s/mile^2	=	10.9332 l/s/km^2		=	0.0914645 ft^3/s/mile^2

HARDNESS

mg/l $CaCO_3$	Grains per UK gal $CaCO_3$ (Clark scale-British degrees)	Grains per US gal $CaCO_3$ (American degrees)	Parts per 100,000 $CaCO_3$ (French degrees)	Parts per 100,000 CaO (German degrees)	Parts per million Ca (Russian degrees)
1.00	0.07	0.058	0.10	0.056	0.40
14.29	1.00	0.83	1.43	0.80	5.72
17.15	1.20	1.00	1.72	0.96	8.86
10.00	0.70	0.58	1.00	0.56	4.00
17.86	1.25	1.04	1.79	1.00	7.14
2.57	0.18	0.15	0.26	0.14	1.03

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APPENDIX C

LIST OF INDIAN STANDARDS RELATING TO WATER SUPPLY

Sl No.	IS No.	Title
I. GENERAL		
1.	SP 7 (Part 9 Selection 1): 1983	National building code of India 1983 Part 9 Plumbing services: Section 1:Water Supply
2.	SP 35: 1987	Handbook on water supply and drainage with special emphasis on plumbing
3.	1172: 1983	Code of basic requirements for water supply drainage and sanitation (third revision)
4.	2065:1983	Code of practice for water supply in buildings(second revision)
5.	456:1978	Code of practice for plain and reinforced concrete (third revision)
6.	457:1957	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
7.	1343:1980	Code of practice for prestressed concrete (first revision).
8.	3103:1975	Code of practice for industrial ventilation.
9.	3370	Code of practice for concrete structure for the storage of liquids.
(a)	Part 1 : 1965	General requirements.
(b)	Part 2 : 1965	Reinforced concrete structures.
(c)	Part 3 : 1967	Prestressed concrete structures.
(d)	Part 4 : 1967	Design tables.
10.	6518 : 1972	Code of practice for control of sediment in Reservoirs.
11.	5330 : 1984	Criteria for design of anchor block for penstocks with expansion joints (first revision).

Sl No.	IS No.	Title
12.	6748 :	Recommendations for watershed management relating to soil conservation.
(a)	Part 1 : 1973	Agronomic aspects.
13.	7357 : 1974	Code of practice for structural design of surge tanks.
14.	3913 : 1966	Suspended sediment load samplers.
15.	3917 : 1966	Scoop type bed material samplers.
16.	4890 : 1968	Methods for measurement of suspended sediment in open channels.
17.	4926 : 1976	Ready-mixed concrete (first revision).
18.	6295 : 1986	Code of practice for water supply and drainage in high altitudes and/or sub-zero temperature regions(first revision).
19.	4880	Code of practice for design of tunnels conveying water.
(a)	Part 1 : 1975	General design.
(b)	Part 2 : 1976	Geometric design(first revision).
(c)	Part 3 : 1976	Hydraulic design(first revision).
(d)	Part 4 : 1971	Structural design of concrete lining in rock.
(e)	Part 5 : 1972	Structural design of concrete lining in soft strata and soils.
(f)	Part 6 : 1971	Tunnel support
20.	5477	Methods for fixing the capacities of reservoirs
(a)	Part 1 : 1969	General requirements
(b)	Part 2 : 1969	Dead storage
(c)	Part 3 : 1969	Live storage
(d)	Part 4 : 1971	Flood Storage
21.	9668 : 1980	Code of practice for provision and maintenance of water supply for fire fighting
22.	8062	Code of practice for cathodic protection for steel structures

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(a)	Part 1 : 1976	General principles
(b)	Part 2 : 1976	Underground pipelines
23.	10221: 1982	Code of practice for coating and wrapping of underground steel pipelines
24.	12183 : 1987	Code of practice for plumbing in multi-storeyed buildings Part 1 water supply
II. PIPE AND PIPE LAYING		
Cast Iron		
1	1536 : 1976	Centrifugally cast(spun) iron pressure pipes for water, gas and sewage(second revision)
2	1537 : 1976	Vertically cast iron pressure pipes for water, gas and sewage (first revision)
3	1538 (Parts 1 to 24)	Cast iron fittings for pressure pipes for water, gas and sewage(second revision)
(a)	Part 1 : 1976	General requirements
(b)	Part 2 : 1976	Specific requirements for sockets and spigots of pipes
(c)	Part 3 : 1976	Specific requirements for sockets of fittings
(d)	Part 4 : 1976	Specific requirements for flanges of pipes and fittings
(e)	Part 5 : 1976	Specific requirements for raised flanges
(f)	6 : 1976	Specific requirements for standard flange drilling of flanged pipes and fittings
(g)	Part 7 : 1976	Specific requirements for flanged sockets
(h)	Part 8 : 1976	Specific requirements for flanged spigots
(j)	Part 9 : 1976	Specific requirements for double socket bends
(k)	Part 10 : 1976	Specific requirements for double socket bends
(l)	Part 11 : 1976	FIC REQUIREMENTS FOR TEES, ALL SOCKETS
(m)	Part 12 : 1976	Specific requirements for double socket tee with flanged branch
(n)	Part 13 : 1976	Specific requirements for crosses, all sockets
(o)	Part 14 : 1976	Specific requirements for double socket tapers (third revision)
(p)	Part 15 : 1976	Specific requirements for caps
(q)	Part 16 : 1976	Specific requirements for plugs
(r)	Part 17 : 1976	Specific requirements for bell mouth pieces
(s)	Part 18 : 1976	Specific requirements for double flanged bends

Sl No.	IS No.	Title
(t)	Part 19 : 1976	Specific requirements for all flanged tees
(u)	Part 20 : 1976	Specific requirements for all flanged crosses
(v)	Part 21 : 1976	Specific requirements for double flanged taper
(w)	Part 22 : 1976	Specific requirements for split puddle or body flanges
(y)	Part 23 : 1976	Specific requirements for blank flanges
(z)	Part 24 : 1984	Specific requirements for all flanged radial tees(second revision)
4.	1879 : 1975: Pipe Part 1 to 10	malleable cast iron pipe fittings (first revision)
5.	3114 : 1985	Code of practice for laying of cast iron pipes (third revision)
6.	782 : 1978	Caulking lead(third revision)
7.	6163 : 1978	Centrifugally cast(spun) iron low pressure pipes for water, gas and sewage(first revision)
8.	7181 : 1986	Horizontally cast iron double flanged pipes for water, gas and sewage(first revision)
9.	8329 : 1977	Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage
10.	9523 : 1980	Ductile iron fittings for pressure pipes for water, gas and sewage
11.	11606 : 1986	Methods of sampling cast iron pipes and fittings
12.	11906 : 1986	Recommendations for cement mortar lining cast iron, mild steel and ductile iron pipes and fittings for transportation of water .
13.	12288 : 1987	Code of practice for laying of ductile iron pipes
CONCRETE		
14.	458 : 1971	Concrete pipes(with and without reinforcements) (second revision)
15.	784 : 1978	Pre-stressed concrete pipes(including fittings)(first revision)
16.	1916 : 1963	Steel cylinder reinforced concrete pipes
17.	3597 : 1985	Methods of test for concrete pipes(first revision)
18.	783 : 1985	Code of practice for laying of concrete pipes(first revision)
19.	4350 : 1967	Concrete porous pipes for under drainage.