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1.0 Introduction :

The water demand is met from a suitable source. This source should satisfy the requirement in terms of quantity as well as quality. The usual sources of supply of water are rivers, canals, lakes, ponds, and wells etc.

2.0 Availability of water:

The water availability and the associated features and constraints are as follows:

a) Surface water – Surface water is water in river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapo-transpiration and sub-surface seepage. Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial reservoirs, the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All these factors also affect the proportions of water lost.

Human activities can have a large impact on these factors. These often include increase in storage capacity by constructing reservoirs and decrease by draining wetlands, increase in runoff quantities and velocities by paving areas and channelizing stream flow. Also surface water may be lost or become unusable through pollution.

b) Under river flow – Throughout the course of the river, the total volume of water transported downstream will often be a combination of the visible free water flow together with a substantial contribution flowing through sub-surface rocks and gravels that underlie the river and its floodplain called the hyporheic zone. For many rivers in large valleys, this unseen component of flow may greatly exceed the visible flow. The hyporheic zone often forms a dynamic interface between surface water and ground water, receiving water from the ground water when aquifers are fully charged and contributing water to ground water when ground waters are depleted.

c) Ground water - Sub-surface water, or groundwater, is fresh water located in the pore space of soil and rocks. It is also water that is flowing within aquifers below the water table. Sometimes it is useful to make a distinction between sub-surface water that is closely associated with surface water and deep sub-surface water in an aquifer.

Sub-surface water can be understood in the same terms as surface water, i.e. in terms of inputs, outputs and storage. The critical difference is that due to its slow rate of turnover, sub-surface water storage is generally much larger compared to inputs than it is for surface water. This difference causes a tendency to use sub-surface water unsustainably for a long time. However, it should be noted that the natural input to sub-surface water is seepage from surface water and this source is not infinite. However, the input to a sub-surface water source can be increased by building reservoirs or detention ponds.

d) **Desalination** – Desalination is an artificial process by which saline water (generally sea water) is converted to fresh water. The most common desalination processes are distillation and reverse osmosis. Desalination is currently expensive compared to most alternative sources of water. It may be economically viable only for high-valued uses, such as household and industrial uses, in arid areas.

3.0 Aquifers and aquicludes:

The layers of soil and rock below the water table are classified in two broad categories:

- Aquifers
- Aquicludes.

Aquifers are water bearing layers (or formations) that yield water to wells in usable amounts. Typical aquifers are made of sand, gravel or sandstone. These materials have large interconnected pore spaces between grains that water moves freely. Coal and shale are more tightly compacted but may also be suitable aquifer materials if they are fractured enough to allow water to move through them.

Aquicludes are water bearing formations that cannot yield adequate water for wells. Examples of these are clay and un-fractured shale and coal. The pore spaces between grains of these materials are so small that water moves through them extremely slowly.

4.0 Confined and unconfined aquifers

Unconfined aquifers are exposed directly to the atmosphere through openings in the soil. The volume of water in unconfined aquifers is mainly dependent on seasonal cycles of precipitation that refills the aquifer. A water table aquifer is an example of an unconfined aquifer.

A confined aquifer is trapped below an upper confining layer of rock, clay or shale. When a well is drilled into a confined aquifer, the water level in the well rises above the upper boundary of the aquifer. Aquifers that are completely saturated with water and under pressure are called artesian aquifers. A flowing artesian well results when the pressure in the aquifer raises the water level above the ground surface.

The common source of water supply is underground water. The underground water is extracted through tubewells.

- **Deep Borewell** : A deep borewell shall be defined as a borewell of depth more than 30m below the ground surface, having casing diameter of 6 inches or more.
- **Shallow Borewell** : These are Borewells less than 30 m deep

One of the main reason of borewell failure is that the necessary design aspects are not properly taken care of and old practices seem to have deteriorated over time. In fact, the flaws in the design of borewells also affect the quality of water: for example, the practice of filling the entire annular space around the casing pipe with a filter pack of pea gravel increases contamination proneness of the borewells due to migration of surface water into the well through the annular spaces of filter media.

5.0 Classification of borewells: Borewells are also classified according to yield as under:

i) High Capacity Borewell (HCB) : Borewells of casing pipe diameter 10 or 12 inches and depth >80m with design yield in the range of 20,000gph to 45,000gph.

ii) Medium Capacity Borewell (MCB) : Borewells of casing pipe diameter 8 inches and depth >80m with design yield in the range of 10,000gph to 20,000gph.

iii) Low Capacity Borewell (LCB) : Borewells of casing pipe diameter 6 inches and depth 30m to 50m with design yield in the range of 1500gph to 5,000gph.

6.0 Common shortcomings in design, construction and management of Borewells:

The main shortcomings observed in design, construction and management practices in borewells are as under:

(i) The design and selection of size of opening and length of the screen, and the size and grading of filter media are of utmost importance as these aspects affects quantity and quality of water and service life of borewell. Coarser formations in aquifers require larger grain size of filter media and larger opening of the screen, and the finer formations require smaller size of filter media and smaller openings in the screen. Design of the screen and the filter media should be decided on the basis of the grain size distribution of the formation in the aquifer at the intake zone and not on the general grading of the formation. Decision on the selection of screen and filter media should not be left to contractor or someone's general experience. The guidelines regarding this aspects are contained in IS 2800 (Part 1): 1991 "Code of Practice for Construction and Testing of Tubewells/borewells", and IS 8110:2000 "Well Screens and Slotted Pipes" – Specifications.

(ii) The screen portion is many time kept too long in most of the borewells and covers almost $1/3^{rd}$ to $2/3^{rd}$ of the depth of the borewell. It is advisable to always keep the screen in the deepest part of the borewell. Screen extending so high in the borewell is likely to affect development of graded zone, and also increase proneness to contamination because water from the higher levels will tend to flow into the well through the annular space filled with gravel.

(iii) If the thickness of filter pack is too large (> 200mm), then it hinders the development of the graded zone. Filter pack thickness of 200mm is the upper limit permissible under IS code and should be adopted for very deep wells (>150m deep) of large diameter. There is also inadequate control in lowering of the casing pipe and screen into the borehole with the result that the screen may not be properly aligned along the axis of the bore resulting in failure to achieve uniform thickness of the filter pack all around the screen which is essential for proper development of the well and good yield.

(iv) Even borewells in coarse grained strata, like sandy gravels, where there is no need of providing a filter pack and the borewell can be developed naturally, full filter packs are being provided. This is unnecessary expenditure and also adversely affects development of the well.

(v) Normally, slotted casing pipes are being used as screen. These screens have small open area and result in very long screens. Wire wound continuous screens provide large slot area without loss of strength of the pipe and are now commonly used for high yielding deep borewells.

(vi) In case of corrosive aquifer conditions, such as, high content of chlorides, TDS, Hydrogen sulfide etc. MS casing pipes and screens should not be used as they are prone to corrosion.

(vii) The existing practice of classification of formation strata is faulty. Terms like “fine-sand”, “coarse sand”, “fine silt”, “very fine clay” is being used when in nature, such soils rarely exist. This flawed classification impairs appreciation of strata-charts of existing wells.

(viii) Well completion reports should be prepared properly, highlighting and documenting the essential features of the borewell. Similarly, strata samples should not be destroyed after the installation of a borewell.

(ix) There should be a system of passing of important materials like casing pipes, screens, pea-gravel to be used in the construction of borewells as it is a completely hidden work and it is impossible to check the quality of the material after the borewell has been constructed.

(x) In the alluvium aquifer of North India, borewells of depth 30 to 50 m give good potable water and a deeper borewell is required only from quality considerations at those specific locations where the water at shallow depths is having high TDS or harmful substances like arsenic. Deep borewells of 80 to 150m or more are basically provided for obtaining a higher yield, though undoubtedly quality also improves. The reduced yield in most cases is because of clogging of the screen and filter media. Running a deep borewell at a fraction of its original capacity is uneconomical because of high energy consumption, yet many borewells whose yield has gone down to $1/3^{rd}$ to $1/5^{th}$ or more of the original yield are being used.

(xi) A borewell should be commissioned immediately after its installation. However the practice of providing the pump house right above the borewell delays the commissioning and pumping test by several months. Room for electrical control panel and chlorination plant may be constructed a short distance (5 to 20m) away from borewell to avoid the delay in commissioning of borewell.

(xii) There is also scope of improvements in other aspects like;

- Proper development of the aquifer after installation of casing pipe and screen.
- Proper estimation of yield and pump capacity by drawing drawdown and recovery curves from pumping tests.
- Proper bacteriological and chemical analysis of water.
- Disinfection of the borewell by shock chlorination before commencing supply, if required.

7.0 Construction of Borewell

The Geological Department or Central Ground Water Board / Public Health Engineering department of the State Government should, be consulted wherever necessary, for proposals of deep tube-wells. Where the "normal-water-table" is at greater depth, it would be economical and preferable to sink deep tube-wells instead of open-wells.

7.01 Selection of Drilling Contractor:

Drilling contractor should have work experience and should know the local geology. Officer/supervisor along with contractor should survey the existing wells in the area as it will provide important information about:

- Typical yields and water quality
- Which aquifer to tap into
- Trends in well design and construction
- Prior drilling success rates.

7.02 Choosing a Well Site:

Choice of well site will affect the safety and performance of well. Most contaminants enter the well either through the top or around the outside of the casing. Sewage or other contaminants may percolate down through the upper layers of the ground surface to the aquifer. It should be ensured that:

- The well is accessible for cleaning, testing, monitoring, maintenance and repair.
- The ground surrounding the well is sloped away from the well to prevent any surface run off from collecting or ponding.
- The well is up-slope and as far as possible from potential contamination sources such as septic systems.

7.03 Trial boring:

Before sinking of pipes, samples of strata are examined for yield and samples of water taken for analysis. From the results obtained, the area of strainer necessary for the quantity of water required and the strata in which the strainers should be located are decided upon.

7.04 Samples of water for analysis:

For a large water supply, water should be drawn from as great a depth as possible to eliminate the danger of bacteriological contamination which can be expected in water drawn from the upper strata. Water drawn from deep ground is likely to be bacteriologically pure. As the water obtained from deep wells may contain certain dissolved impurities, the chemical analysis of water to determine its suitability for drinking is always necessary and samples should be sent for the test.

7.05 Minimum Distance Requirements:

Provincial regulations may outline minimum distance requirements. In absence of those, the following may be considered and borewell should be away by

- 10 m from a watertight septic tank
- 15 m from a sub-surface effluent disposal field or an outdoor pit privy
- 50 m from sewage effluent discharge to the ground surface
- 30 m from pesticide or fertilizer storage
- 50 m from above-ground fuel storage tanks
- 100 m from a manure storage facility or manure collection area or livestock yard
- 100 m from dead animal burial or composting site
- 50 m from the outer boundary of a graveyard
- 450 m from any area where waste is or may be disposed of at a landfill

Borewell design and construction details are determined after a test hole has been completed and the geological zones have been logged. There are many components to well design and decisions should be made about:

- Type of well
- Intended use
- Well depth
- Casing material, size and wall thickness
- Intake design
- Annular seal
- Monitoring and preventive maintenance provisions.

7.06 Selecting Type of Well

There are two main types of wells, each distinguished by the diameter of the bore hole. The two types are bored wells and drilled wells.

Bored wells

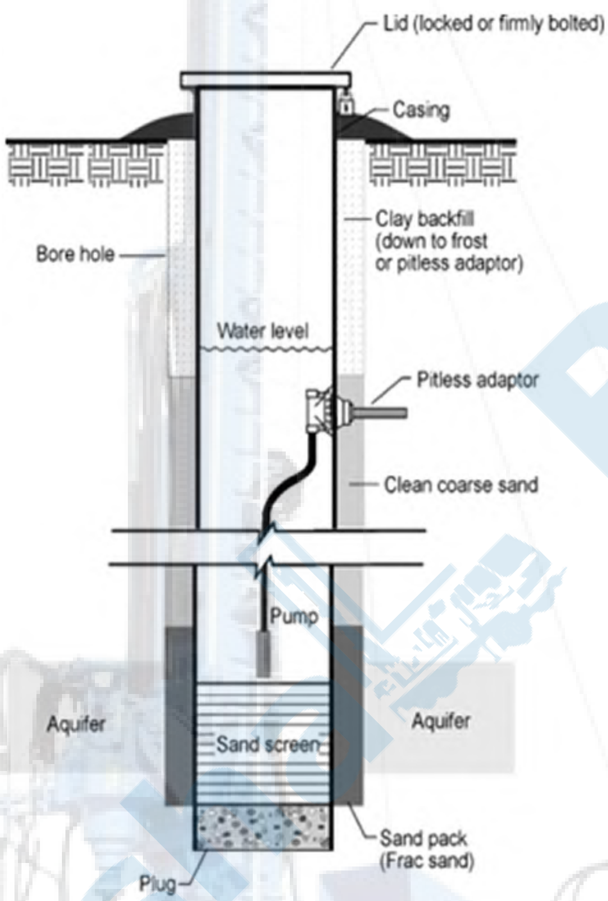
Bored wells are constructed when low yielding groundwater sources are found relatively close to the surface, usually under 30 m (100 ft.). Bored wells are constructed using a rotary bucket auger. They are usually completed by perforating the casing or using a sand screen with continuous slot openings. One advantage of bored wells is the large diameter of the casing, from 450-900mm which provides a water storage reservoir for use during peak demand periods. A disadvantage is of utilizing a shallow groundwater aquifer and water shortages may occur following long dry periods in summer. It is also more susceptible to contamination from surface land-use activities.

Drilled wells

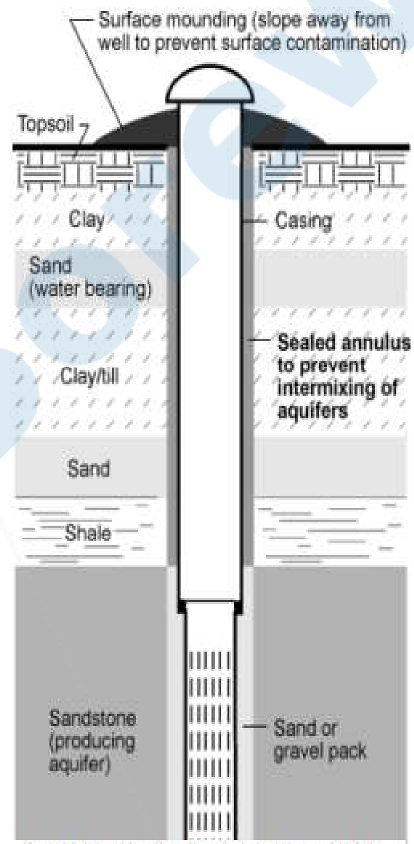
Drilled wells are smaller in diameter, usually ranging from 100-200 mm, and completed to much greater depths than bored wells, up to several hundred metres. The producing aquifer is generally less susceptible to pollution from surface sources because of the depth. Also, the water supply tends to be more reliable since it is less affected by seasonal weather patterns.

7.07 Well Depth

During the test hole drilling, a lithologic or formation log should be prepared. Soil and rock samples are taken at various depths and the type of geologic material is recorded. This help in identifying the zones with the best potential for water supply. Generally a well is completed to the bottom of the aquifer. This allows more of the aquifer to be utilized and ensures the highest possible production from the well.



Construction of Borewell



ANNULAR SEAL & WELL CAP

7.08 Casing Size and Type

The casing must be large enough to house the pump and should allow sufficient clearance for installation and efficient operation. Casing of one nominal size larger than the outside diameter of the pump is sufficient. There are two common materials used for casing: steel and plastic. Steel casing is the strongest but is susceptible to corrosion. Plastic casing is becoming more popular because of its resistance to corrosion. All casing must be new and uncontaminated. Plastic casing must be made of virgin resin, not recycled material.

7.09 Intake Design

Water moves from the aquifer into the well through either a screen or slotted or perforated casing. Screens are manufactured with regularly shaped and sized openings. They are engineered to allow the maximum amount of water in with minimal entry of formation sediments. Stainless steel screens are preferred because they are strong and relatively able to withstand corrosive water. Pre-slotted plastic pipe are also used as they are economical. Screens are manufactured with various slot sizes and shapes to match the characteristics of the aquifer. A good screen should allow the flow of water into the well and should be effective in holding back the formation sediments.

Cuttings from the borehole should be examined and a judgment should be made whether to use a screen, or slotted or perforated casing/liner. While a screen is the more expensive alternative, it is necessary if the aquifer is composed of loose material such as fine sand, gravel or soft sandstone. A slotted or perforated casing/liner can be used when the aquifer formation is more consolidated, such as hard sandstone or fractured shale.

Slot / screen size openings

The slot openings must be small enough to permit easy entry of water into the well while keeping out sediment. The slot size chosen will depend on the particle size of the earth materials in the producing aquifer. Typically one should select a slot size that allows 60 percent of the aquifer material to pass through during the well development phase of drilling. The remaining 40 percent, comprising the coarsest materials, will form a natural filter pack around the perforations or screen.

Total open area of screen

The amount of open area in the screen or slotted or perforated casing/liner will affect how quickly the water from the aquifer enters the well. A larger amount of open area allows the water to enter the well at a slower rate, causing a lower drop in pressure as the water moves into the well. If the water flows too quickly, dissolved minerals in the water will precipitate out of solution and create an incrustation build-up in restricting the flow of groundwater into the well. Incrustation is a buildup that occurs when dissolved minerals in the groundwater come out of solution and deposit on the screen or casing. The pore spaces in the aquifer immediately adjacent to the perforations may also get plugged, restricting the flow even more.

The total area of the slot openings is dependent on the length and diameter of the screen. While the length of the screen is variable, the diameter of the screen is determined by the diameter of the well casing. The yield from a well increases with an increase in screen diameter but not proportionately.

Placement in the aquifer

The screen or perforations on the casing/liner must be placed adjacent to the aquifer. If improperly placed, the well may produce fine sediment which will plug plumbing fixtures and cause excessive wear on the pump. Therefore bore log data should be analyzed to accurately identify the boundaries of the aquifer for exact placement.

7.10 Verticality of Tube Wells

Tubewells must be perfectly vertical. A simple method is to use plumb disk. Two disks made out of 3mm thick steel plate are connected together by a rod of 25mm diameter and 3 m long tightened with the help of nuts at the ends. Some holes are punched in plates to facilitate immersion in water.

A knob is fixed on the top nut to which a thin steel wire is attached. The disk is suspended into the tube by the wire passing over a pulley on a tripod. When the disk is lowered into the pipe, the wire is exactly in the centre of pipe. When the disks are further lowered down and if the well pipe is not truly vertical, the wire will deviate from the centre and that shall be indicated at the top of pipe.

Absolute verticality is ideal but a deviation of 100mm per 30 metres of boring is generally acceptable where submersible pumps are not to be installed.

7.11 Annular Seal & Well cap

Sealing the well protects the well from contamination. The diameter of the borehole is usually slightly larger than the casing. The space between the borehole and the casing is called the annular space. It must be sealed to prevent any surface contamination from migrating downward and contaminating the water supply.

A commercially manufactured, vermin-proof well cap is designed to keep animals, insects and contaminants from entering the well. It comes equipped with rubber gaskets and screened vents to ensure air circulation. Coverings for large diameter wells must be custom made because of their larger size. Ideally they should be made of steel, or fiberglass or plastic.

7.12 Well Completion

Once the well has been drilled and the equipment is in place, there are three more steps that should be completed before the well is ready to use. These are:

- Developing the well.
- Conducting a yield test.
- Disinfecting the well.

7.12.1 Well Development

Well development is the process of removing fine sediment and drilling fluid from the area immediately surrounding the perforations. This increases the well's ability to produce water and maximize production from the aquifer. If the aquifer formation does not naturally have any relatively coarse particles to form a filter, it may be necessary to install an artificial filter pack. This pack is placed around the screen or perforations so the well can be developed. For example, this procedure is necessary when the aquifer is composed of fine sand and the individual grains are uniform in size. It is important to match the grain size of the filter pack material with the size of the slot openings of the screen to attain maximum yield from the well. Typically the slot size of the screen is selected so that 85 percent of the artificial pack material will remain outside of the screen after well development.

7.12.2 Yield Test

A yield test is important because it gives the information of:

- Rate at which to pump the well
- Depth at which to place the pump.

After drilling and developing a well, one must remove water from the well for at least 2 hours. If a pump is used to remove the water, then water level measurements can be recorded as the water level draws down during pumping. If the yield test is performed using an air compressor to remove the water, water level measurements cannot be taken during the water removal portion of the test.

After 2 hours, water removal should be stopped and the recovery of the water level monitored and recorded. Measurements must be taken at specific time intervals for a 2 hour period or until the water level returns to 90 percent of its original level. Once the yield test is complete, it can be decided at what rate the well can be pumped without lowering the water level below the top boundary of the aquifer, the top of the perforations or below the pump intake.

This also help in deciding the pump capacity as pump should have a capacity equal to, or less than, the rate at which the well can supply water for an extended period of time without lowering the water level below the pump intake. That pumping rate is considered the long-term, safe and sustainable pumping rate for the well.

A tubewell should be tested for yield by experienced staff as per IS:2800-1979.

7.12.3 Disinfecting the well

New well should be disinfect with chlorine. The concentration must be at least 200 milligrams of chlorine per litre of water present in the well and must be left in the well for at least 8-12 hours to ensure any bacteria present are destroyed.

8.0 DESIGN CONSIDERATIONS FOR BOREWELLS:

8.1 Naturally developed borewells and borewells with filter pack :

In aquifers of silts and sands, borewells shall be provided with a filter pack, but in aquifers having gravelly sands, sandy gravel and gravel with D_{10} (grain size to which 10% of the formation material finer) more than 0.3mm and uniformity coefficient more than 5 (D_{60} / D_{10} >5) gravel pack shall not be provided and such wells shall be naturally developed to create a graded zone at the screen in the intake zone.

8.2 Design Yield:

So that good discharge is achieved even under continuous pumping, borewells shall be designed for a rate of discharge 25% more than the required rate of discharge.

8.3 Annular Space:

The annular space between the bore and the casing pipe shall be as follows:

Type of Borewell	Depth of Borewell	Thickness of Annular Space	Diameter of bore hole
Borewells with filter pack	Less than 125m	3”	D+6”
	125 to 250m	4”	D+8”
	More than 250m	6”	D+12”
Naturally developed borewells without gravel pack	Less than 125m	1”	D+2”
	More than 125m	1½”	D+3”

Filter pack material and sealing grout shall be placed around the screen by tremie pipe emplacement method using a rigid pipe of 1-1/2 inch diameter depending on the maximum grain size of the filter material.

8.4 Screens:

Slotted pipes may be used as screens in fine grained aquifers but preferably continuous wire wound screens shall be used in all types of aquifers. Screens conforming to **para 7.2 of IS 8110 : 2000 " Well screen and slotted pipes** - Specifications" should be used. The total surface area of the screen shall be such as to give entrance velocity less than 3 cm/sec even with 50% decrease in the effective open area due to "incrustation, rearrangement of the aquifer particles around the screen and coverage by gravel etc" at the design discharge of the well (Para 7.3 of IS: 8110:2000). The diameter of the screen shall be kept the same as the diameter of the casing pipe.

8.5 Slot size:

Slot size shall be selected as follows:

i. Borewells with filter pack- Slot size shall be so selected as to retain 90-100% of the pack material.

ii. Borewells naturally developed and without filter pack : Slot size shall be such that it would allow 40-60% of the aquifer materials to pass through.

8.6 Filter pack :

Following aspects of design of gravel pack need special attention :

i. Filter pack shall consist of well-rounded particles, with uniformity co-efficient (D_{60}/D_{10}) less than 2.5. The gravel / sand used in the filter pack shall be 95% siliceous (Not>5% soluble in hydrochloric acid), free from foreign matters, washed and disinfected. Gravel shall conform to IS:4097:1988 " Gravel for use as filter pack in borewells".

ii. The filter pack shall extent above the screen a distance of 1 to 2 m, to account for setting and loss during development to prevent the filter pack around the screen from being fouled by and the sealing grout.

iii. The size and grading shall be as per B-3 of Annexure B of IS:8110:2000 "Well screens and slotted pipes – Specifications". Gravel shall be consist of sand or gravel .The grain size shall be so selected as to have D_{50} of the filter pack 9 – 12.5 times the D_{50} of the formation in the aquifer in uniform aquifers and 11-15.5 times the D_{50} of the formation in the aquifer in non-uniform aquifers. Another criteria is that the average pore size of the gravel pack, which may be taken as 0.4 times D_{10} of the gravel pack, should be less than D_{85} of the formation in the aquifer.

8.7 Casing pipe :

Casing pipe shall be of mild steel conforming to IS Code 4270:2001. However, in areas where borewells are known to give water with high levels of TDS (>1000ppm), chlorides (>500ppm), high acidity (pH <6) the casing pipe and screens made of corrosion resistant material like PVC and alloy steels shall be used (refer IS:12818:2010 Unplasticized polyvinyl chloride (PVC-U) Screen and casing pipes for Bore/ tubewells – specification).

8.8 Housing pipe :

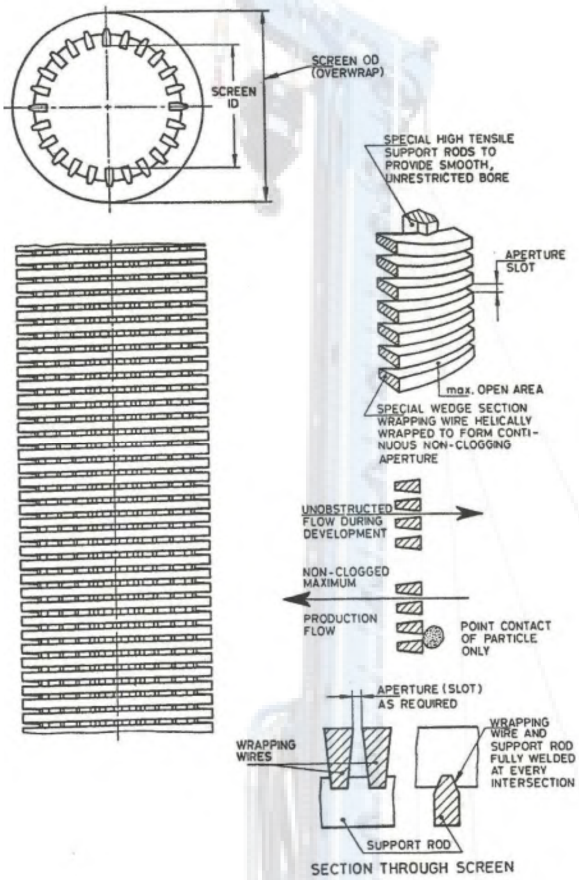
The practice of providing a housing pipe of a much diameter larger than the casing pipe shall be discontinued. Modern submersible pumps do not require large housing pipes. Further, the size of the casing pipe itself has been increased from 8”-10” for higher yields of wells (HCBs).

8.9 Intake zone:

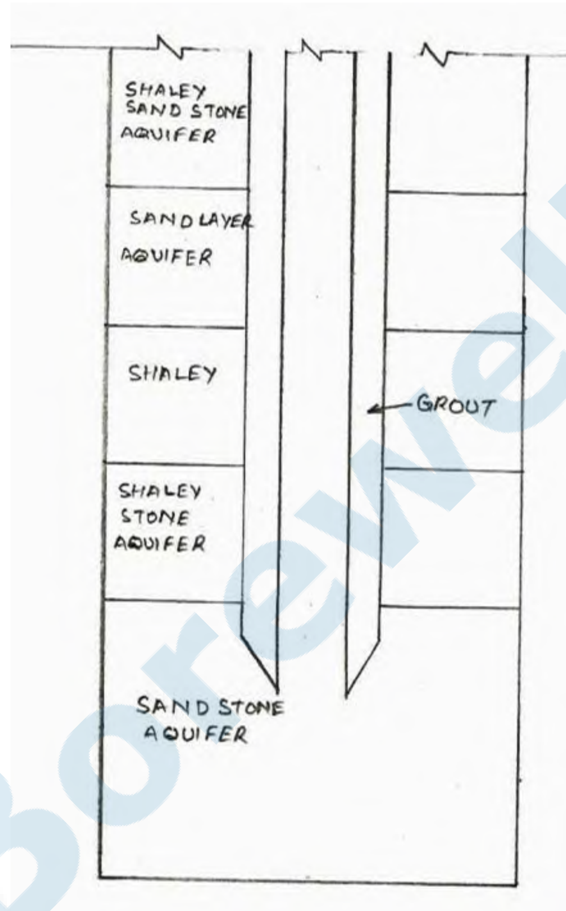
The intake zone shall be so selected as to cover a continuous aquifer of the same type of formation. If the intake zone is non homogeneous, the slot size and filter media for the coarser and the finer formation shall be designed as per para B-3.2 of Annexure B of IS:8110.

8.10 Field measurement of grain size :

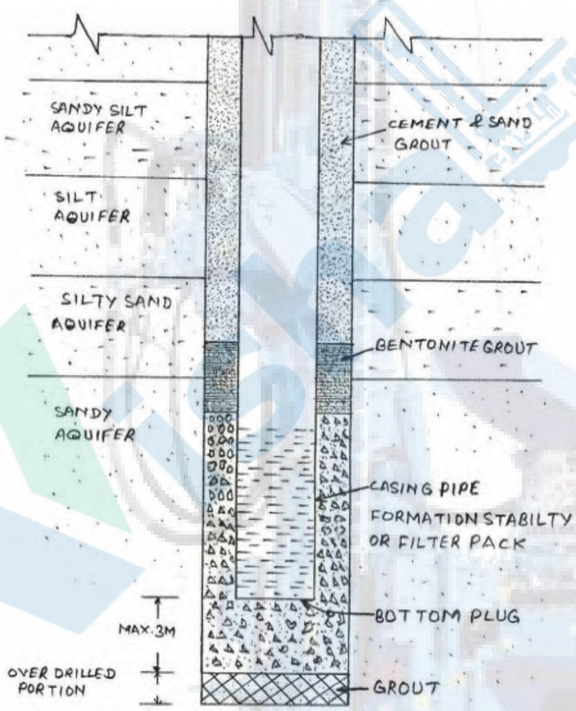
The grain size distribution (value of D_{10}, D_{15}, D_{60} and D_{85}) shall be measured by the field method of classification by putting the sample of formation mixed with water in a calibrated cylindrical jar of glass, shaking well the solution and allowing to mixture to settle down so that the coarsest particle settle down at the bottom and the finest at the top.



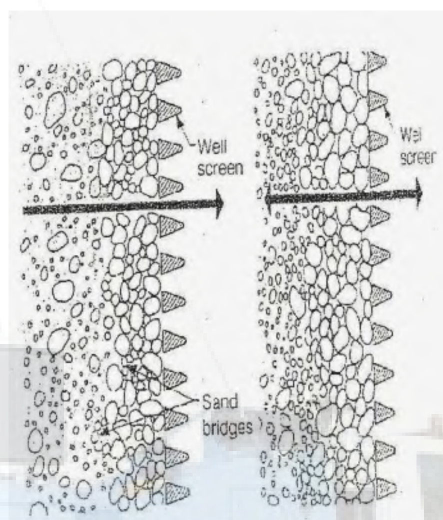
Cage type wire wound screen



Intake zone in a rock aquifer



Intake zone in a unconsolidated aquifer



Development of the aquifer to form a graded zone around the screen

9.0 Classification of formation material:

Classification of formation shall be done according to the Unified Classification System, using nomenclature such as "well-graded sandy gravel, poorly-graded sand, well-graded silty, sandy gravel sandy, clay of medium plasticity" etc. If it is not possible to accurately assess the grain size and grading of the formation and the yield of the aquifer, the values of yield, slot size, grading of filter pack and screen length given in Table-I, Table-II and Table-III below may be adopted which will also be used for preliminary design of the borewell.

TABLE- I

(For HCB and MCB Class borewells with filter pack)

Formation of Aquifer	Design Yield	Nominal diameter of casing pipe	Filter Pack	Length of the screen	Type of Screen	Slot size of Screen
Clayey sandy silt, and sandy silt D_{85} = Less than 0.08 mm	10,500 to 16,000 GPH	200mm	0.2 mm to 0.6 mm	15 to 20 m	Preferably cage type wire-wound slotted pipe may also be used	0.25 mm (10% open area)
Silty sand D_{85} = 0.08 to 0.24 mm	13,500 to 20,000 GPH	200mm	0.6 mm to 1.6 mm	10 to 15 m	Preferably cage type wire-wound slotted pipe may also be used	0.50 mm (18% open area)
Silty Sand, Sand D_{85} = 0.24 to 0.8 mm	23,000 to 35,000 GPH	250 mm	2.0 mm to 4.75 mm	10 to 15 m	Case type wire wound screen	1.0 mm (25% open area)
Sand and gravelly sand D_{85} = 0.8 to 1.6 mm	30,000 to 45,000 GPH	250mm	3.35 mm to 8.0 mm	10 to 15 m	Case type wire wound screen	1.5 mm (33% open area)

TABLE-II

(For naturally developed HCB and MCB Class borewells without filter pack)

Formation	Design Yield	Nominal diameter of casing pipe	Length of the screen	Type of Screen	Slot size
Gravelly sand D_{50} >0.9 to 1.25 mm	23,000 to 35,000 GPH	250mm	10 to 15 m	Cage type wire wound screen	1.0mm (25% open area)
Sandy gravel and gravel D_{50} >1.25 to 1.75 mm	30,000 to 45,000 GPH	250mm	10 to 15 m	Cage type wire wound screen	1.5mm (33% open area)
Sandy gravel and gravel D_{50} > 1.75 mm	30,000 to 45,000 GPH	250 mm	8 to 12 m	Cage type wire wound screen	2 mm (40% open area)

TABLE-III

(For LCB Class borewells)

Formation	Design Yield	Type of Screen	Length of screen	Slot size
Silty sand $D_{50} < 0.25$mm	1,500 to 2,000 GPH	Slotted pipe	2.0 m to 3.0 m	0.25 mm (10% open area)
Sand $D_{50} = 0.25$ to 0.5 mm	2,000 to 3,000 GPH	Slotted pipe	1.5 m to 2.5 m	0.50mm (18% open area)
Sand $D_{50} > 0.5$ mm	3,000 to 5,000 GPH	Cage type wire wound	1.50 m to 2.5 m	1.0mm (30% open area)

Notes regarding Tables I, II and III:

i) If the open area of the screen is more or less than the figure in the last column in the above tables, length of screen shall be proportionately increased / decreased.

ii) The actual yield may be lower than those indicated in the tables above in places with poor aquifers and due to factors like a low rainfall area.

iii) A casing pipe of a 200 mm diameter can be used in place of 250mm and a 250 mm diameter pipe can be used in place of 200mm provided the length of the screen is proportionately increased/reduced.

10.0 Sanitary seal and sealing of intake aquifer:

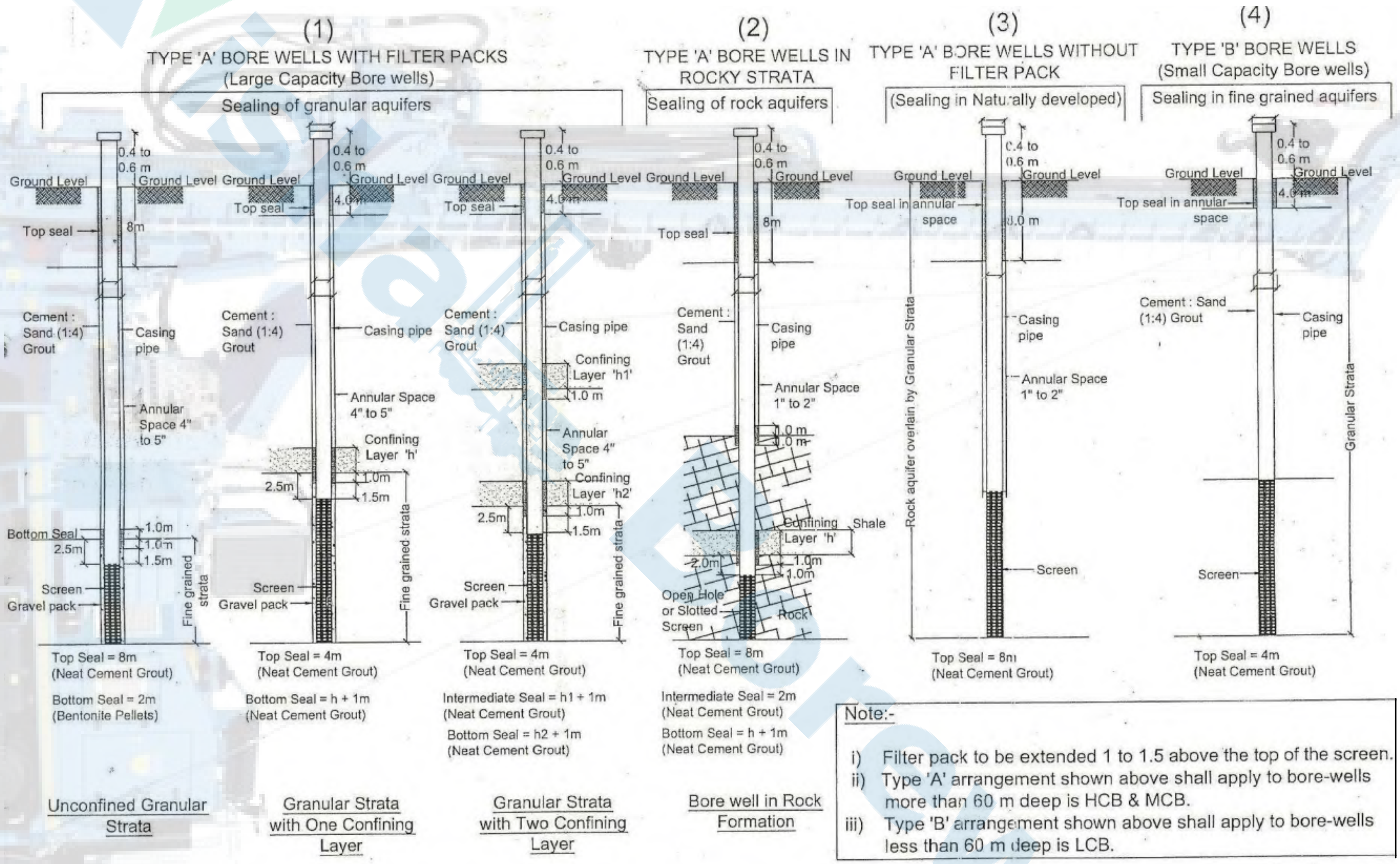
All drinking water borewells shall be properly sealed to prevent migration of surface water into the intake aquifer, and in case of confined aquifers sealing shall be done to also prevent migration of water from aquifer above the confining layer in to the lower intake aquifer. A confined aquifer is a layer of thickness more than 3m of the clay, silty clay or sandy clay with vertical hydraulic conductivity $<10^{-6}$ m/sec.

There will be three type of seals:

i) Neat cement grout near the top of the well, and at the confining layer.

ii) bentonite pellet seal just above the filter pack (Bentonite pellets expand several times over when wet and thereby fill up the space created due to settling of the filter media during development), and

iii) cement-sand grout in the intermediate space. Details are shown in figure 3. Neat cement grout shall be prepared by mixing 50kg of cement in 26.63 liter of water. Bentonite powder shall be added to cement in the ratio of 3% to reduce shrinkage cracks. The grout so prepared shall have a volume of 33 liters. Bentonite pellets shall be emplaced using tremie pipe of inside diameter 1-1/2 inches. Neat cement grout and cement sand grout shall also be emplaced using tremie pipe. Grouts generate substantial heat during hydration. So in bore wells of PVC pipe casing, precautions should be taken to prevent melting of the pipe.



Note:-

i) Filter pack to be extended 1 to 1.5 above the top of the screen.
ii) Type 'A' arrangement shown above shall apply to bore-wells more than 60 m deep is HCB & MCB.
iii) Type 'B' arrangement shown above shall apply to bore-wells less than 60 m deep is LCB.

Fig.A: SCHEME FOR SEALING OF BORE-WELLS

11.0 Development:

Proper development is essential for good yield and service life. The objective of development is to create a good graded zone of formation material in the aquifer at the borewell intake around the screen /filter –pack so as to prevent fines from entering into the borehole. For borewells without filter pack, typically 3 to 4 hour of development is required per meter length of the screen. In borewells with filter pack, development of about 1 to 2 hrs per meter length of the screen is required. **IS code 11189: 1985** deals with “Methods for tubewell development”. Development of the borewell shall be done using one of the following methods.

i) **Air lifting and surging**: The air surging method uses compressed air injected in to the well to lift water to the surface. The air in then turned –off, allowing the column of aerated water to fall back in to the well, reversing flow back into the aquifer. The cycle of the lifting the water column and then letting it drop by switching of the compressor is vital for surging action which is essential for proper development (fig. 4). This operation shall be performed repeatedly till the water becomes free of turbidity. Air surging shall be done at 1 to 1.5 times the design capacity of the well. The well shall be developed in 1.5 m sections starting near the top of the screen. Air should not be injected into the screen .

ii) **High velocity water jetting**: Development by water jetting is more effective than air lifting and surging. However jetting shall be done under properly controlled condition by a trained operator. Jetting shall be done using a jetting tool of diameter 1” less than the inside diameter of the screen. The minimum exit velocity of water should be 50m/sec and the tool should be rotated at a speed less than 1 rpm. Jetting shall proceed from bottom of the screen to the top with pumping from the well occurring at 15 to 25% more than rate of jetting.

12.0 Disinfection of newly constructed borewells:

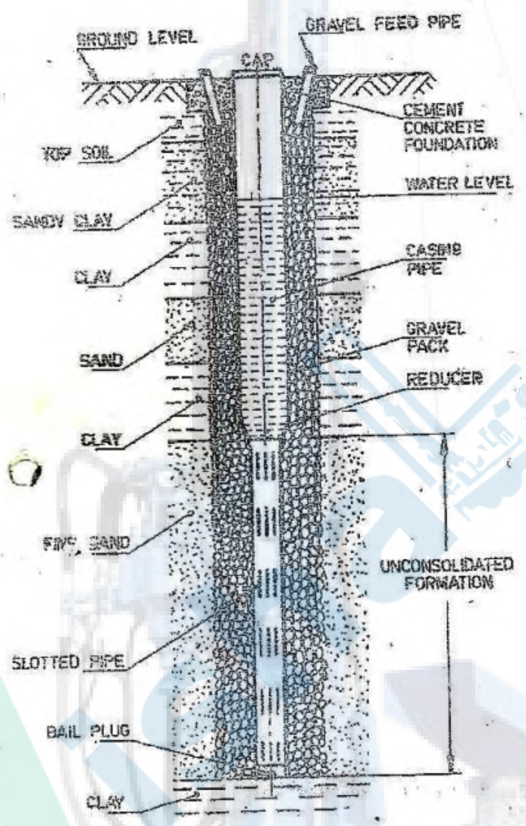
All new bore-wells shall be disinfected by super chlorination for 8 hours at 50 to 200 ppm for the full volume of water in the borehole (sodium hypochlorite solution may be used). After disinfection is completed the bore well shall be run at full discharge for two to three hours to remove all residues chlorine and chlorination by products which may affect testing of the quality of the water from the bore well. Samples of water for chemical and bacteriological examination of the water from the well shall be taken at least seven days after disinfection of the borewell.

13.0 Yield Test and determination of the discharge capacity of the pump for optimum performance:

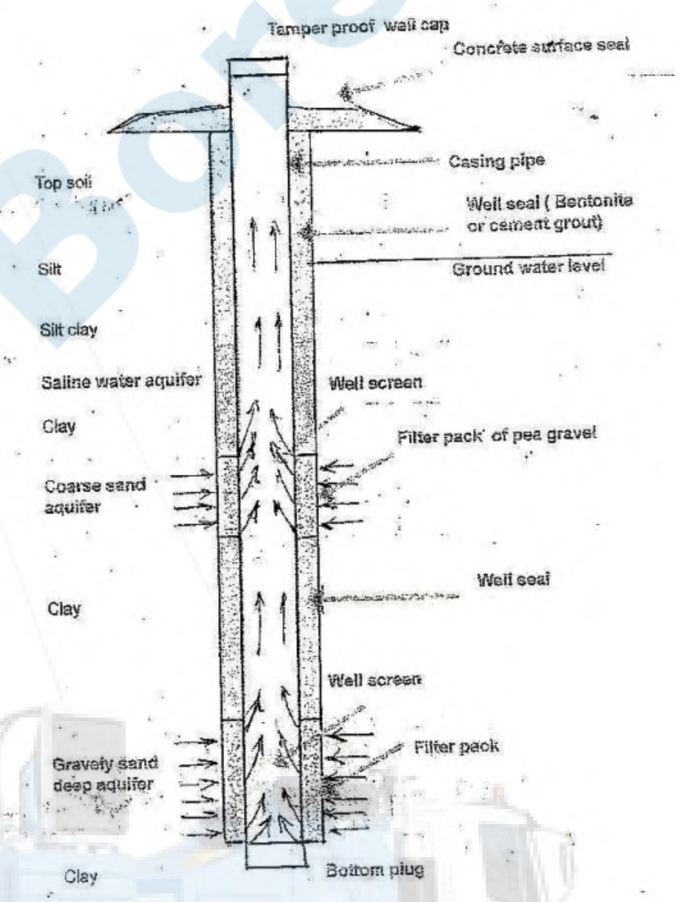
The yield measured with the drilling contractor’s air compressor shall be taken as a rough indicator of the yield as actual yield for optimum performance may vary by as much as 50%. Therefore, yield test with compressor should be followed with a pumping test (step down test) to accurately assess the performance of the well and the capacity and horsepower of the permanent pump. Procedure for pumping test is given in Par 5 of **IS Code 2800 (Part II)** “Code of Practice for Construction and Testing of Tubewells/borewells, Part II, Testing”. In the step-down test, the drawdown shall be measured at the end of two hour of pumping at the following rates of discharge:

(i) First: 0.5 Q
(ii) Second: 0.75 Q
(iii) Third: 1.0 Q
(iv) Fourth: 1.15 to 1.5 Q

Q shall be taken as the yield determined from the yield test done with the compressor of the drilling rig. The final discharge should be free from sand with a maximum tolerance of 20 parts of sand in one million parts of water by volume after twenty minutes of starting the pump. **<u>If the discharge is not sand free the well shall be redeveloped. In case the discharge is still not sand free even after redevelopment, the pump set of a lesser discharge should be installed to get sand free water. Pump of capacity equal to about 2/3rd of the yield determined from the drawdown curve shall be installed for regular operation of the pump.</u>**



Borewell construction for irrigation purpose but unsuitable for drinking water



Borewell construction with proper sealing of aquifer to prevent contamination from surface water and unsuitable aquifers such as aquifers with saline water

14.0 Approval of site plan, preliminary and final designs, and installation, testing and commissioning:

Stage 1: The site plan and a preliminary design of the bore well on the basis of data about aquifer obtained through electrical resistivity mapping of the aquifer, and design as per para 4 above shall be prepared. The data regarding strata obtained from mapping shall be compared with the strata chart of the nearest existing bore-well. The site for the bore well shall selected so as to be sufficiently away from possible sources of contamination like drains, septic tank manure animal farms, rubbish dumps, petrol and chemical storage site. The site plan and the preliminary design shall require approval of competent authority.

Stage 2: After the approval of site plan and preliminary design, tendering, contracting etc if the work is to be executed through contract shall be carried out. Following information to be furnished by Drilling agency:

a) Suitability of the site proposed by the owner (if a more suitable site, other than the one proposed by the owner is available, it should be suggested) :
b) Whether a test bore hole is proposed and if so, its diameter and depth, and also depth of production tubewell proposed:
c) Likelihood of increase or decrease of the depth given at (b) above:
d) Method of drilling with size of bore in different depths:
e) Types of plain pipe with size, wall thickness and slotted/strainer pipes openings, may be mentioned:
f) Guarantee with regard to the verticality of tubewell and sand content (ppm) in the discharge from the well at the time of handing over:
g) Development methods to be adopted may be stated :
h) Any other information and conditions :

Stage 3: A pilot bore of 6 to 8 inches diameter shall first be done which can be finished to the required final diameter by reaming. Strata chart shall be prepared based on samples collected during drilling of the pilot bore. Geophysical log of the borehole shall also be taken which shall be used in conjunction with the strata chart for assessing quality of the aquifer. Geophysical logging is today common and equipment is inexpensive. When this is done, Engineer-in-charge or his representative will inspect the site, and collect all the data needed for designing the well. Based on this data, the well shall be designed, and issued for further execution. If the site is not suitable the pilot bore shall be abandoned, and an alternative site shall be selected.

Stage 4: All the construction material like casing pipe, screen, filter pack and grout material etc. shall be brought to the site for inspection of the material by AEN/ Officer-in-charge . Electrical Department will be informed about the design yield of the well so as to arrange for a pump of suitable capacity for conducting the pumping test.

Stage 5: Completion of borewell by widening the pilot bore, lowering of the casing pipe and screen, placement of the filter pack, grouting etc followed by finishing, disinfection, yield test, collection of sample for bacteriological and chemical analysis etc. Construction of the panel room for the pump and chlorination plant room should also be started after approval of the location of the borewell and detailed design so that commissioning is not delayed on account of delay in their construction.

Stage 6: Pumping test will be done jointly with the engineering and electrical supervisor, and the borewell shall be commissioned after redevelopment, if necessary with pump of suitable capacity as per para 9.0 above.

15. Quality of Water

Aquifer contamination, problems with a well's structure, or lack of routine maintenance could each lead to a change in water quality. During the construction of the well, due precautions shall be taken by the drilling agency to maintain the premises in a sanitary condition and to avoid as much as practical, the entrance of contaminated water into the safe water bearing formations. Any water or materials used shall be free of contamination and, if their nature permits, should be adequately disinfected with chlorine before use. The slush pit should be constructed so that no material there from will enter the well, except mud reused when the construction is by rotary method. In such cases the slush pit and mud return channels should be protected against contamination from surface water or any other sources. Water shall be collected during aquifer performance test and analyzed chemically, for different constituents depending on the ultimate use to which water will be put.

Water Quality Measurements

Use the following checklist as a starting point to determine if a problem exists.

- Unpleasant odour or taste
- Red discoloration on plumbing fixtures and fabric
- Cloudy, dirty water
- Scale in pipes and water heater
- Salty alkali taste

Some changes in water quality are not detected by changes in taste, smell or appearance. For this reason it is important to sample and analyze the water on a routine basis.

Bacteriological Analysis

Bacteriological analysis determines the total coliform and faecal coliform bacteria in the water. Coliform bacteria are usually present in soil and surface water. Faecal coliform are present in animal and human waste. Both are indicator organisms for the potential presence of pathogenic (disease causing) bacteria. A bacteriological analysis should be done annually.

Chemical analysis

A routine chemical analysis tests for the most common chemical parameters found in water, such as iron, sodium, sulfates, nitrates and nitrites. In some cases, there will be need to request testing for additional parameters when a health concern is identified (such as arsenic or fluoride).

Sampling

Collect the sample as close to the well head as possible to avoid any effect the water treatment or distribution system may have on the sample.

Interpreting results

Whenever an analysis is done, obtain a written copy of the results and keep its record as it helps to create a history of well to use for comparison should the water quality ever change. This is also useful in deciding whether any other water treatment equipment/method is needed to improve water quality.

16. Handing Over of Tubewell

The following information should be furnished by the agency on completion of testing of the Tubewell in terms of clause 7 of IS:2800(Part-II):1979 "Code of Practice for Construction and testing of tubewells, Part-2: Testing":

a) Results of the tubewell depth and water level measurements,
b) Report on the chemical and bacteriological analysis of water, and
c) Results of development and drawdown test as given in Table 1.

TABLE 1 : TEST RESULTS

A. Normal Test

Sl No.	Rated Discharge	Depression at Rated Discharge	Specific Yield 2/3	Total Hours Run	Sand in ppm at End of Test	Static Water Level	Pumping Water Level

B. Discharge at 1.2 times normal yield or 1.5 times the normal depression

Specific Yield Discharge Drawdown	Total Hours Run	Sand in ppm at End of Test	Static Water Level	Pumping Water Level

16.1 Sampling of strata and preservation of samples: Sampling shall be done at every 2m of drilling and at every charge of strata. **Samples shall be preserved .**

16.2 Well Completion Report: Completion report of the well showing all necessary details of the strata, the main design features, pump details etc shall be prepared. Data in the completion report format shall be kept up to date as the work proceeds.

16.3 Well cap and vent pipe: The well cap should form insect-tight and water tight seal with the casing pipe. The well cap shall be properly secured to discourage unauthorized removal. All wells shall be provided with vent pipe. Vent pipe should be self-draining and screened with a non-corroding 0.43" size screen that prevents entry of insects. The vent should extent 0.45m above the ground surface.

16.4 Location of pump house: Pump house need not to be provided right above the borewell. The bore well shall be finished by providing a proper apron and chamber for enclosing the head of the borewell which shall be properly capped and secured with lock to prevent unauthorized access. The cover of the borewell chamber shall also have locking arrangement.

16.5 Use of centralizers for properly aligning the casing pipe and screen along the axis of the bore: Centralized which can be attached to the casing pipe and screen at intervals of 3 to 5 meters should invariably be used for aligning the casing pipe along the axis of the bore.

17.0 Maintenance of Borewell:

Proper care and maintenance of water source are key to protecting the water supply. An effective monitoring practice will identify changes in water levels and water quality before they become serious problems. Regular, systematic inspections and treatment of problems will help increase the life of borewell. The important step in preventative maintenance of borewell is taking regular Water level and Water quality measurements:

Water Level Measurements

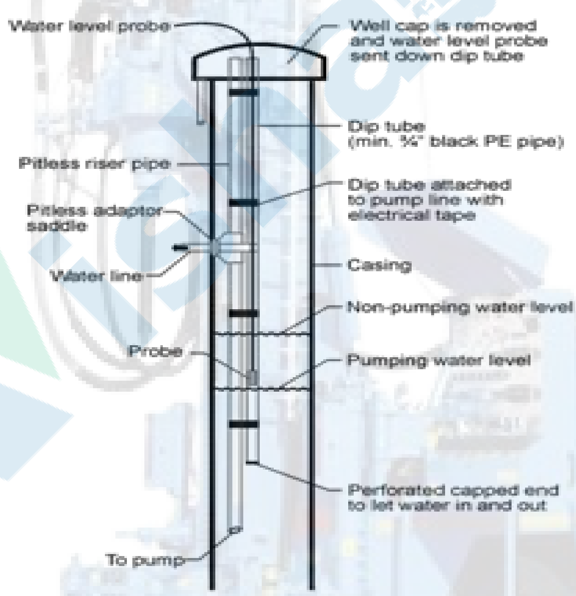
Taking water level measurements on a regular basis will help in identifying if borewell is experiencing any of the following problem:

- Pumping the well at a greater rate than it is designed for (stressing the well by over-pumping)
- Pumping the well at a greater rate than the aquifer is capable of producing (depleting the aquifer)
- A plugged screen (or slotted casing) can diminish the well's efficiency and production rate
- Reducing groundwater recharge due to land clearing and surface water drainage.

It is good practice to take a water level reading monthly or quarterly as shown in the table below. Readings are taken both with the pump on and the pump off (with time to recover). Readings taken with the pump on will identify problems with the efficiency of the well (for example, a plugged screen). Readings taken with the pump off will identify any problems with the aquifer and the quantity of water available for pumping.

Month	Water Level from top of casing	Time	Pump on / off	Remarks
Jan'2013	3.28 m	6:00 am	on	
April'2013	4.30 m	7:45 am	off	
July'2013				

Measurement of water level can be recorded with the help of Dip tube which is a 1-2 in. plastic pipe or hose lowered into the well, to below the pumping water level with a floating probe inside as shown in figure. Water level can also be recorded with the help of Water well sounder or Sonic Sounder.



DIP TUBE

Interpreting Non-pumping Water Levels

The non-pumping water level is recorded after the water level in the well has been allowed to fully recover and before the pump is turned on. A good time to take a non-pumping reading is first thing in the morning before there has been any water use. **A yearly record of water level measurement should be kept for comparison and assessing the performance of borewell.**

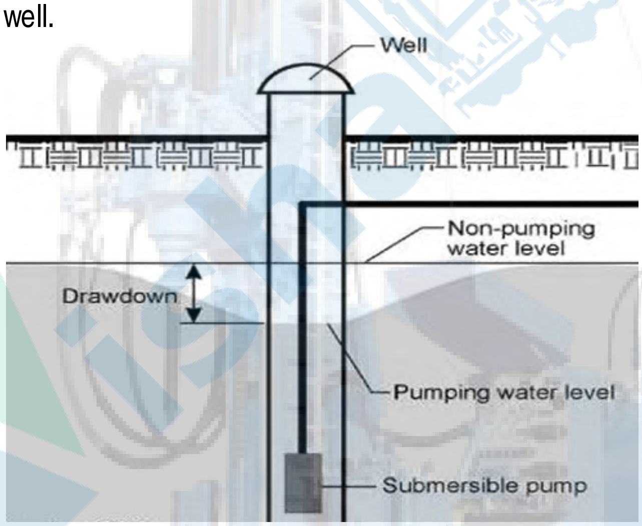
After recording several measurements over a period of time, one should be able to determine if the non-pumping water level in the well has changed significantly. Some change will occur due to seasonal fluctuations. For example, in shallow wells, water levels are usually highest in June to September and gradually decline in late September or October and throughout the winter.

If water level is more or less maintained, it indicates that the aquifer seems to be able to supply water to the well commensurate with pumping rates and no action is required. If there is significant drop in water level in comparison to the same or previous year's record, it indicates pumping is being done at the rate higher that aquifer can supply. To address the drop in water level, reduce the amount of water drawn from the well. In such situations, one should take another measurement in a month to see if the water level is recovering. If the water level begins to rise again, it means one is over-pumping the aquifer, producing more water from the well than the aquifer can supply. To prevent the well from going dry, pumping rate should be reduced. If the water level does not recover, one should further reduce water use and look for other possible water sources.

If the non-pumping water level suddenly drops after remaining steady for many years, it may be a result of increased use from nearby wells that are completed in the same aquifer.

Interpreting Pumping Water Levels:

Record the pumping water level while the pump is operating, i.e. Pumping Water Level Drawdown. If several readings are taken over the time, then this data can help in assessing the efficiency of the well.



Now if the pumping water level drawdown is more or less steady, there does not seem to be a problem with the efficiency of the well and no action is required. If over the yearly records, it is observed that although the original non-pumping water level has remained constant, the pumping water level has declined significantly, it indicates that the screen (or slotted casing) may be plugged with sand, bacterial growth or mineral incrustation. When this happens, the efficiency of the well is diminished and the production rate (yield) drops and the well may need to be serviced. The screen or slotted casing may either be surged to remove sediments or replaced. There may also be need of shock chlorination of the well to reduce bacteria incrustation on the casing or screen.

Other Maintenance issues:

17.1 Chemical and bacteriological examination of borewells: Chemical and bacteriological examination of the water from borewells shall be done once in every year. A tap shall be provided on the rising main of the borewell so samples of borewell water can be collected regularly.

17.2 Yield test: Yield of all borewells shall be checked once in a year.

17.3 Redevelopment of bore wells in service: Redevelopment of borewells shall be taken as a regular exercise of maintenance, and it should normally be done when the yield reduces to 60 to 70% of the bore well's original yield.

18.0 Plugging Abandoned Wells

When a well is no longer being used or maintained for future use, it is considered abandoned. Abandoned wells pose a serious threat to the preservation of groundwater quality and are also a serious safety hazard for children and animals. Hence abandoned wells should be plugged as per the process given below:

Preparation

To know exactly how much plugging material is needed, measure the total depth and diameter of the well, plus the non-pumping water level (the depth to the standing water in the well). Ideally the casing should be removed from the well before the plugging process begins. Often only the liner casing is removed and the surface casing is left intact because it is more difficult to remove and it could separate down hole.

Materials

Materials that are used to plug a well must be uncontaminated and impervious. They must prevent any movement of water. Sand and cement grouts, concrete, high yield bentonite and clean, uncontaminated clay are ideal material for plugging. High yield bentonite is a special type of clay that swells when wet to provide a very effective impervious seal. Sand and gravel are not acceptable materials. They are not impervious materials because water can easily move through them.

Method

Aside from choosing the appropriate plugging material, the method of placing material into the well is most critical. The plugging material must be introduced from the bottom of the well and placed progressively upward to ground surface.

If the plugging material is cement grout, concrete or bentonite slurry, it must be placed into the well through a tremie pipe that is usually about 3-6 in. in diameter. At all times this pipe must be kept below the surface of the plugging material to prevent it from separating. When bentonite pellets are chosen for the plugging material, they can be slowly poured into the well from the ground surface so that they reach the bottom of the well before swelling and sealing the borehole.

19.0 Troubleshooting Guide

There are four common symptoms associated with most water well problems:

- Reduced well yield
- Sediment in the water
- Change in water quality
- Dissolved gas in the water.

Against each symptom, possible causes and indicators for checking and correcting the problem are given. In many cases the well problem can be the result of a combination of causes and therefore correction may be a combination of actions as well.

Symptom # 1 - Reduced Well Yield

SN	Possible causes:	What to check for:	How to correct:
1.	Pump and/or water system	Low pump production in spite of normal water level in well. Leak in system; worn pump impeller.	Have a water well agency and electrical foreman to check the pump and water system.
2.	Bio-film build-up in well casing, well screen or pump intake	Slime build-up on household plumbing fixtures. Inspect pump to check for slime build-up	Shock chlorinate the well and water system as required.
3	Mineral scale (incrustation) build-up on perforated well casing, well or pump screen.	Scale formation on plumbing fixtures. Inspect pump.	Once the type of mineral scale has been identified, the well should be physically cleaned through agency. May also require chemical/acid treatment as outlined below.
a	Clogging due to fine sand, clay and silts	Sodium hexametaphosphate 50gm/litres depending on the capacity of borewell be left therein for 24 hours. The same should be followed by surging, jetting with chemical mix or normal development till well is freed from clogging	
b	Chemical clogging	Hydrochloric or sulphuric acid with inhibitor may be added to the well	
4	Sediment plugging on outside of perforated casing or screen.	Sediment in water, followed by a sudden decline in yield.	Redevelop the well through Agency.
5	Collapse of well casing or borehole due to age of well.	Sediment in water. Compare current depth of well with original records. A collapsed well will show a shallower depth than the original well.	Recondition the well. If repair is not economical, abandon and plug the well and redrill.
6	Neighboring well interference.	Check for significant drop in water levels in nearby wells. Check if groundwater use in the area has increased.	Identify other nearby wells located in the same aquifer. Reduce pumping rates as required.

SN	Possible causes:	What to check for:	How to correct:
7	Aquifer depletion • rate of withdrawal exceeds rate of recharge • periods of drought can temporarily deplete • shallow groundwater zones	Compare current non-pumping static water level with the level at the time of well construction. A lower level confirms aquifer depletion. Check if water levels in the area are declining.	Reduce the water use. Install additional storage to meet peak water requirements. Drill a deeper well or one that taps into another aquifer.

Symptom #2 - Sediment in Water

SN	Possible causes:	What to check for:	How to correct:
1	Improper well design or construction.	Sediment appears in water shortly after well completion. Well production does not improve with pumping.	Ask agency to redevelop and repair the well and to identify the construction problem.
2	Insufficient well development after construction.	Sediment appears shortly after well completion. Well production may improve with pumping.	Ask water well contractor to redevelop the well.
3	Continuous over-pumping of well.	Sediment appears in water. Compare current discharge rate of well with the rate at the time of construction.	If the current flow rate is higher than the initial rate, then reduce the pumping rate and if required, install additional storage to meet peak water requirements.
4	Corrosion of well casing, liner or screen for holes. Holes can allow water of undesirable quality to enter the well.	Sudden appearance of sediment in water when there was no previous problem. May be coupled with a change in water quality. Analyse the water sample to determine the water's corrosion potential.	Abandon and plug the well and redrill in a different aquifer.

Symptom #3 - Change in Water Quality

SN	Possible causes:	What to check for:	How to correct:
1	Corrosion of well casing, liner or screen, causing holes.	Change in water quality, may be coupled with sudden appearance of sediment in water. Analyse the water sample to determine the water's corrosion potential.	Consult a water well Agency. Depending on the well construction, repair or replace well using alternate construction materials.

SN	Possible causes:	What to check for:	How to correct:
2	Failure of the annulus or casing seal.	Sudden appearance of sediment, coupled with a change in water quality. Test water quality regularly and investigate when quality changes occur.	Consult a water well Agency. It may be possible to re-establish the seal. If repair is not economical, plug the well.
3	Iron-related bacteria or sulfate-reducing bacteria (biofouling).	Change in water quality such as colour, odour (e.g., rotten egg) or taste. Check inside of toilet tank for slime build-up and inspect pump.	Shock chlorinate the well.
4	Contamination sources.	Changes in water quality such as colour, odour or taste. Compare results from regular water analyses for changes.*	Identify and remove contamination source. Continue to monitor water quality through regular water testing.

* In many cases, variations in water quality will not result in observable changes in odour, taste or colour. For instance, in situations where nitrate levels are increasing, there may be no apparent change in the odour, taste or colour of the water.

Symptom #4 - Dissolved Gas in the Water

SN	Possible causes:	What to check for:	How to correct:
1	Dissolved gases in well water including: - carbon dioxide - methane	Spurting household water taps. Milky color to the water which lasts only a few seconds. Get the water sample checked for Carbon dioxide and Methane.	For low concentrations of gas: • Ensure the water tank is properly vented. For higher concentrations of gas: • Determine the depth that the gas is entering the well. • If possible, lower the pump intake to below where the gas is entering as the gas will accumulate at the top of the well.
2	Over-pumping the well.	Gas/Air locking of pump. Also compare the rate of pumping the well with the recommended rate in the drilling report.	Have electrical foreman to check the pump. Reduce well pumping rate if necessary and install additional storage to meet peak water requirements if required.

DO's & DONOT's

DO's :

- Prepare bore log / strata-charts and preserve strata samples.
- Design the size of opening and length of the screen, size and grading of filter media, as per IS 2800 (Part 1):1991 "Code of Practice for Construction and Testing of Tubewells/borewells", and IS 8110:2000 "Well Screens and Slotted Pipes" – Specifications.
- Always keep the screen in the deepest part of the borewell.
- Use Wire wound continuous screens which provide large slot area without loss of strength of the pipe.
- Material like casing pipes, screens, pea-gravel should be passed and 100% checked by the competent authority, as these being hidden items.
- Seal the borewells properly to prevent migration of surface water into the intake aquifer.
- Insist upon yield test to estimate the yield and pumping tests to pump capacity and by drawing drawdown and recovery curves.
- Disinfect the new bore-well by super chlorination before use.
- Do proper bacteriological and chemical analysis of water before use.
- Prepare well completion reports properly.

DONOT's :

- Don't depend upon the experience of contractor or any other supervisor/mistry.
- Don't use the material like casing pipes and screens which are not conforming to relevant IS Specification.
- Don't use slotted casing pipes as screen as these screens have small open area and result in very long screens.
- Don't destroy the strata samples soon after completion of installation of a borewell.
- Don't use the pump on the previous data base. Estimate the pump capacity properly by drawing drawdown and recovery curves from pumping tests.
- Don't forget disinfection of the borewell by chlorination before commencing supply from the well.