Pumping Stations Design

For Infrastructure Master Program
Engineering Faculty-IUG

Lecture 6: Design of water supply pumping stations

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Lecture 6: Design of waster supply pumping stations

6.1 General introduction

- Main Types of water pumping stations :

1. Wells pumping stations
2. Distribution pumping stations
3. Booster pumping stations
4. Surface water pumping stations

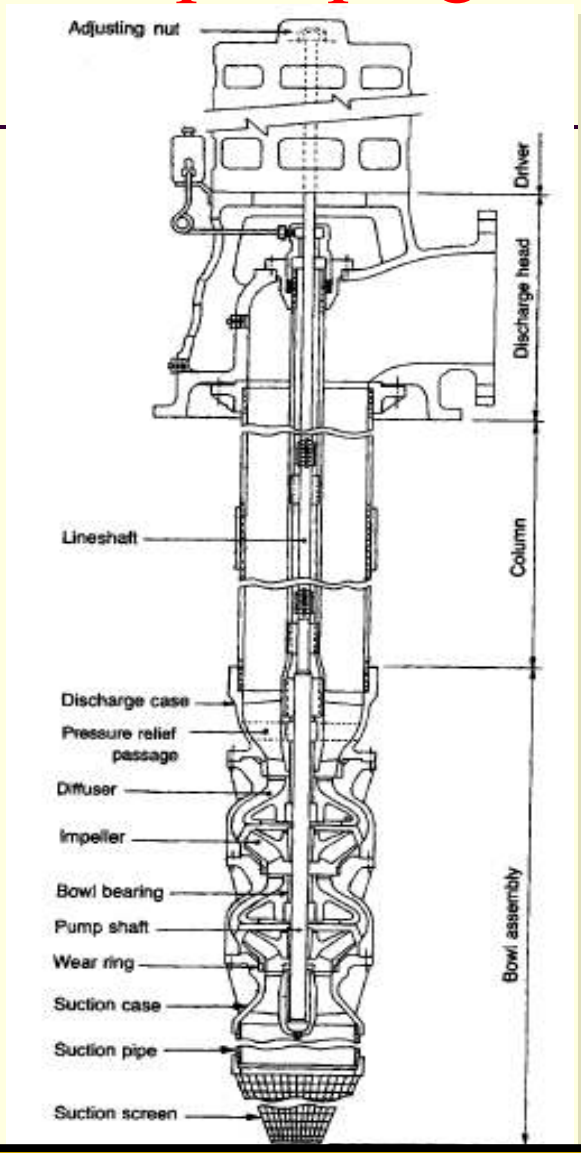
Lecture 6: Design of waster supply pumping stations

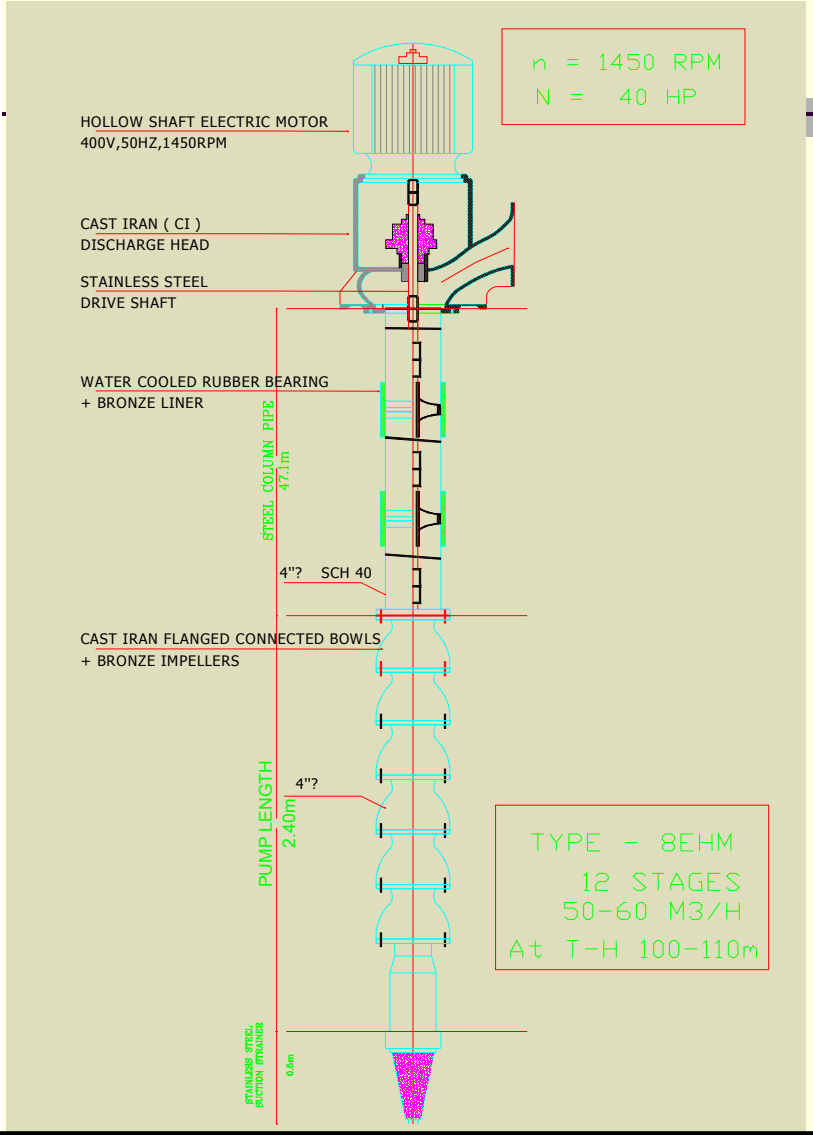
6.2 Well pumping stations

- Main components of well pumping stations :

1. Multi stage pumps (connected in series)
2. Suction shaft (pipe)
3. Vertical motor (above ground or submerged)
4. Delivery pipe
5. Valves
6. Cyclone
7. Surge vessel (air champer for water hammer protection)
8. Chlorination tank and chlorine injection pump.
9. Stand by generator and its fuel tank
10. Main electricity distribution panel and control
11. Service building.

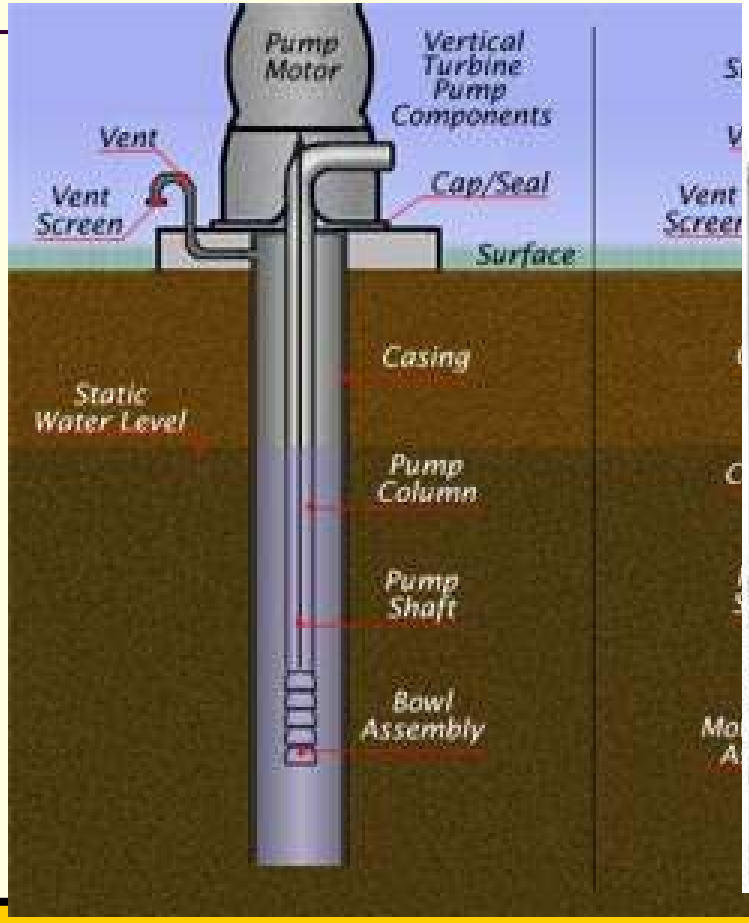
6.2 Well pumping stations





Multi stage pumps connected in series with a dry installation vertical motor

6.2 Well pumping stations



CONSTRUCTION FEATURES:

1. One-piece, stainless steel discharge head & NEMA faced mounting ring.
2. Built-in stainless steel check valve with elastomer ring for positive seal.
3. Sintered lead-free sleeve bearing with polypropylene sand slinger.
4. 304 Stainless Steel Pump shell threaded on both ends for easy attachment to discharge head & mounting ring.
5. Stainless steel suction screen covers a large round suction inlet.

Multi stage pumps connected in series with dry or submersible motor

6.2 Well pumping stations

Multi stage pumps connected in series with diesel motor

6.2 Well pumping stations

CONSTRUCTION FEATURES:

1. One-piece, stainless steel discharge head & NEMA faced mounting ring.
2. Built-in stainless steel check valve with elastomer ring for positive seal.
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Multi stage pumps connected in series- submersible motor

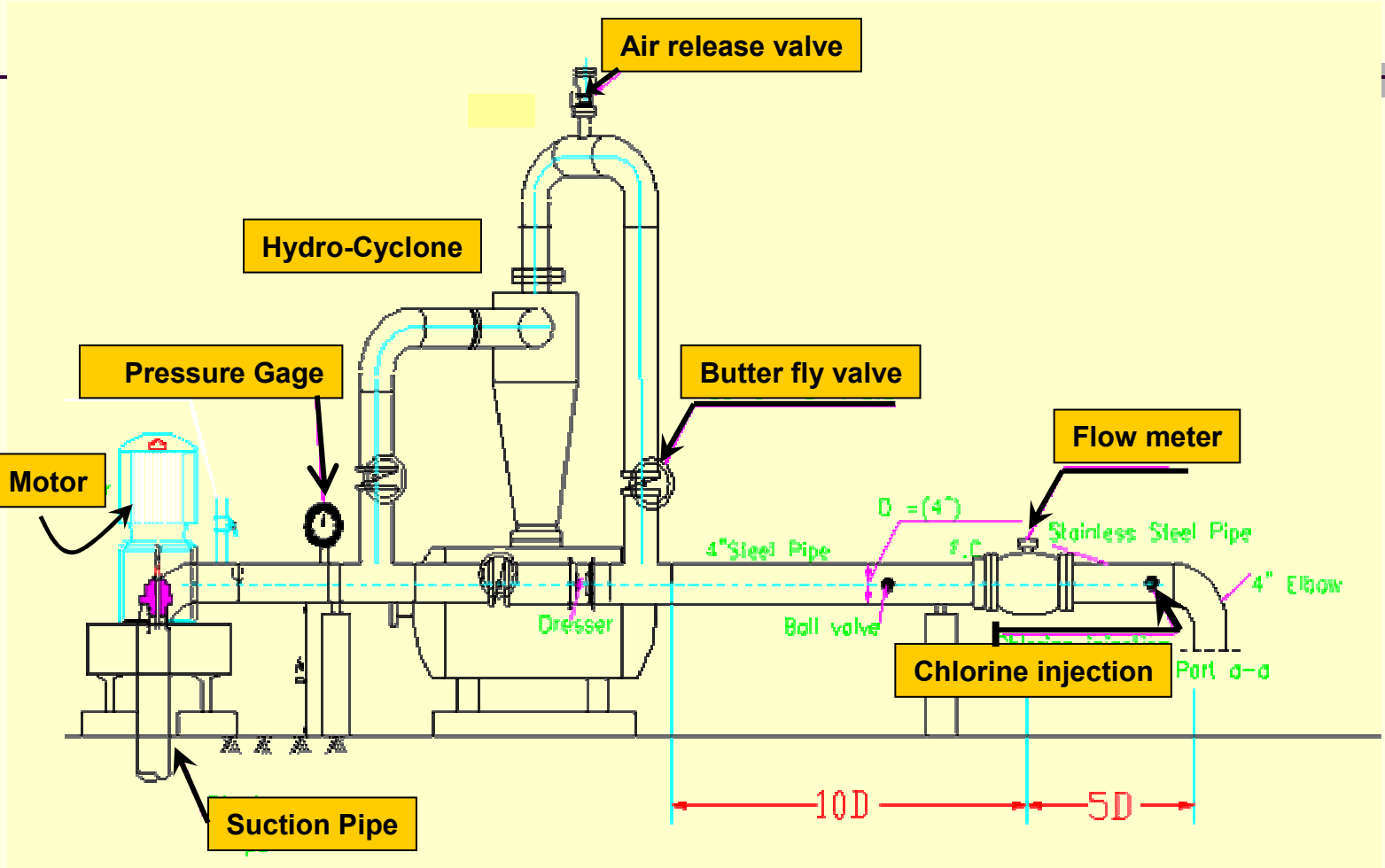
6.2 Well pumping stations

Vertical dry motor installation

6.2 Well pumping stations

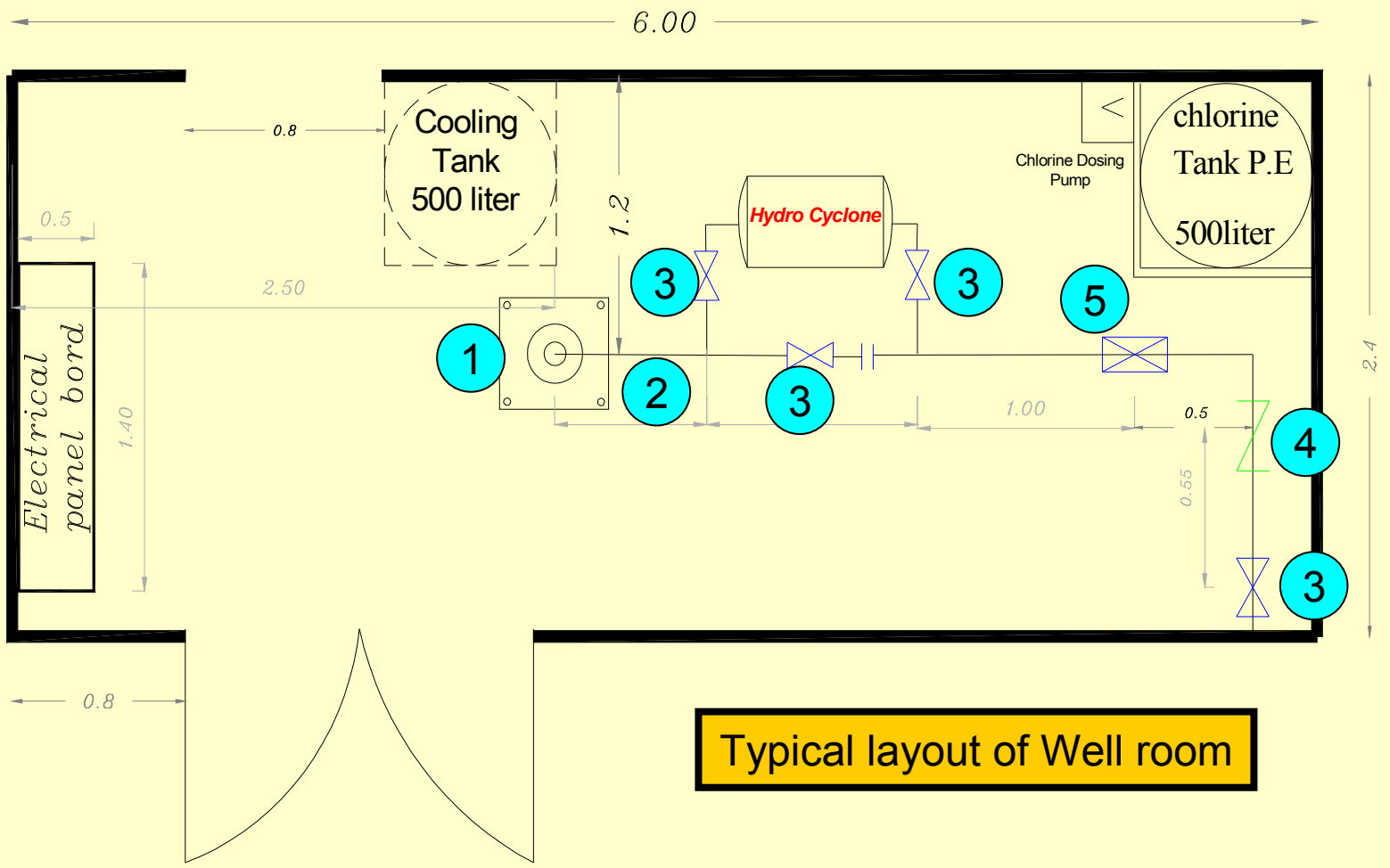
Submersible type motor installation

6.2 Well pumping stations



Typical piping and valves arrangement for well pumping stations

6.2 Well pumping stations

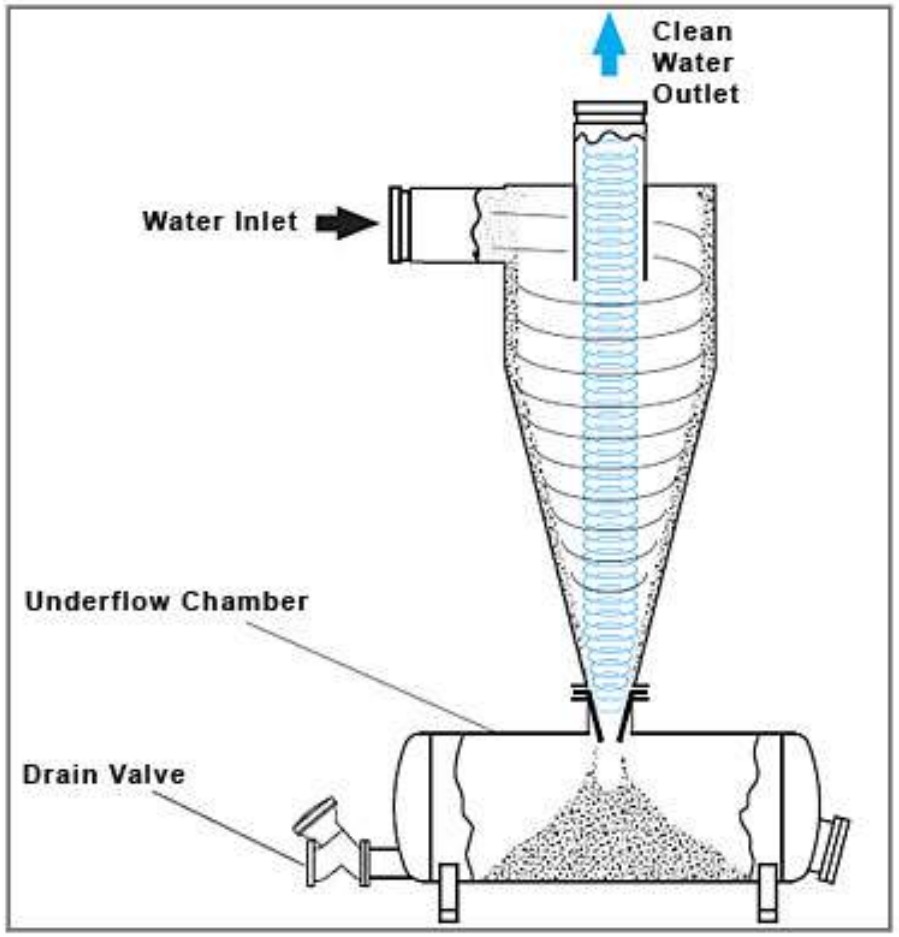


1 Pump well 2 Delivery pipe 3 Butterfly valve 4 Check valve 5 Flow meter

6.2 Well pumping stations

Delivery pipe , see the Hydro Cyclones and valves

6.2 Well pumping stations



Hydro Cyclone function

6.2 Well pumping stations

Delivery pipe , see the Hydro Cyclones and valves

6.2 Well pumping stations

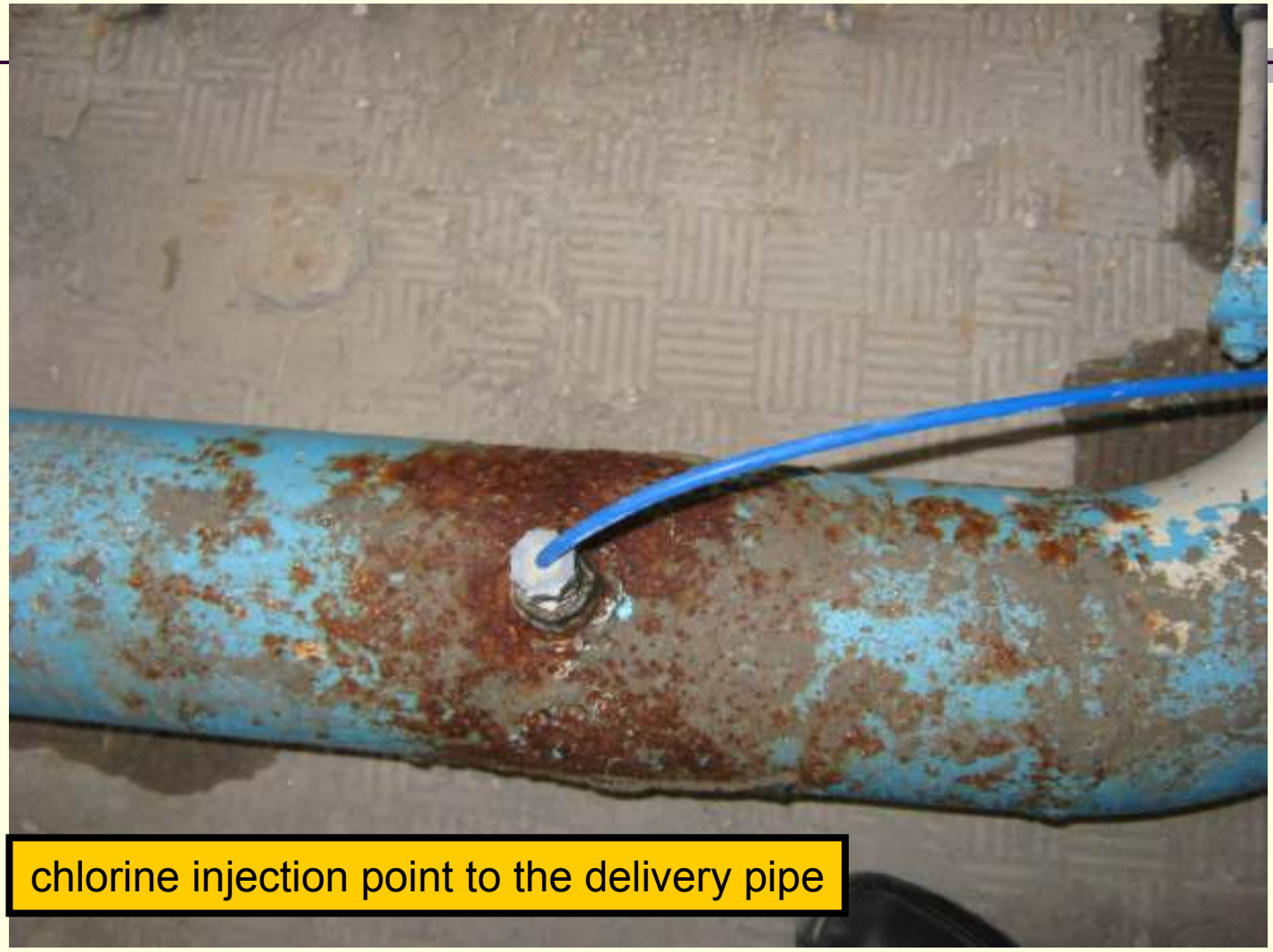
Standby generator

6.2 Well pumping stations

Fuel tank for the standby generator

6.2 Well pumping stations

6.2 Well pumping stations



chlorine injection point to the delivery pipe

6.2 Well pumping stations

Delivery pipe , see the Hydro Cyclone , valves, fuel tank, service building

6.2 Well pumping stations

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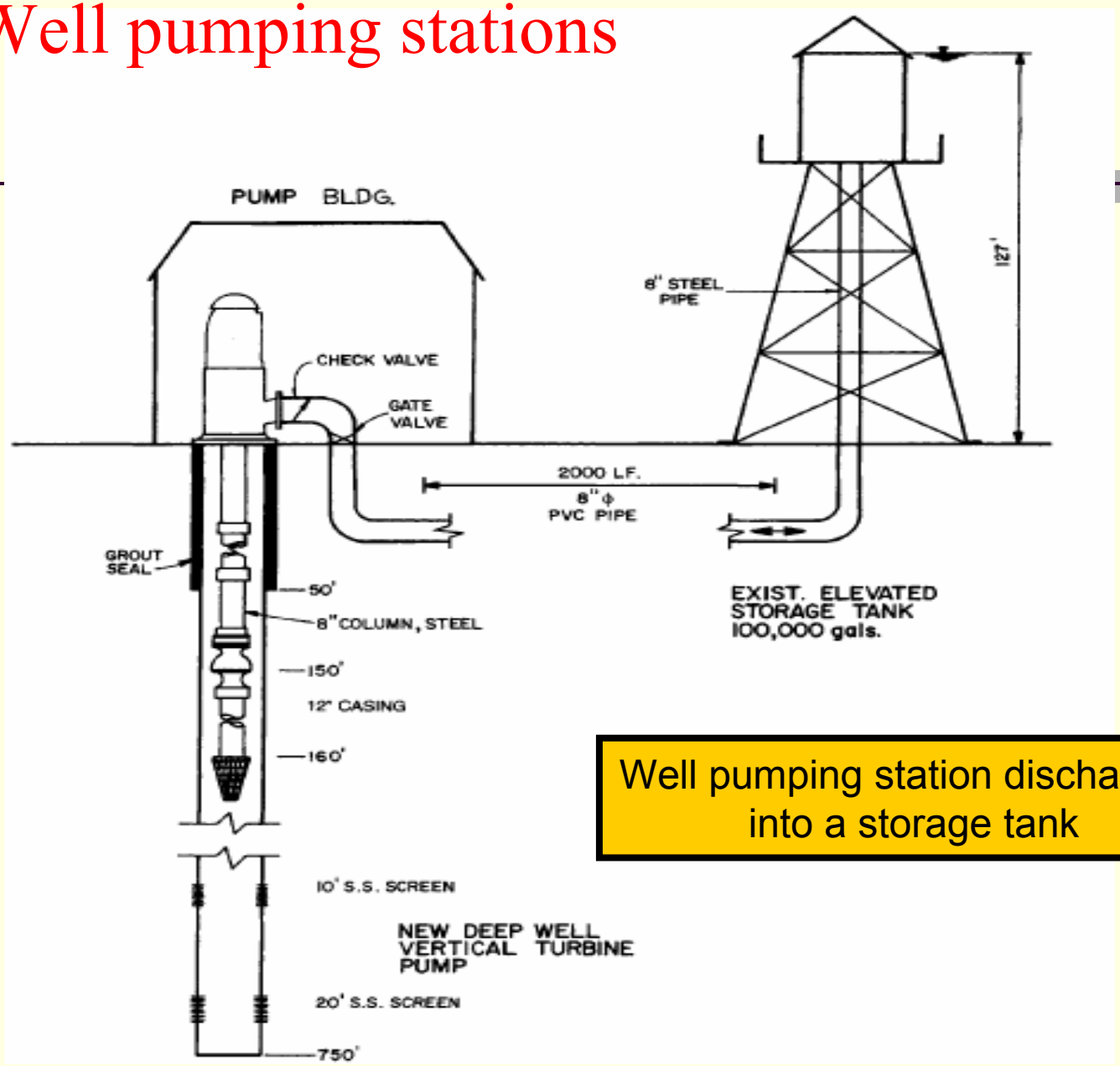
6.2 Well pumping stations

- Types of well pumping stations :

1. Direct pumping from well pumps to the distribution system
   - Most of Gaza wells are from this type
   - Not recommended for long distribution systems and for cases where more than one well pumping directly into the system. This system has two problems: back pressure between wells and lower discharge from each individual well.

2. Pumping from well pumps to a storage or distribution tank.
   - This system is recommended and there is a trend in Gaza to use this system
   - This system solves the problem of back pressure associated with the direct pumping discussed above. It also increase the pumping efficiency from each pump (lower head losses leading to more flat system curve and consequently more discharge)

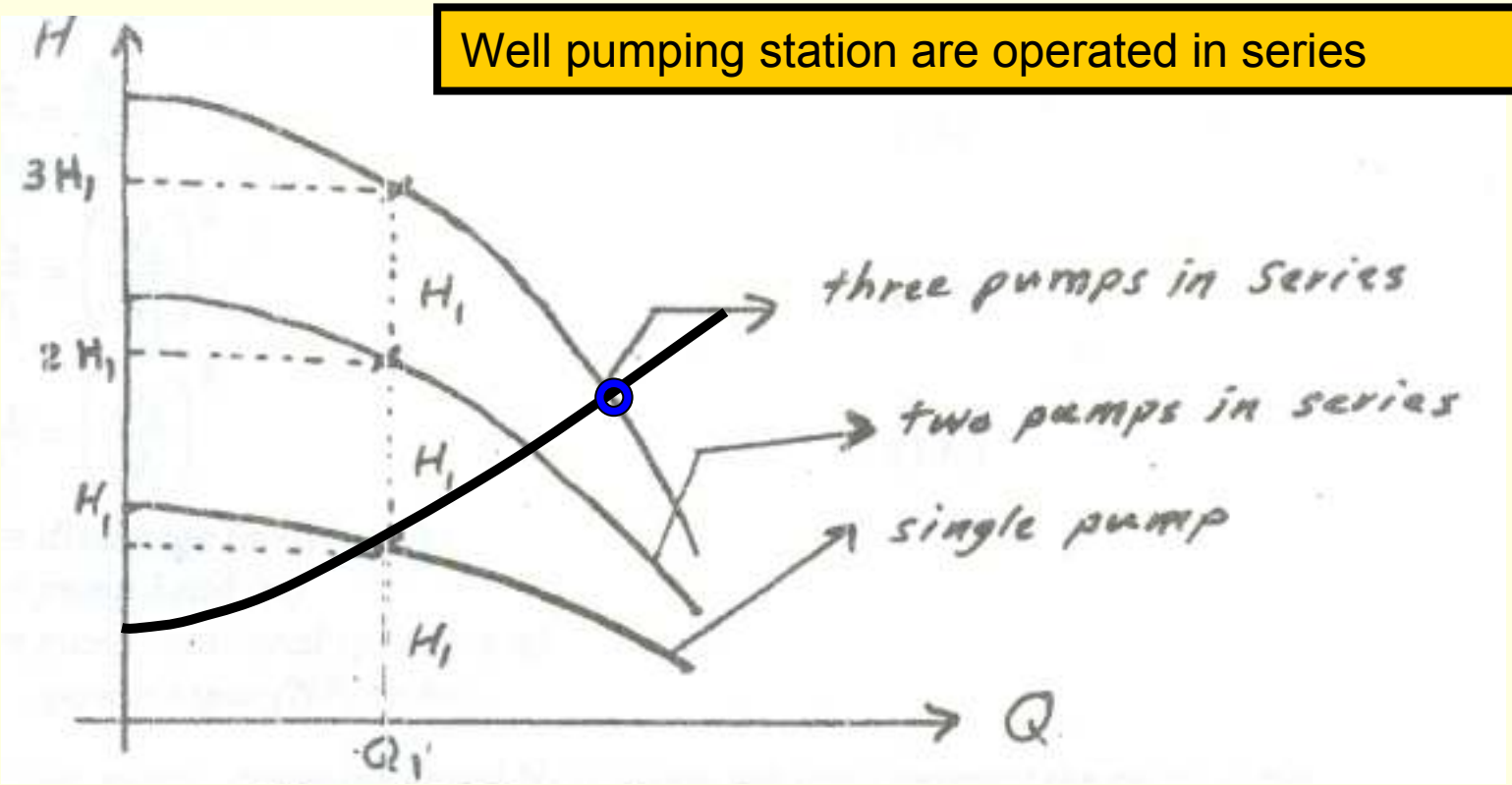
6.2 Well pumping stations



Well pumping station discharging into a storage tank

6.2 Well pumping stations

Well pumping station are operated in series



Note that for well pumps there is only one valid pump curve which is the curve of the total pumps in operation.

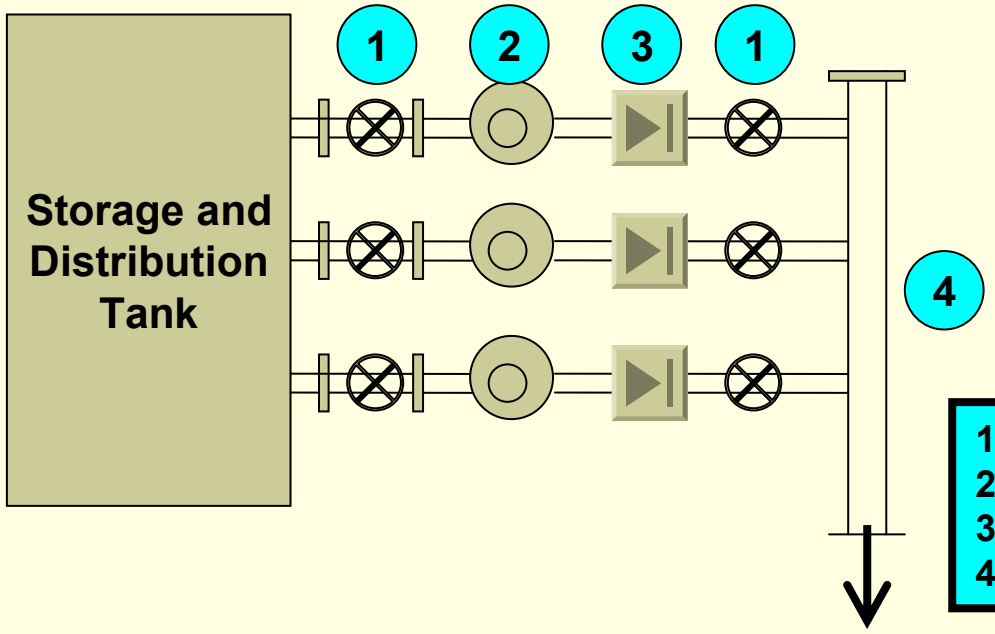
6.3 Distribution pumping stations

- Main components of distribution pumping stations :

1. Dry pumps (connected in parallel)
2. Suction shaft (pipe)
3. Storage and distribution tank
4. Delivery pipe
5. Valves
6. Surge vessel (air champer for water hammer protection)
7. Chlorination tank and chlorine injection pump.
8. Stand by generator and its fuel tank
9. Main electricity distribution panel and control
10. Service building.

6.3 Distribution pumping stations

- Typical layout of distribution pumping stations:

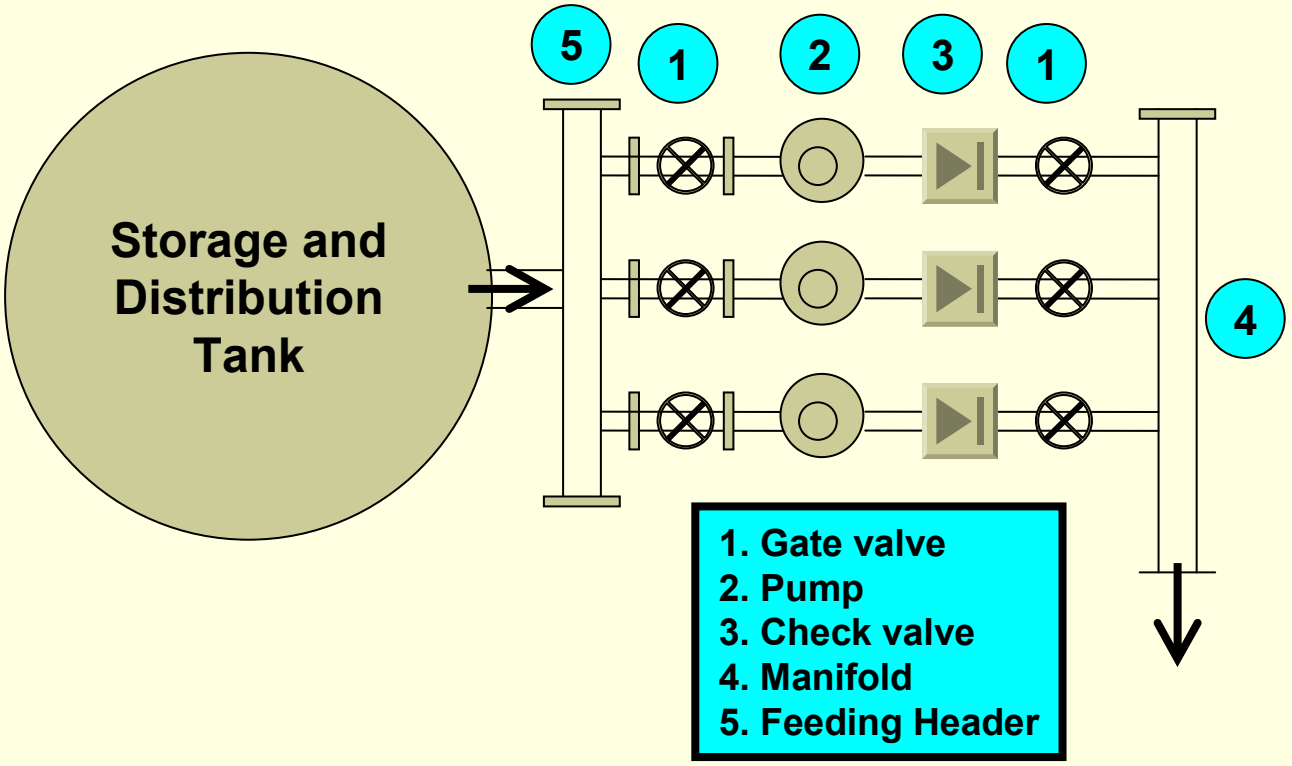


1. Gate valve
2. Pump
3. Check valve
4. Manifold

Distribution pumping station with rectangular storage and distribution tank

6.3 Distribution pumping stations

- Typical layout of distribution pumping stations:

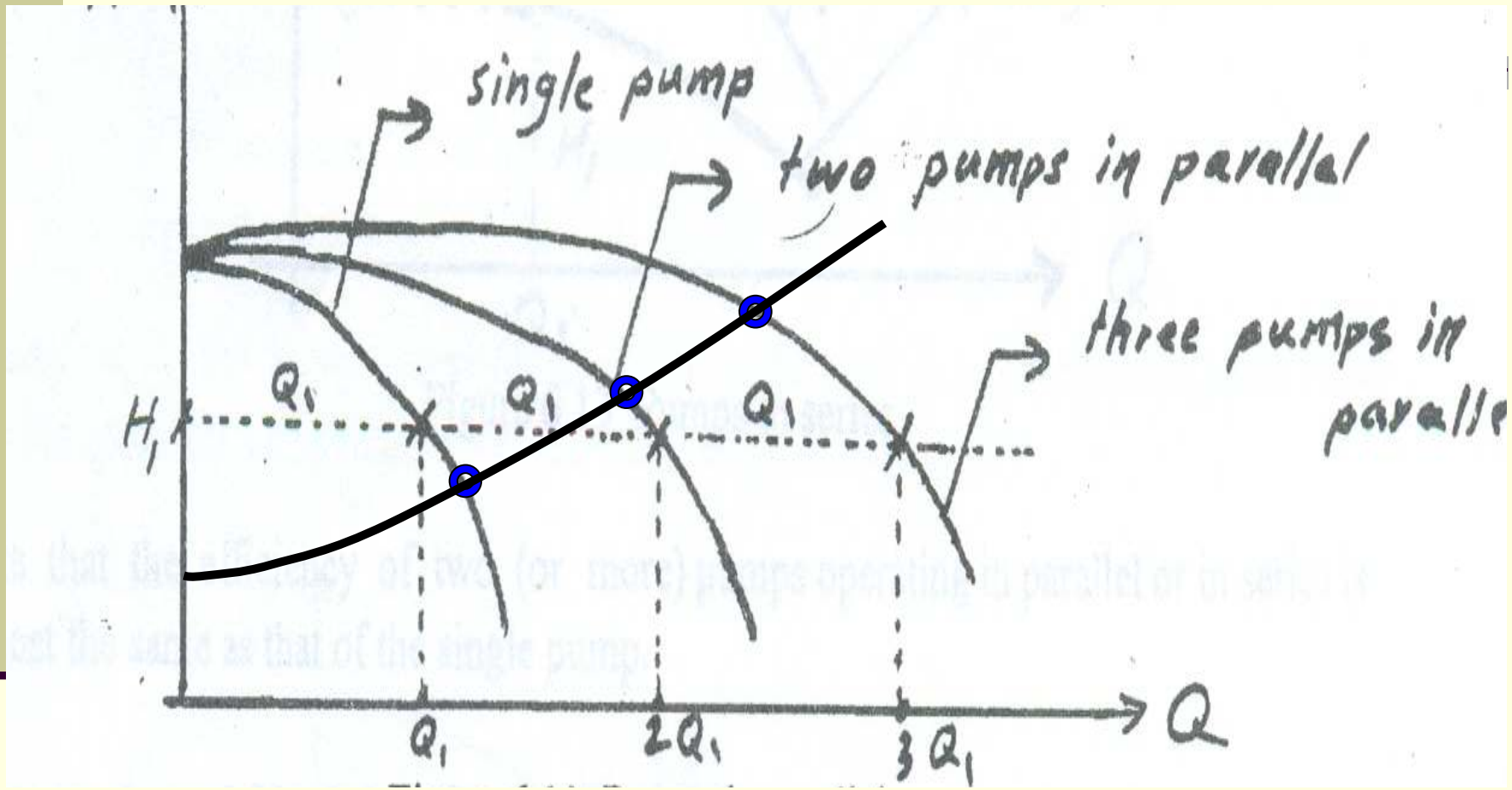


Distribution pumping station with circular storage and distribution tank

6. Design of water supply pumping stations

Distribution pumping station

6.3 Distribution pumping stations



Distribution pumping station are operated in parallel

6.3 Distribution pumping stations

- Control of distribution pumping stations :

1. Pressure switch at the discharge side of the pipe.
   If the pressure in the network increases above a preset value (for example 6 bar) the pumps will be shut down one after the other. The pressure on the delivery pipe increases at low demands when many connections are closed.

2. Level switch connected to the water distribution tank.
   If the level in the water distribution tank drops to the a pre assigned minimum level the pumps are shut off one after the other with a pre assigned intervals. The pumps will be started again one after the other when the water in the tank reaches a pre assigned level. An ultra-sound level detector is usually used for level detection.

6.4 Booster pumping stations

- Main components of booster pumping stations :

1. Dry pumps (connected in series)
2. Suction connection (pipe)
3. Delivery pipe
4. Valves
5. Stand by generator and its fuel tank (for offline large stations only)
6. Main electricity distribution panel and control
7. Service building (for offline large stations only).

6.4 Booster pumping stations

- Main types of booster pumping stations :

1. Inline booster pumps
2. Offline booster pumps

6.4 Booster pumping stations

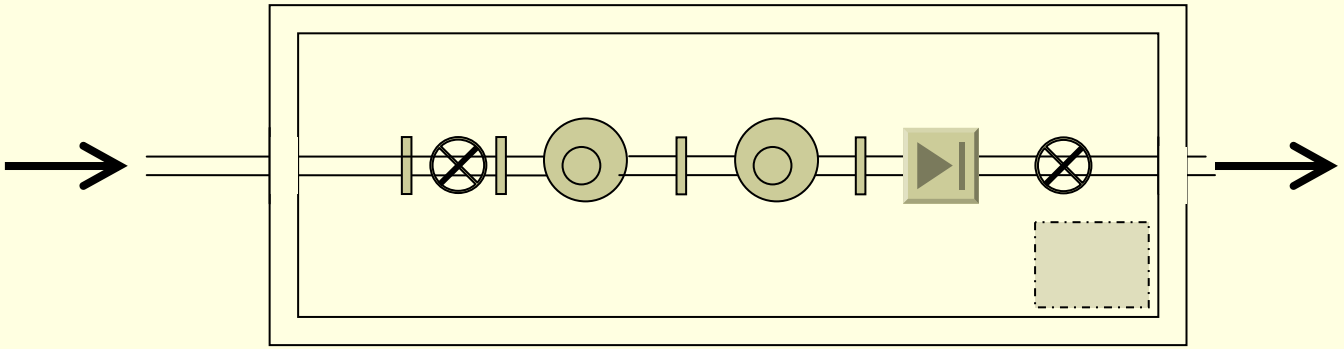
Typical inline Booster Pump

6.4 Booster pumping stations

Inline Package Booster Pump

6.4 Booster pumping stations

- Typical layouts of inline booster pumping stations:

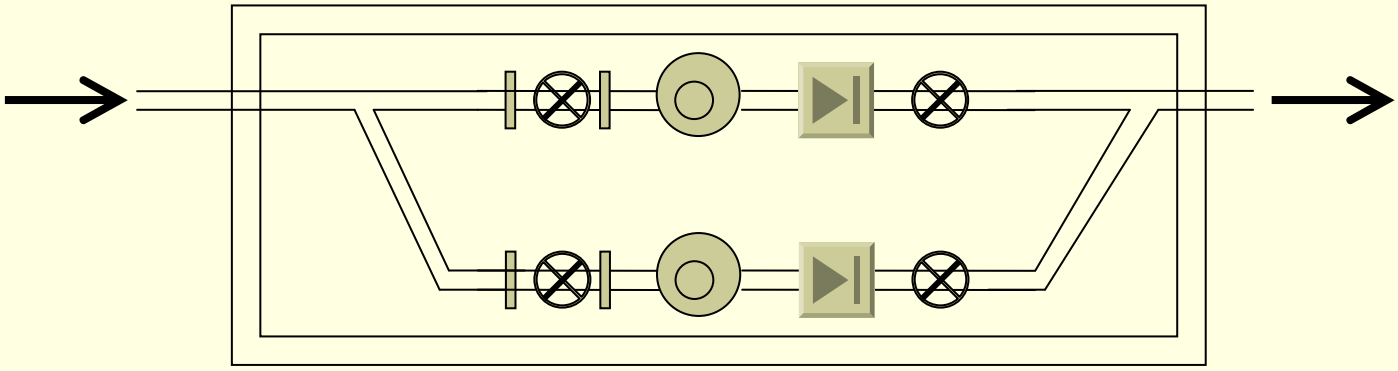


Inline booster pumping station - two pumps in series

This layouts is used when two or three pumps are able to deliver the required flow and head. If more than three pumps are needed or when the pumps are large, we should go to an offline booster pumping station.

6.4 Booster pumping stations

- Typical layouts of inline booster pumping stations:

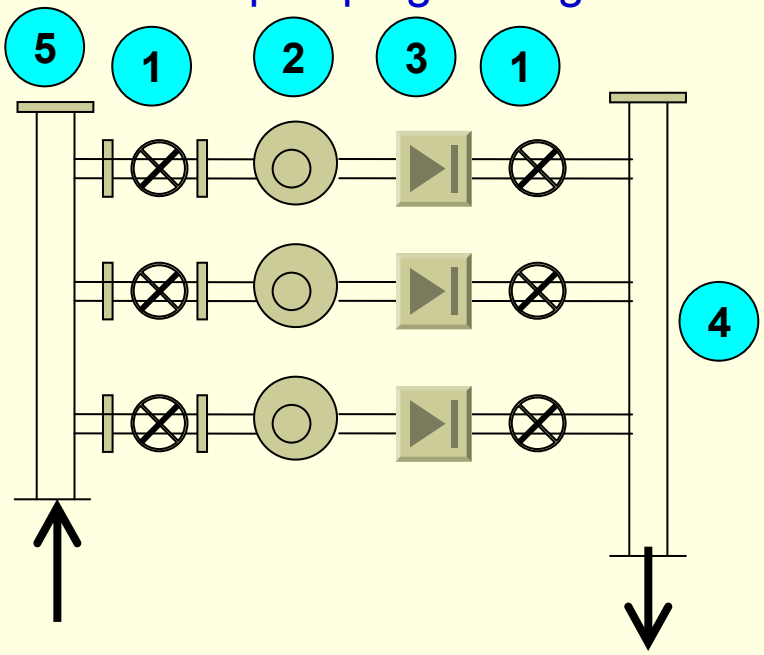


Inline booster pumping station - two pumps in parallel

This layouts is used when one pump is able to deliver the required head but not able to deliver the required flow. In this case we use two or more pumps in parallel. If more than three pumps are needed or when the pumps get large, we should go to an offline booster pumping station.

6.4 Booster pumping stations

- Typical layout of offline booster pumping arrangements:

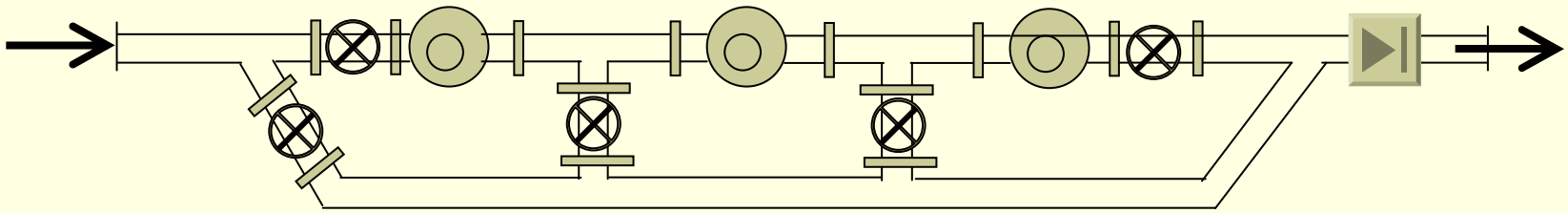


offline booster pumping station - three pumps in parallel

This configuration is used when one pump is able to give the required head but not able to give the required flow, so we need more than one pump in parallel to deliver the total flow.

6.4 Booster pumping stations

- Typical layout of offline booster pumping arrangements:



offline booster pumping station - three pumps in series

This configuration is used when one pump is able to give the required flow but not able to give the required head alone, so we need more than one pump in series to deliver the total head. Note that we use a bypass line to achieve flexibility in operation When one or more pumps are out for maintenance.

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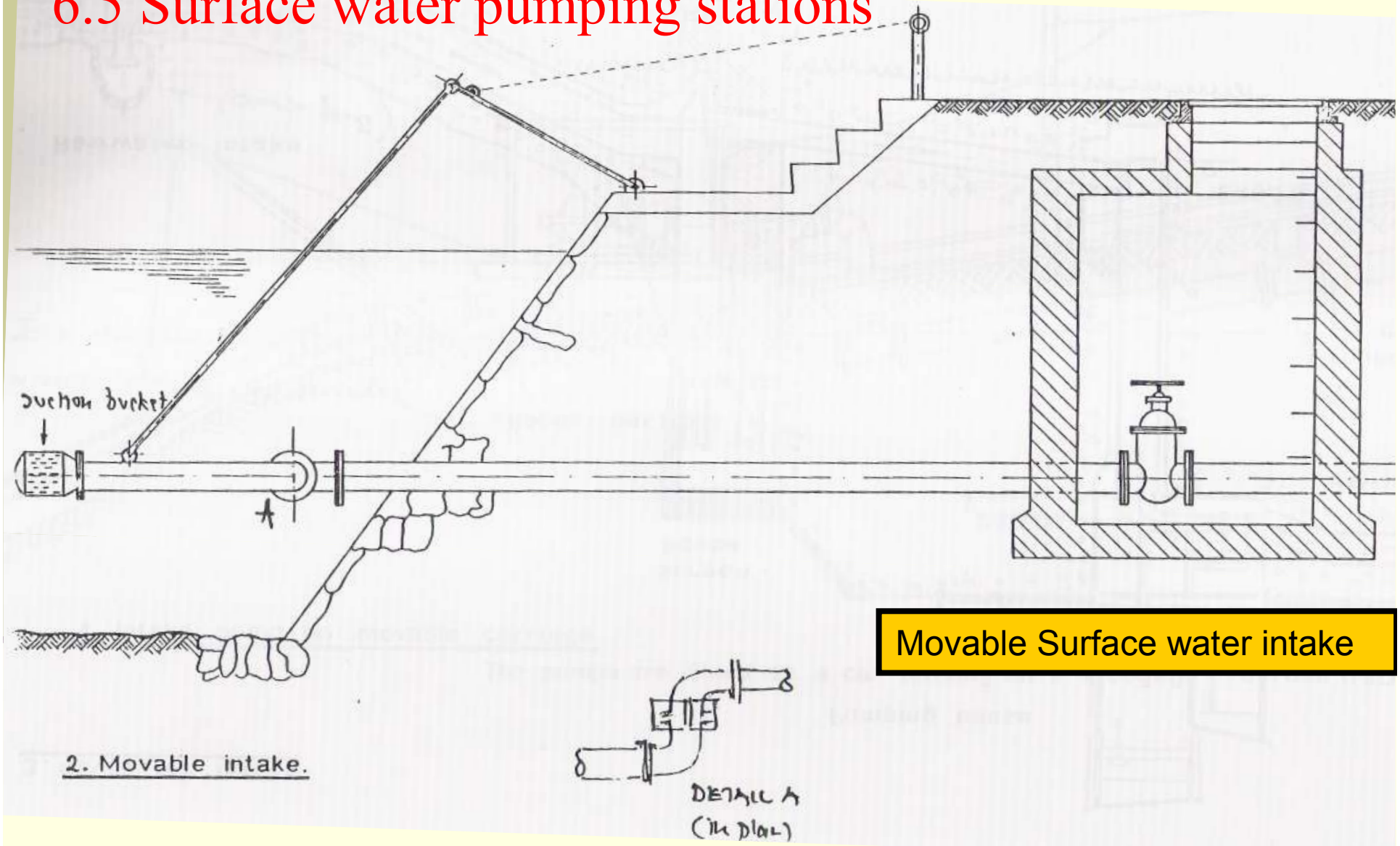
6.5 Surface water pumping stations

- Main components of surface pumping stations :

1. Water Intake structure
2. Submersible or dry pumps (connected in parallel)
3. Suction connection (pipe)
4. Delivery pipe
5. Valves
6. Stand by generator and its fuel tank
7. Main electricity distribution panel and control
8. Service building

6.5 Surface water pumping stations



2. Movable intake.

Movable Surface water intake

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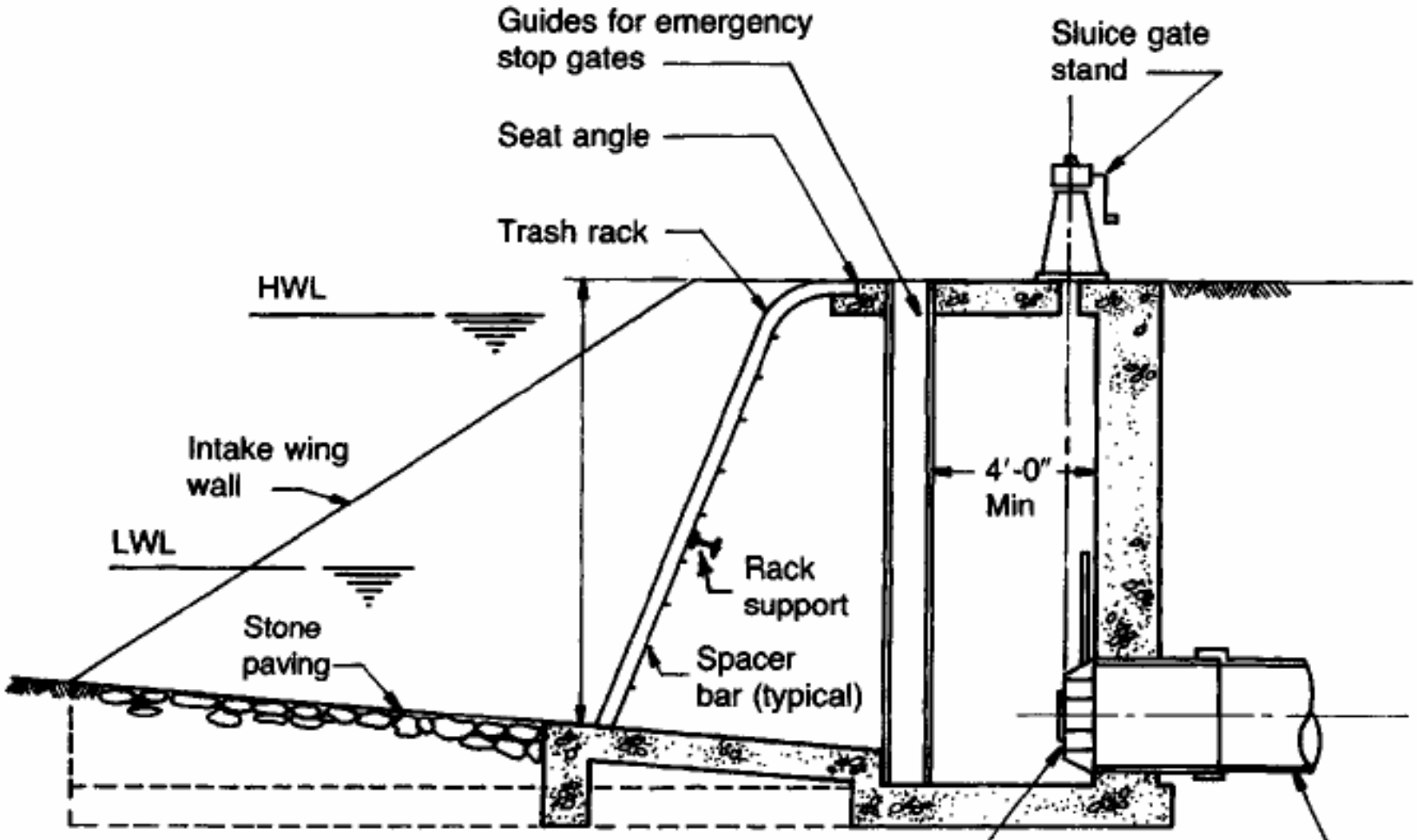
6.5 Surface water pumping stations



Surface water intake

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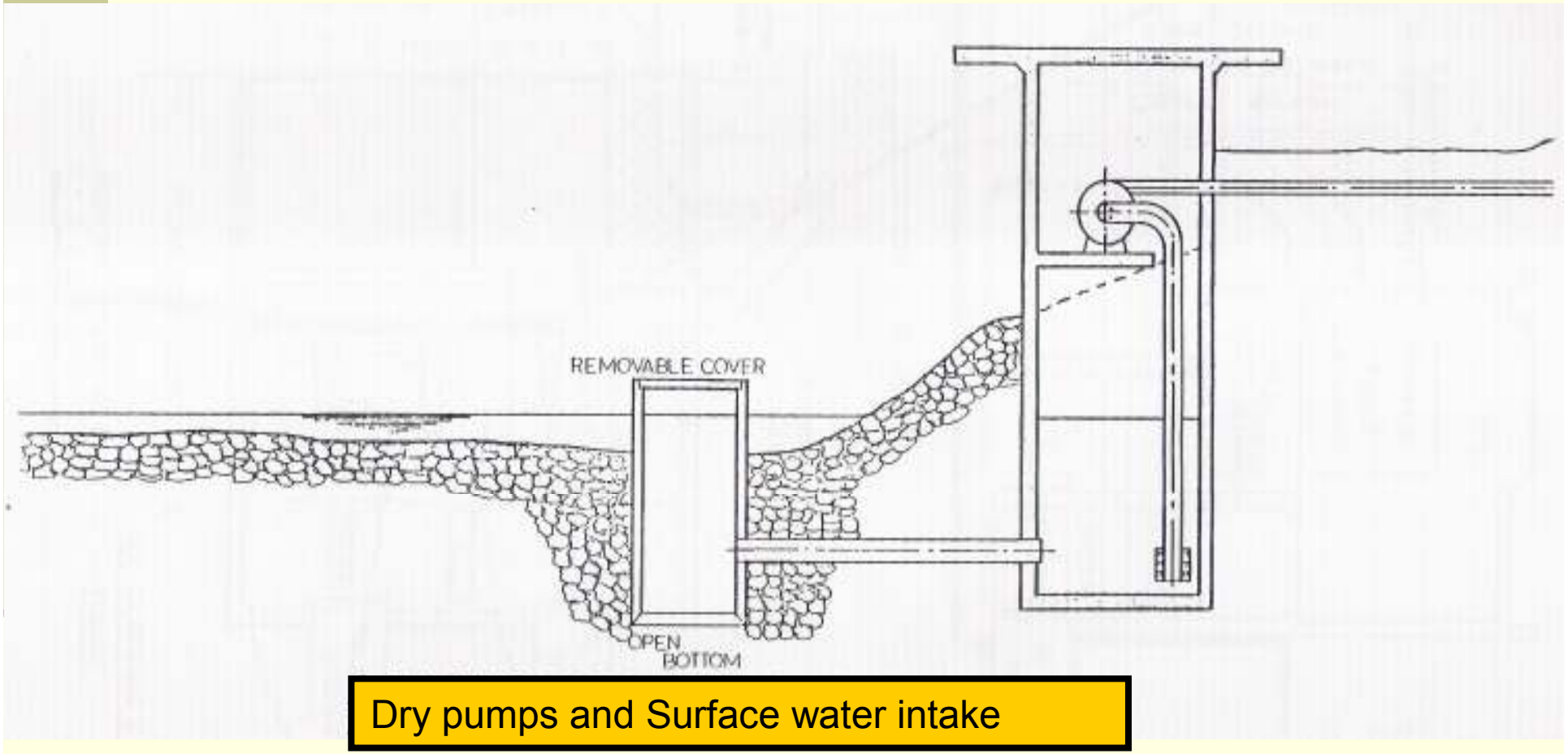
6.5 Surface water pumping stations



Dry pumps and Surface water intake

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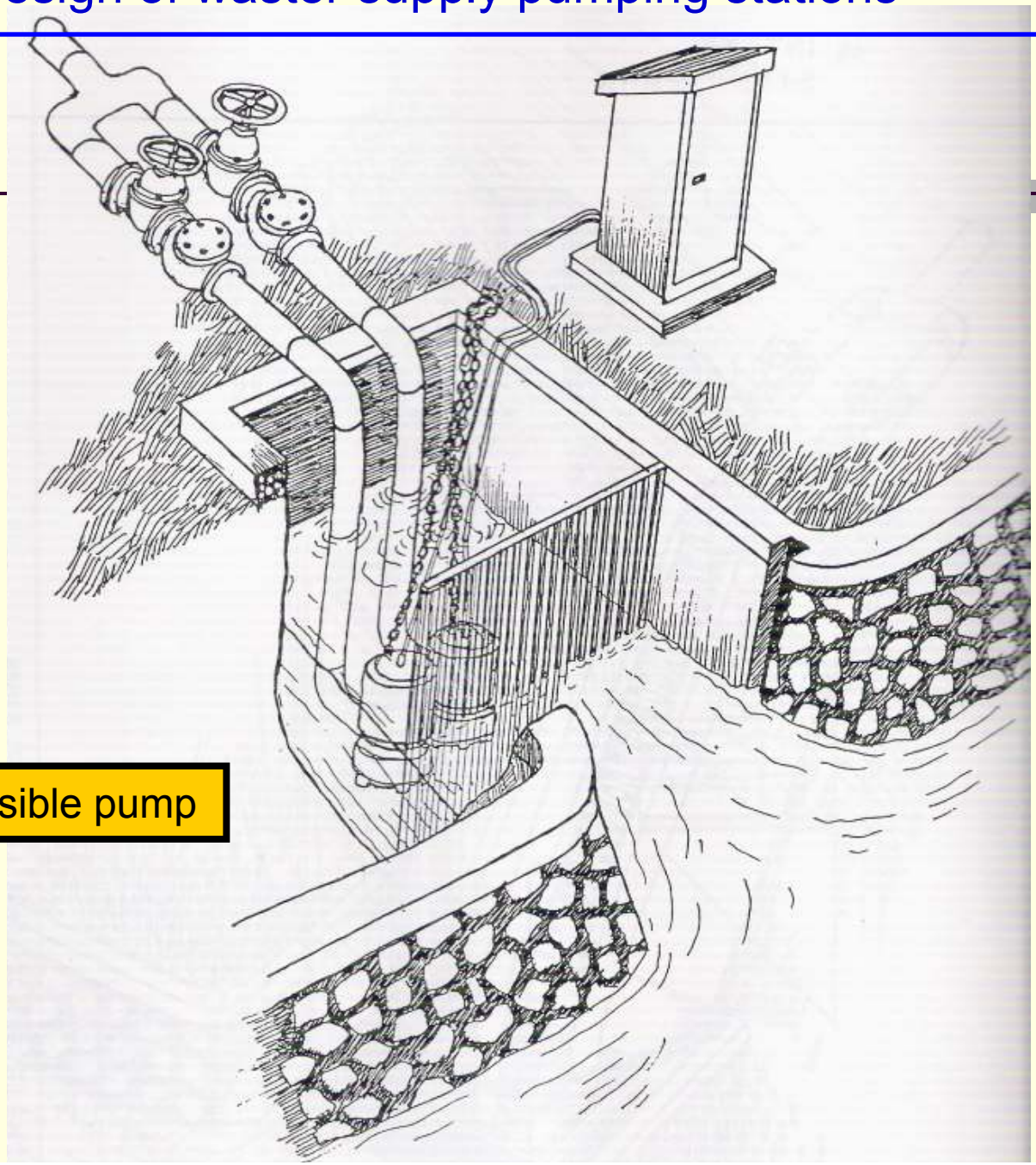
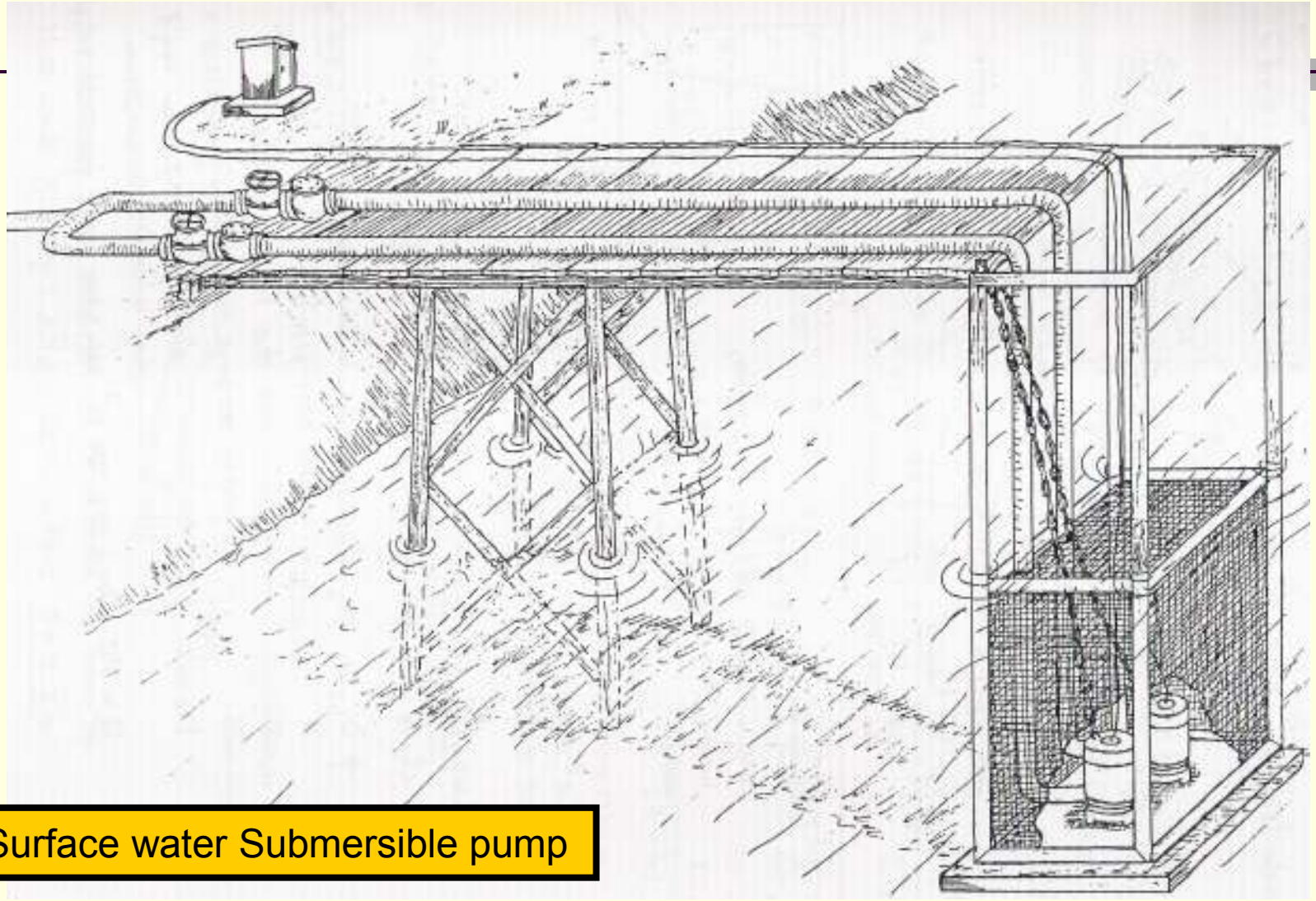


Surface water Submersible pump

6.5 Surface water pumping stations



Surface water Submersible pump