

KARACHI WATER SUPPLY QUALITY - ISSUES, SOURCES & REMEDIES

Save Water ... Save Life



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Water....

- A vital natural resource that forms the basis of life and its crucial to the survival of all living organisms....
- Freshwater comprises 3% of the total water on earth. Only a small percentage (0.01%) of this fresh water is available for human use.
- 78% of the human body is composed of water....
- Animals and plants 60%-65% of water in their bodies.....

The Dilemma...

WORLD WATER DAY 2011
ACTION AGAINST HUNGER | ACF INTERNATIONAL

1 in **8**
people
lacks access to
clean
water

- *Annually, 250 million* people worldwide contract water-related disease and 10 million die
- (PCRWR) claims that in Karachi, there's hardly any potable water...
- Pakistan ranks at number 80 among 122 nations regarding drinking water quality.

Our Project ...

Title: *Karachi Water Supply Quality - issues, sources & remedies*

Objectives:

- To detect the contaminants present in the water supply system of Saddar town, Karachi.
- To trace the source of these contaminants
- To investigate how the said contaminants infiltrated into the system.
- To propose possible and feasible remedies in order to minimize and/or eradicate events which threaten the water quality.

Why Water Quality...?

- Water is the major pathway into the body for contaminants.
- Easy to contaminate.
- Difficult & costly to remediate.
- Health aspects in water are connected to many broader issues of management.
- 66% of water is supplied through piped networks in Pakistan raising a great concern over the quality of water being supplied and its deterioration within the distribution systems.

Scope Of the Study ...

- Pumping Stations of Gow Gali, Bombay Bazaar and Khajoor bazaar could not be covered due to law and order situation.
- The results of analyses performed on a single water sample are only valid for the particular location and time at which that sample was taken. They might show a discrepancy if sampling is done at some other point in time.

Project Methodology ...

Phase I:

Literature Review and
Pilot survey with the residents of
Karachi.



Phase II:

Deciding no. of samples and
contaminants to be detected.



Phase III:

Sampling, Contaminant detection and
comparison with maximum values set
By WHO.



Phase IV:

Proposing suitable remedies.

Phase I : Literature Review

- In the first phase, thorough reading of research papers was done to acquire all the necessary information on the study topic.
- Residents of different areas of the Karachi were then questioned about the water quality issues they were facing and an area was selected on the basis of higher level of water quality concerns

Phase II : Samples and Contaminants

- The second phase comprised of deciding an adequate number of samples and short listing the contaminants to be examined.
- Questionnaires for survey purposes were also drafted in this phase.
- Contaminants that were decided at this stage to be tested in water supply line of Saddar town were as follows:

Parameters Selected for testing ...

- **Physical Parameters:** Electrical Conductivity (EC), pH, and Turbidity
- **Chemical Parameters:** Total Dissolved Solids (TDS), Calcium, Potassium, Sodium, Nitrates, Residual Chlorine, Alkalinity, Chloride, Permanent Hardness, Sulfate, Iron Magnesium, Aluminium, Mercury, Boron, Chromium, and Lead.
- **Biological Parameters:** Total Coliform, Fecal Coliform, and E-Coli.

Phase III : Sampling and Testing ...

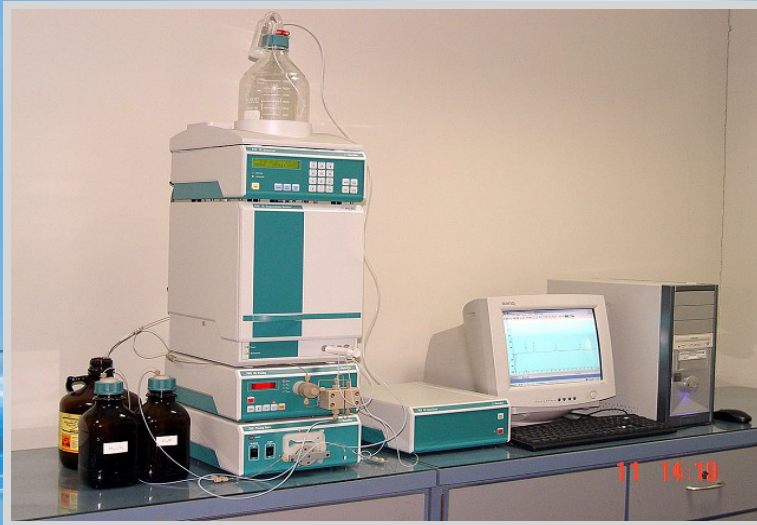
Four samples from each sampling location were collected for the monitoring purpose. They are described as under:

- Type A: sample for microbial analysis in 200 mL bottle.
- Type B: sample for trace elements in 500 mL bottle, with 5-10 mL/L HNO_3 added as preservative.
- Type C: sample for Nitrate Nitrogen in 500 mL bottle, with 1mL/100mL Boric acid induced as preservative.
- Type D: sample for other water quality parameters with no preservatives added.

Sample Preservation

S.No.	Testing Parameters	Preservative Techniques	Safe Preservation Period
1.	Microbes	Keep at 4°C	12 hours
2.	Metals	Add 2-10 mL/L HNO ₃	6 months
3.	Nitrates	Add 1mL/100mL, 1M Boric Acid or H ₂ SO ₄	28 days

SUPARCO Environment Lab



ION CHROMATOGRAPH



BOD TRAK



ICP-MS



SUPARCO Environmental Lab

Phase IV: Proposing Remedies ...

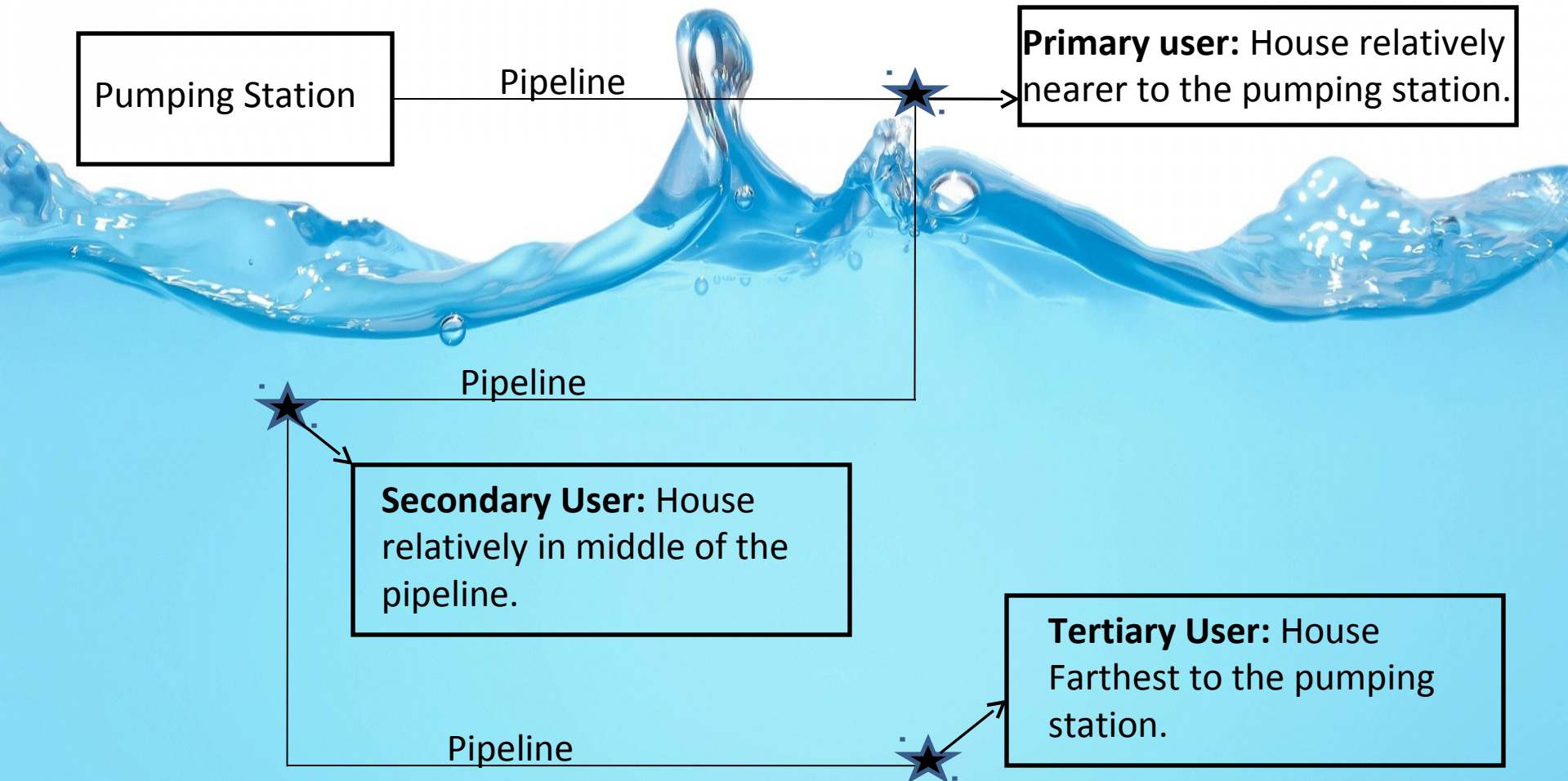
- Phase 4-encompassed proposing remedial measures to exterminate water contamination events.

Sampling Points ...

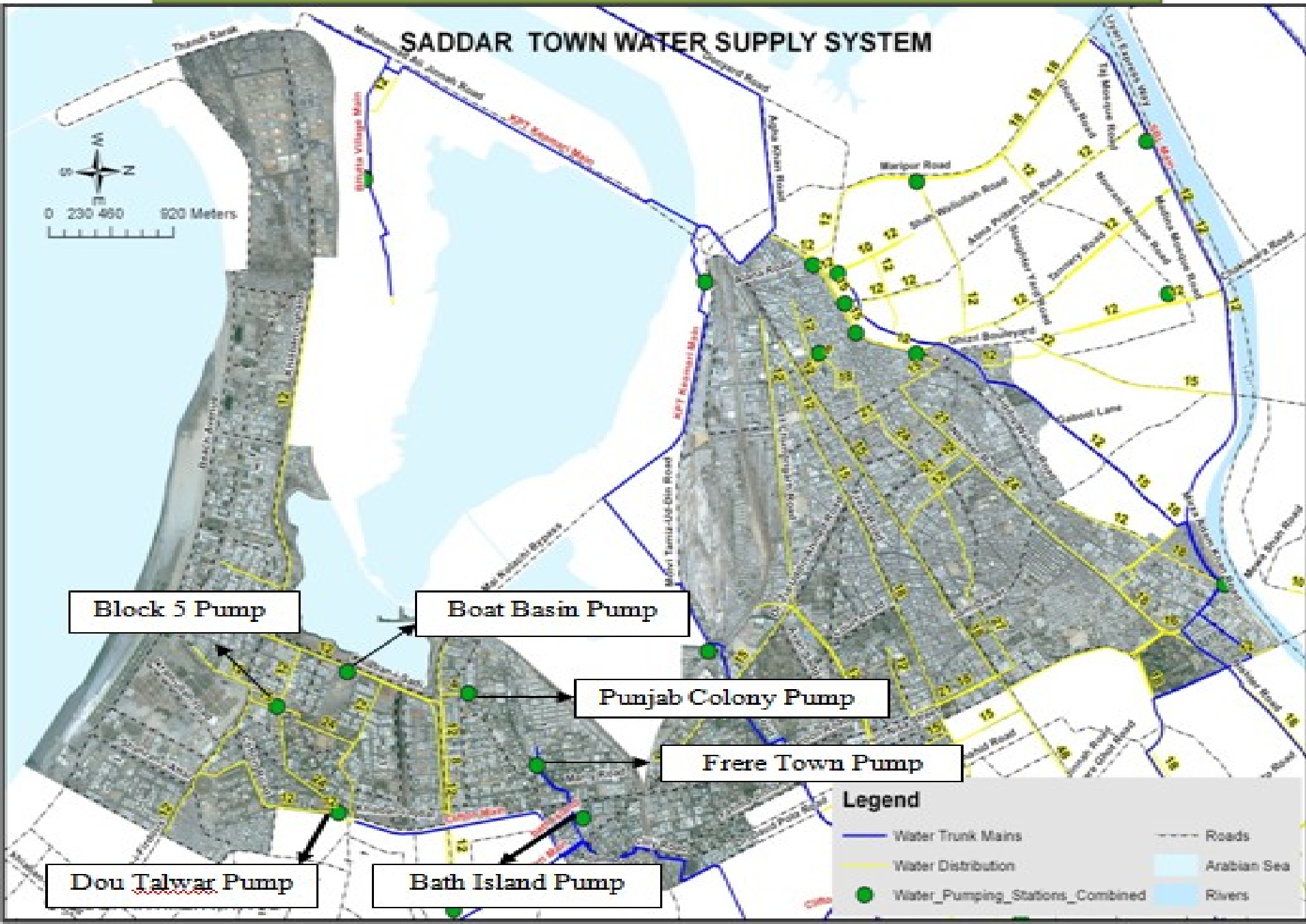


Samples were taken from each stage of the supply

What are primary, secondary, and tertiary Users???



Pumping Stations of Saddar town and their Location ...



Test Methods...

Parameters	Test Method
Electrical Conductivity	Method 2510 (APHA)
Total Dissolved Solids (TDS)	US-EPA 160.2
pH	ASTM D 6764-02 (2007)
Turbidity	Nephelometric Method
Ionic Species	AWWA Method # 4110 B(Ion Chromatography Method), HACH 8171
Residual Chlorine	HACH 8167 ASTM D 1253-03
Alkalinity	Alkalinity Method 2320B
Hardness Total as CaCO ₃	HACH 8213
Trace & Toxic Metals	US EPA 200.8
Microbiological Test (Coliforms)	Membrane Filtration Method

Trace and Toxic Metal Testing

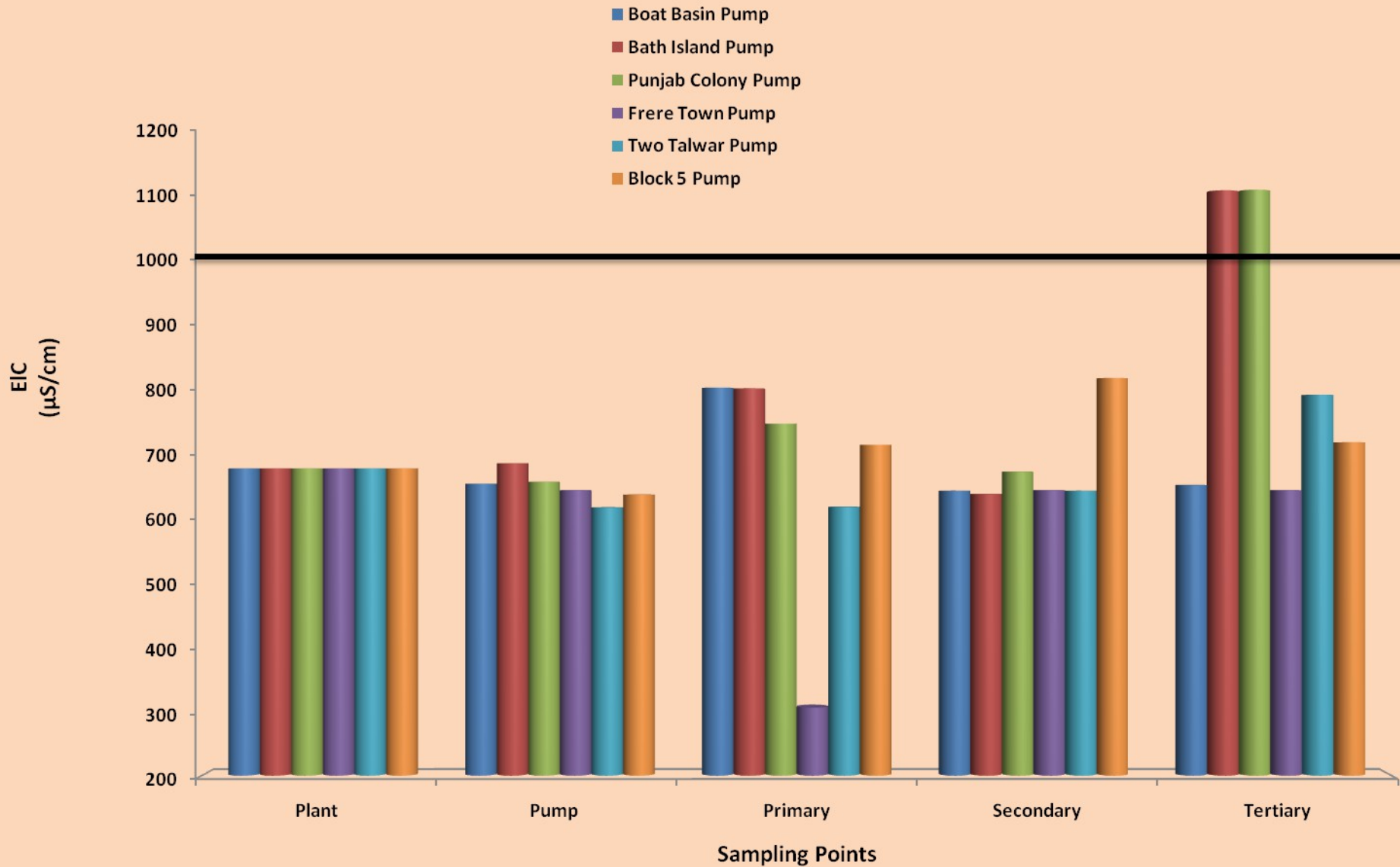
Sample Preparation

- Samples are prepared for trace/toxic and heavy metals analysis.
- Take 50 ml of water sample in a 100 ml beaker and add 5 ml of HNO_3 and place the beaker on Hot Plate for about 2 hrs
- Then filter the sample through 0.45 micron pore size filter paper in a 50 mL volumetric flask and make up the sample up to the mark

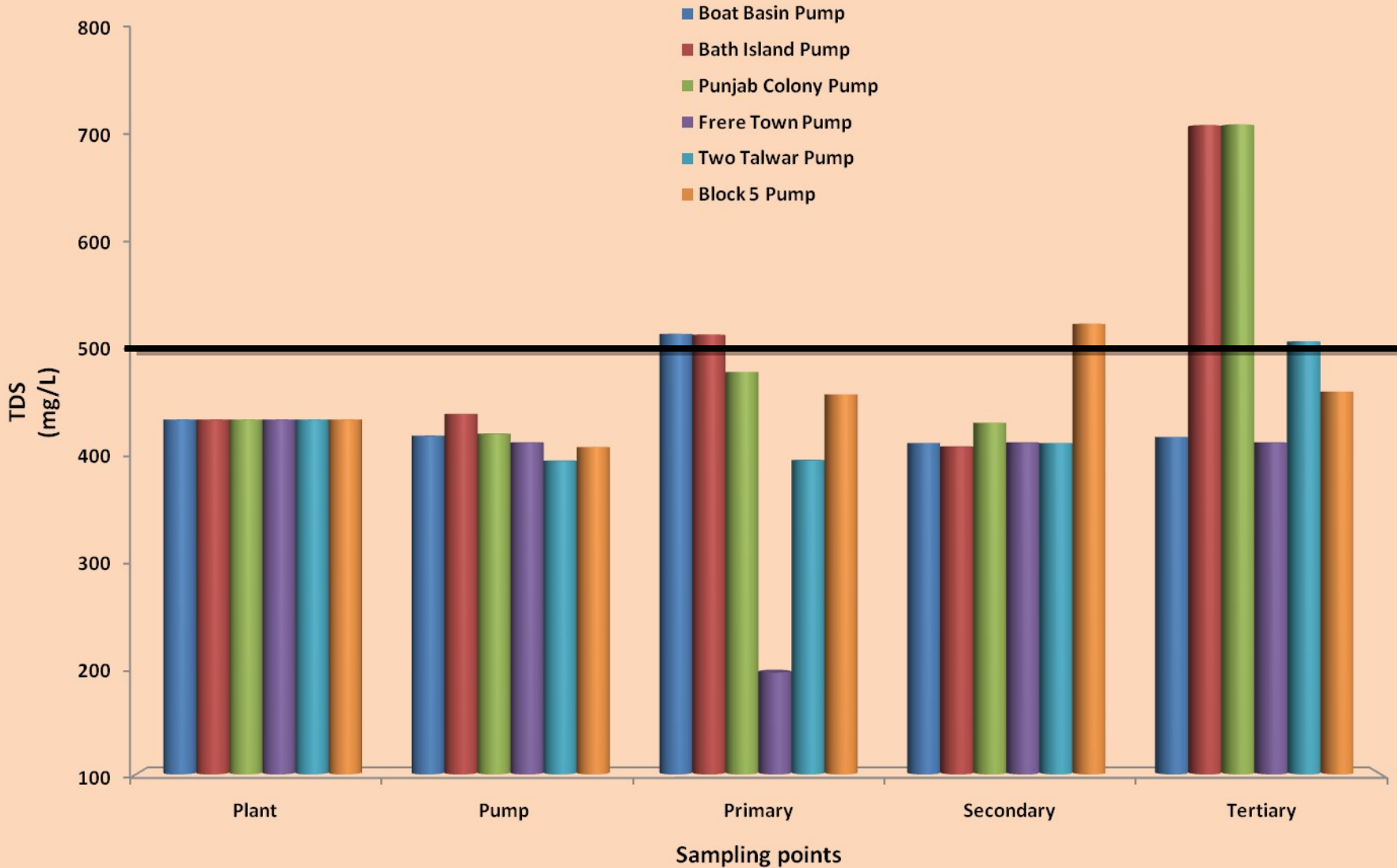
Analysis of Samples

- Analysis of prepared samples on ICP-MS
- The ICP-MS was tuned (using PerkinElmer Smart Tune solution containing 10 ppb of Ba, Be, Ce, Co, In, Mg, Pb, Rh and U, optimized (using PerkinElmer, setup / stab / masscal solution containing 10 ppb of Mg, Cu, Rh, Cd, In, Ba, Ce, Pb, U and detection limit solution containing 10 µg/L of Be, Co, In, U
- Calibration of ICPMS was carried out for the range of 1 to 100 ppb using five multi-element calibration standards prepared from diluting stock standard solution (PerkinElmer, Multi-element calibration standard 3). Each sample is tested in three replicates
- Tests are carried out through QA program including (i) Matrix Test (ii) Sample Spike (iii) QC Sample.

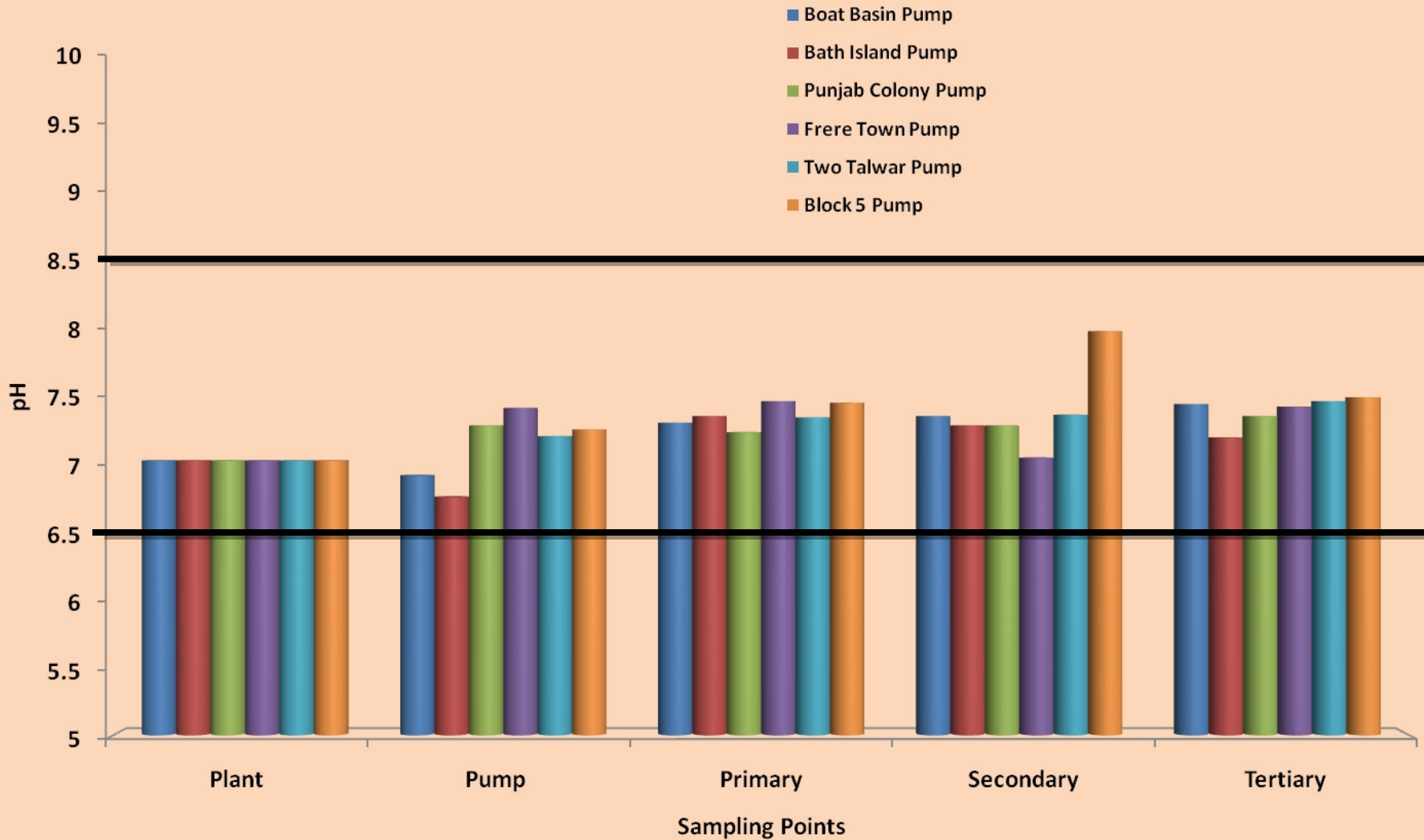
Variation of EC along the system ... Allowable Limit : 1000 $\mu\text{S}/\text{cm}$



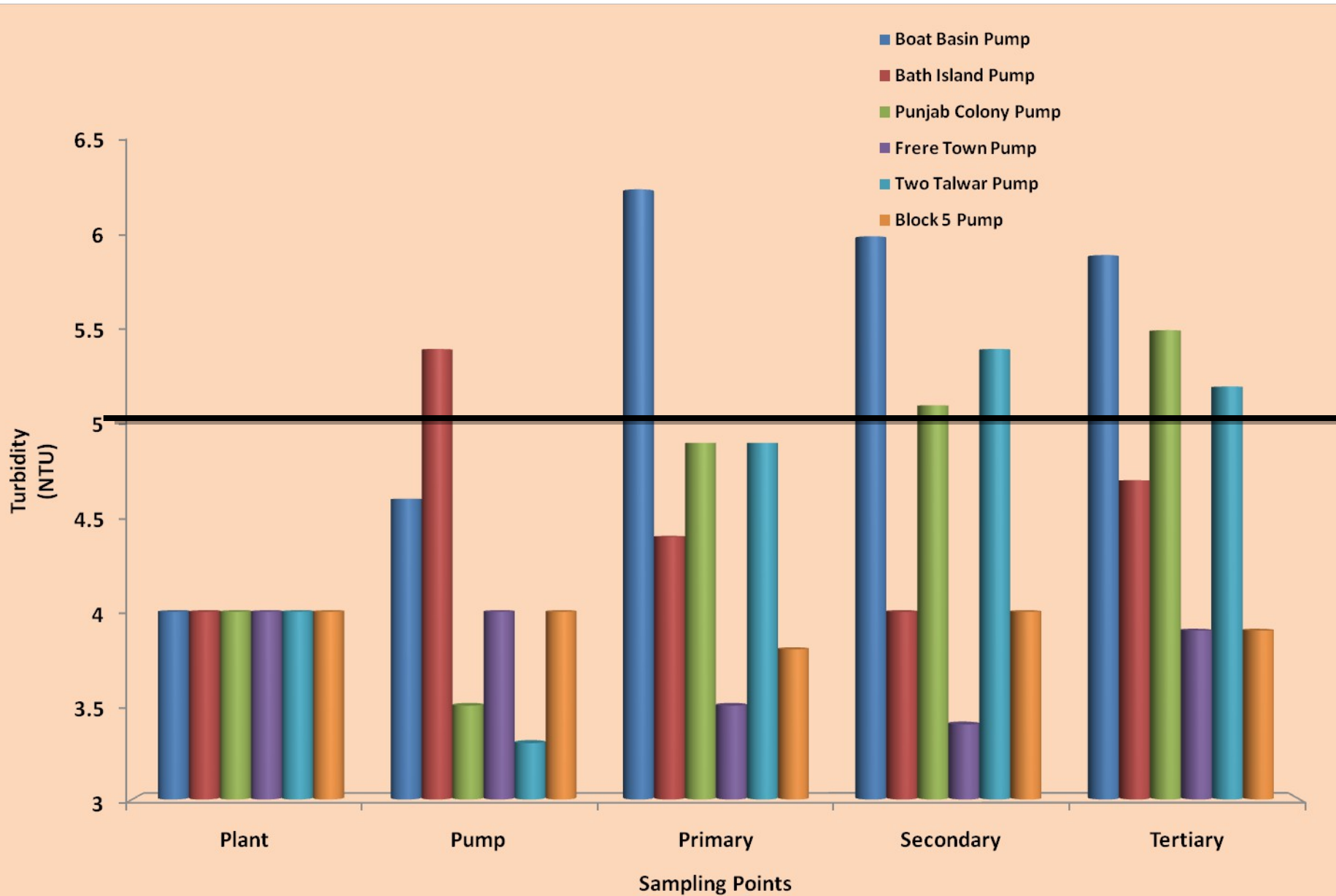
Variation of TDS along the system ...Allowable Limit: 500 mg/L



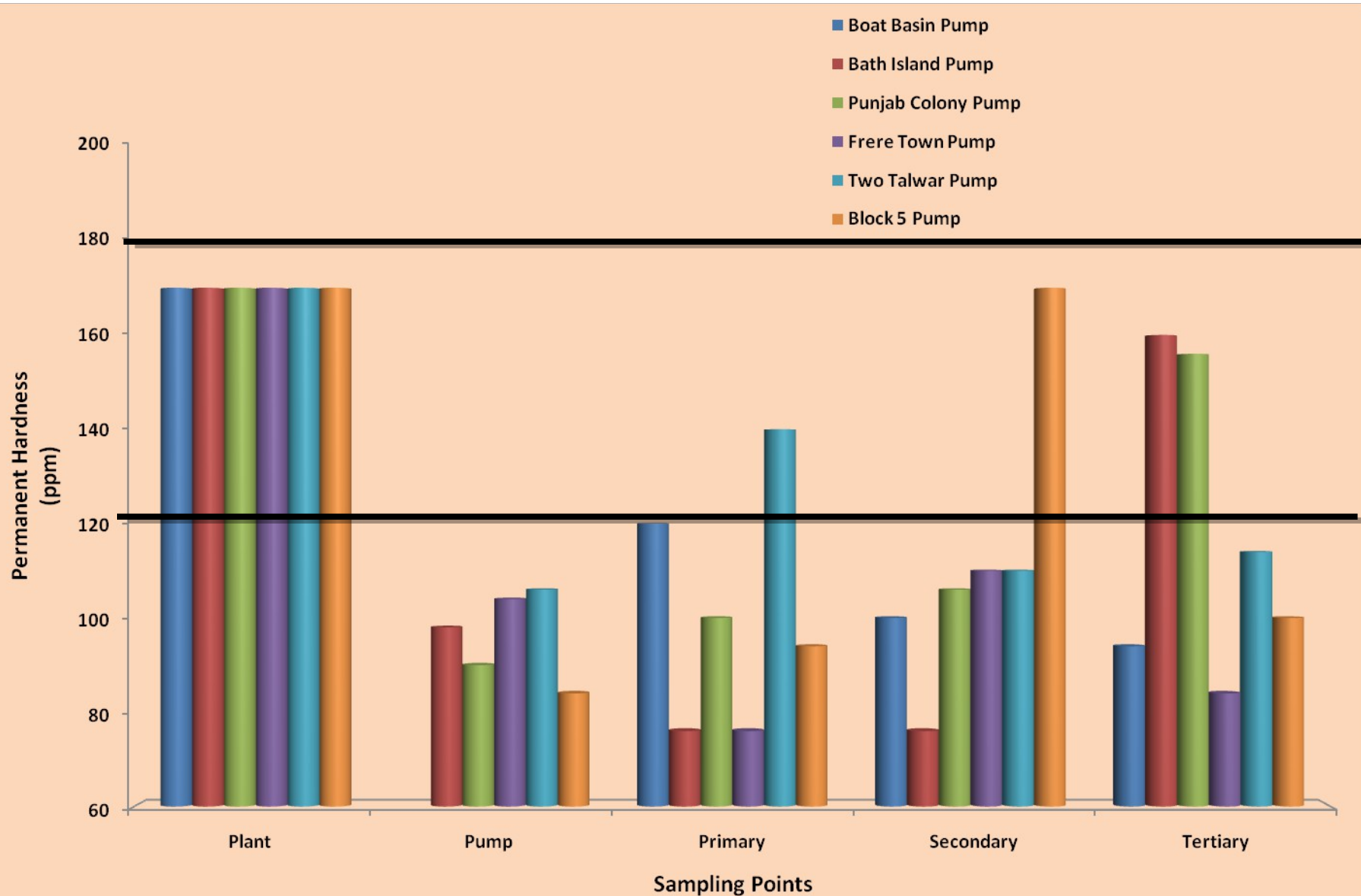
Variation of pH along the system ...Allowable Limit: 6.5 to 8.5



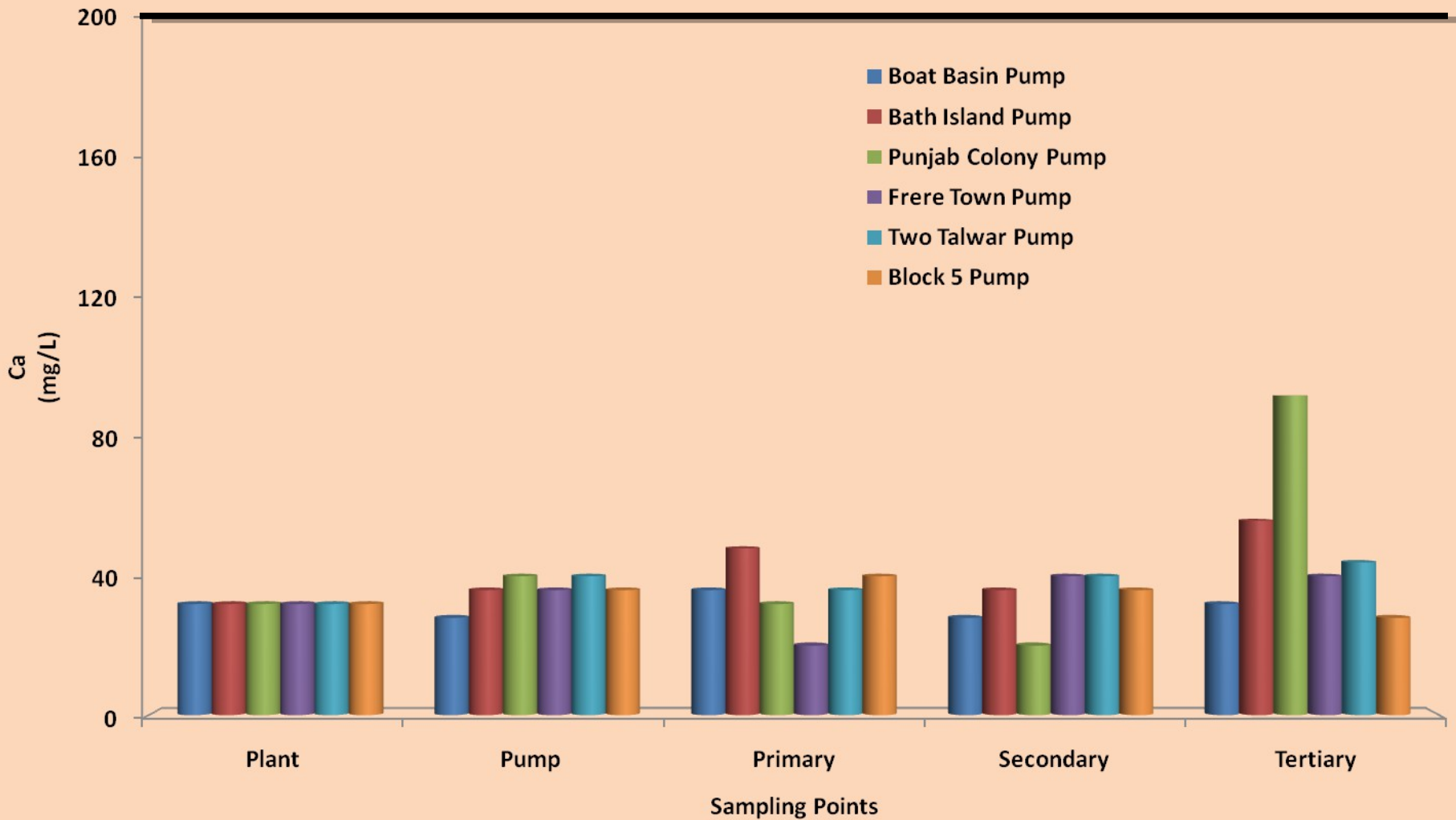
Variation of Turbidity...Allowable Limit: 5 NTU



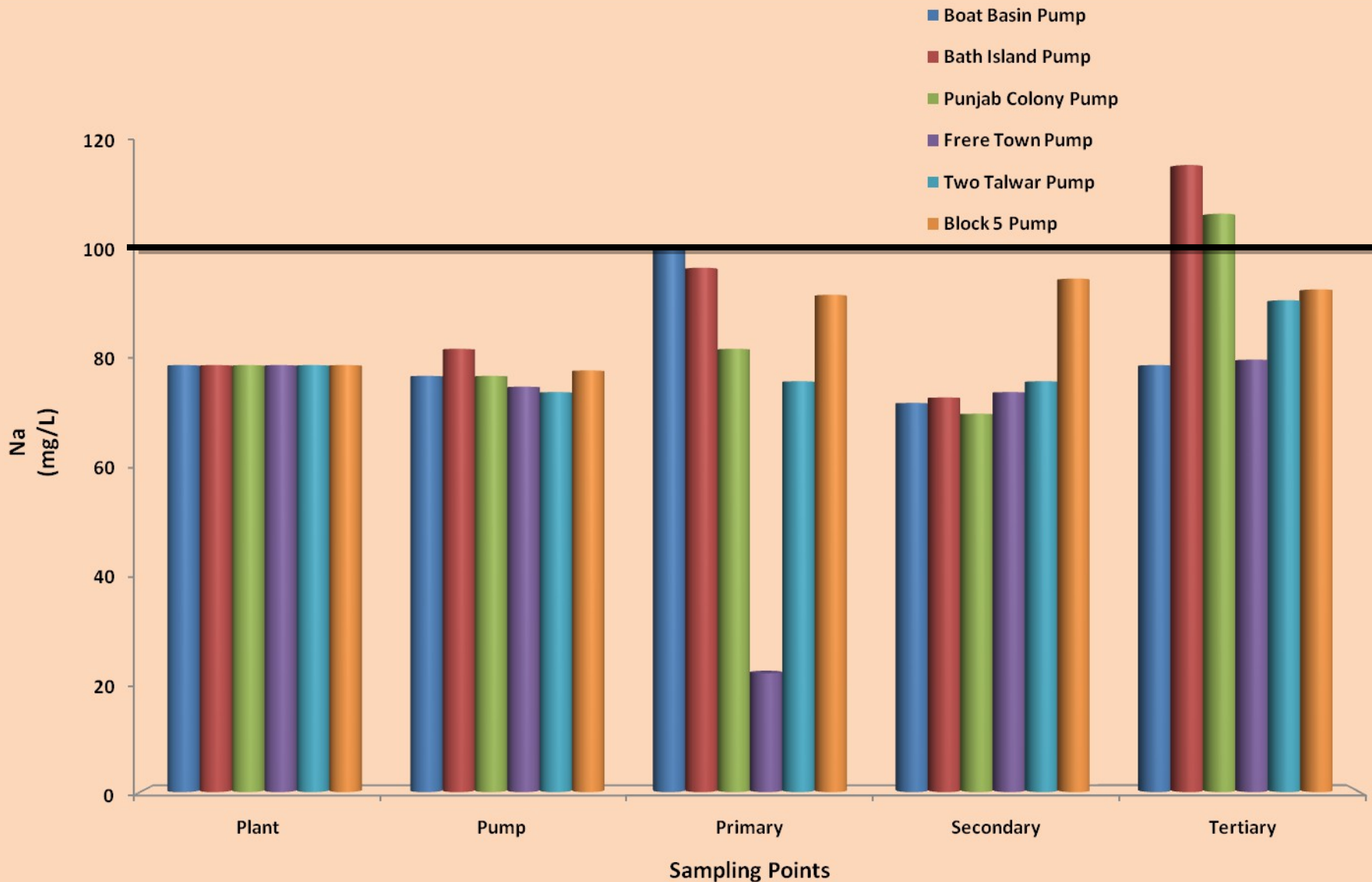
Permanent Hardness ...Allowable Limit: 120 – 180 mg/L



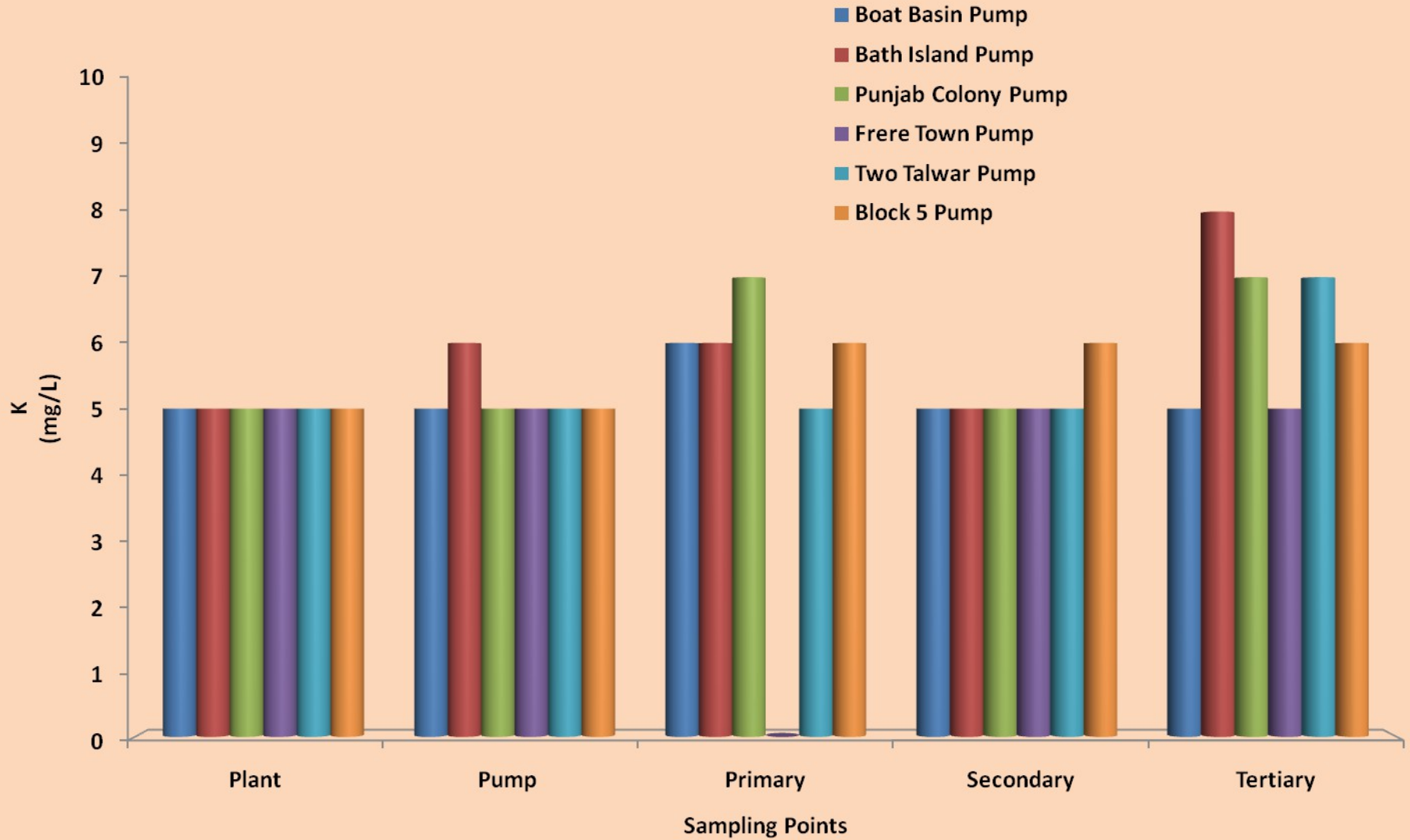
Variation of Calcium ...Allowable Limit: 200mg/L



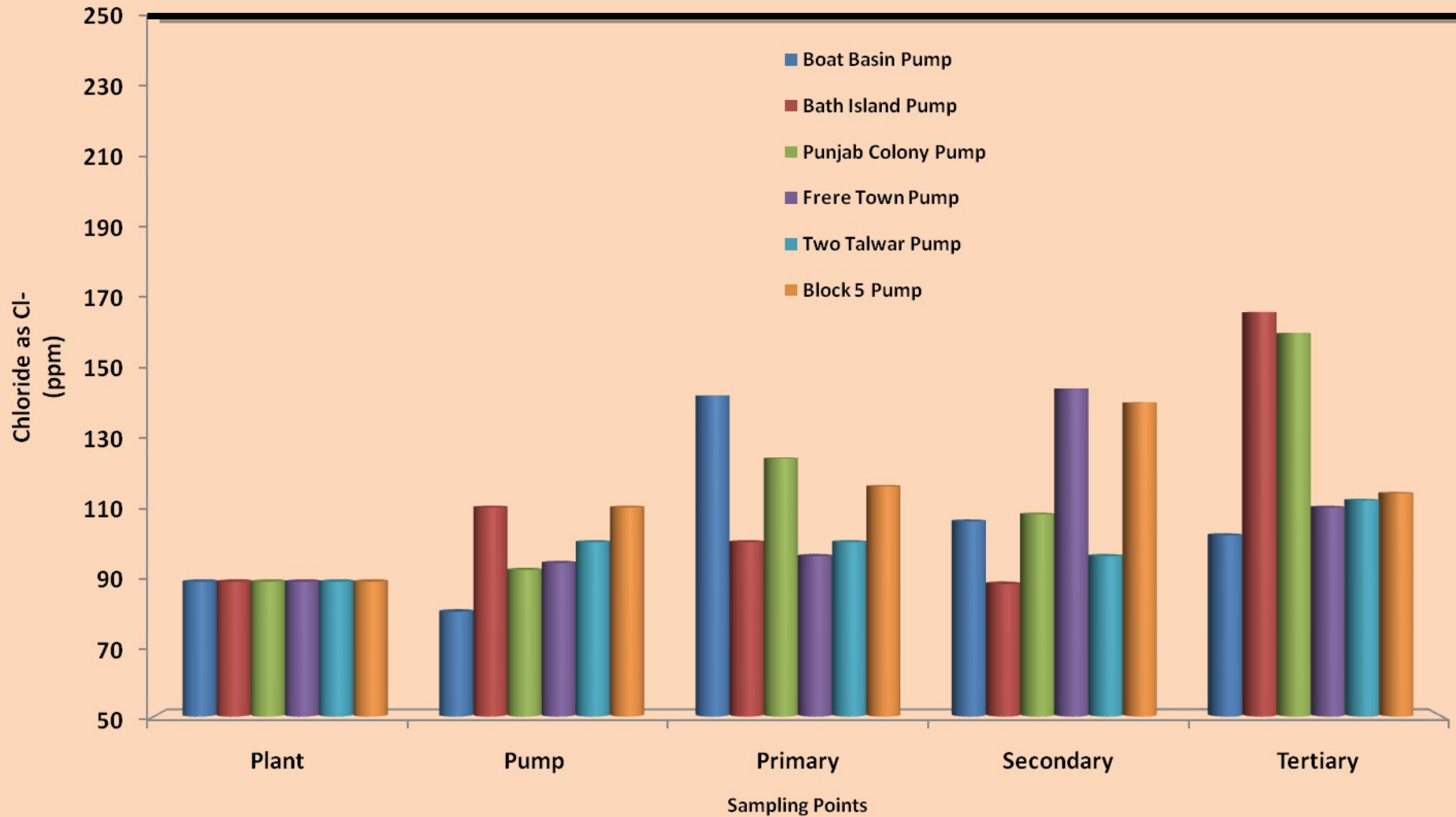
Variation of Sodium ...Allowable Limit: Sodium = 100mg/L



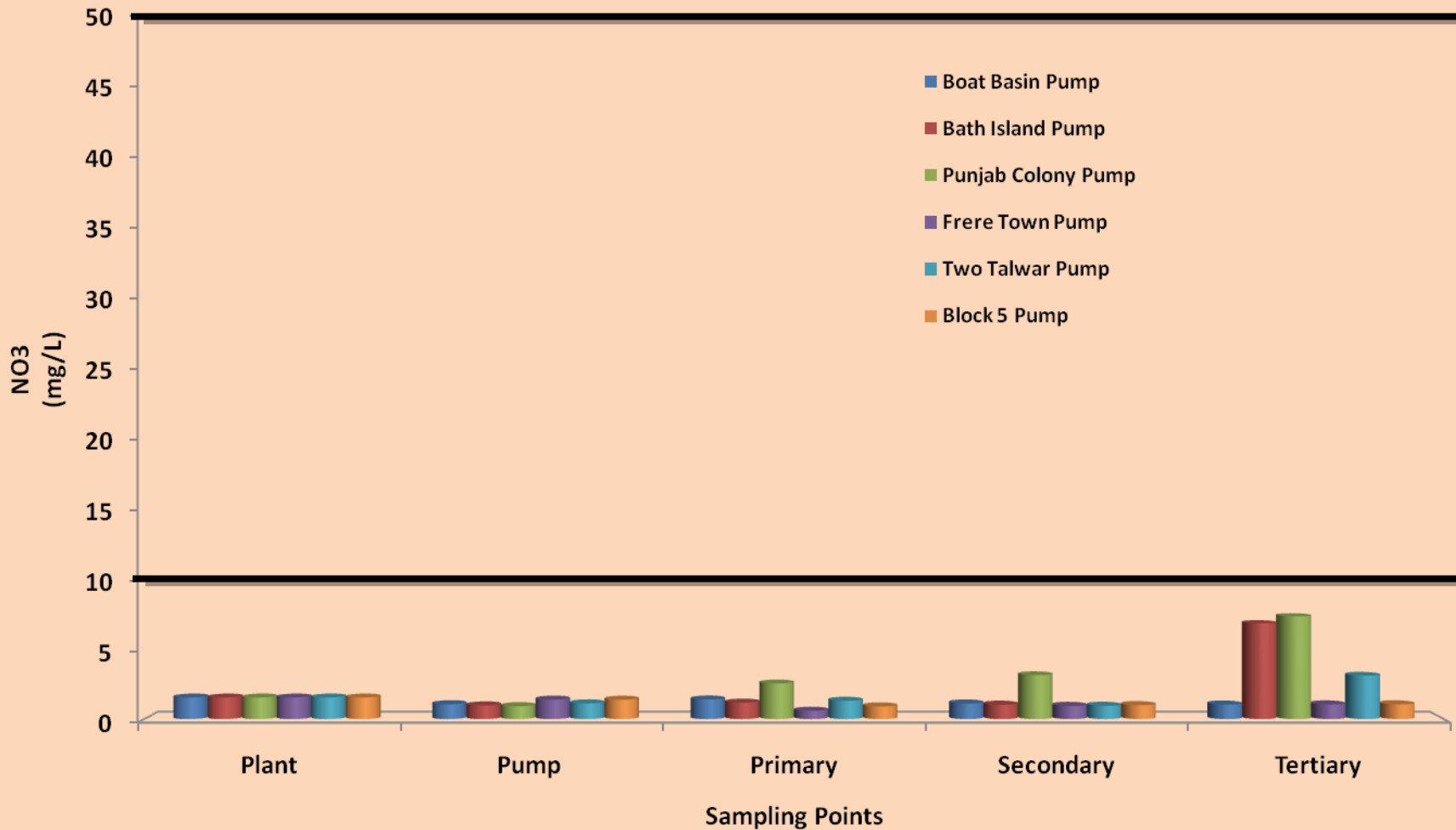
Variation of Potassium...Not Defined by WHO



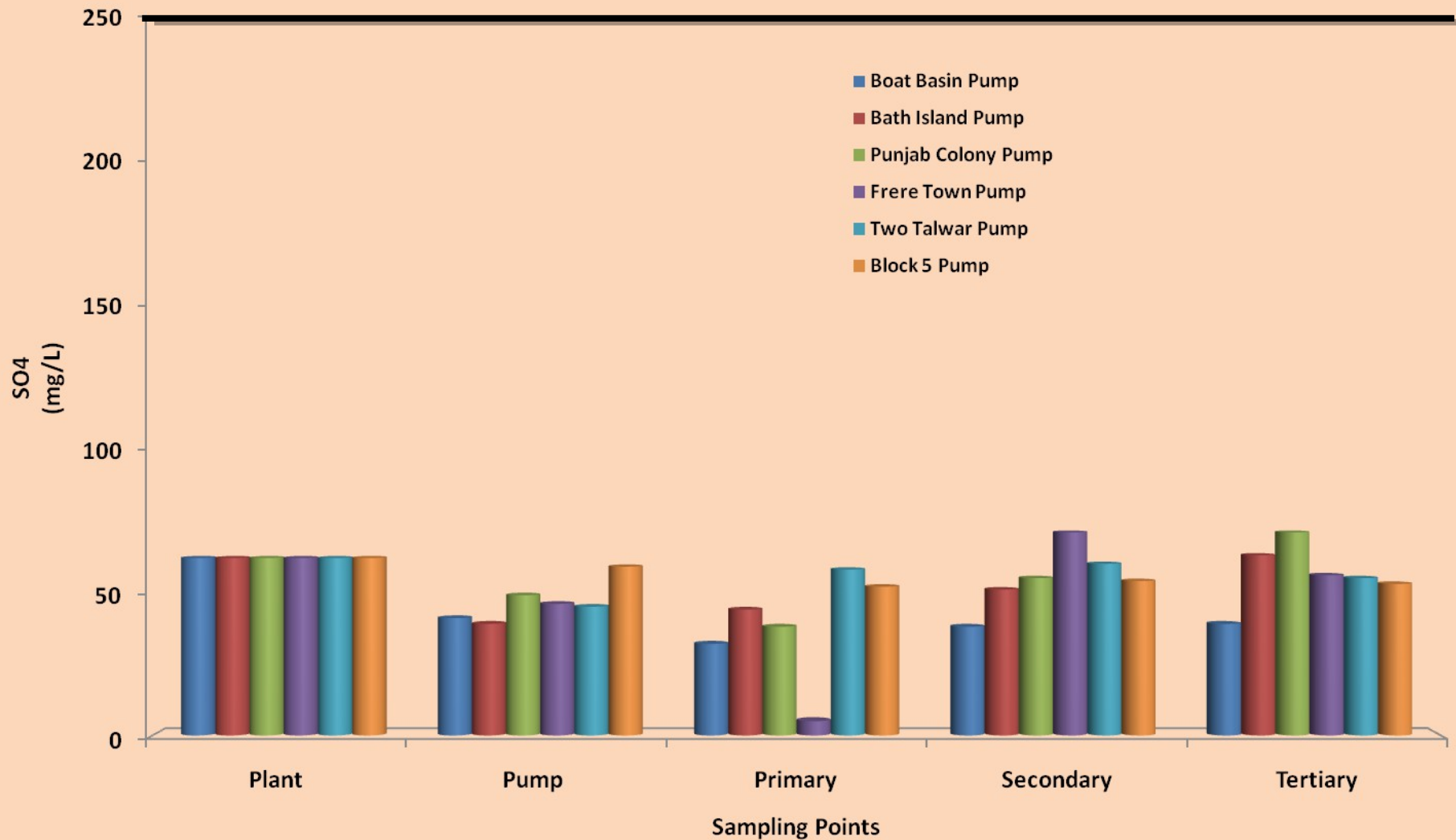
Variation of Chlorides...Allowable Limit: 250 mg/L



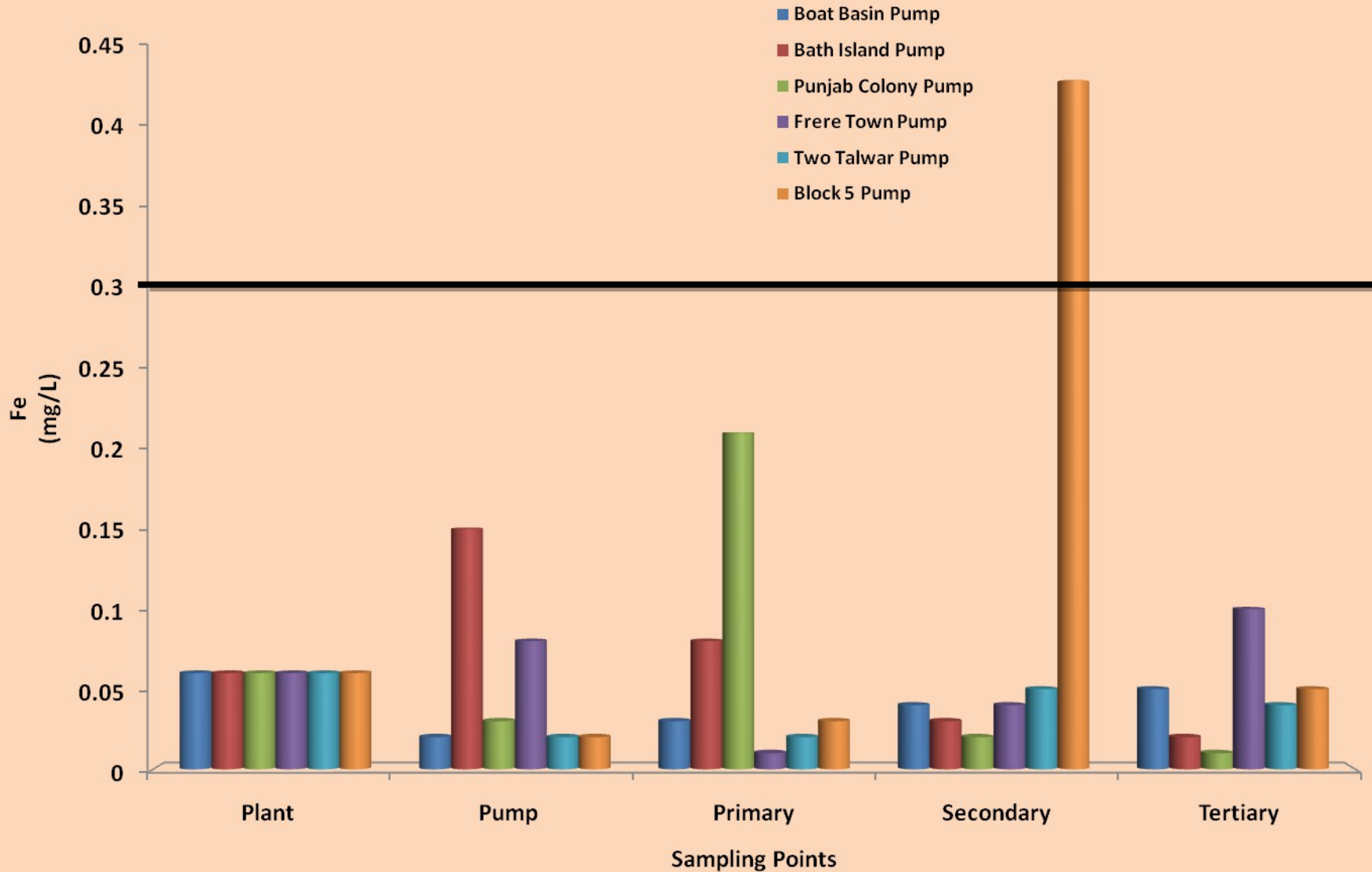
Variation of Nitrates ...Allowable Limit: 50 mg/L; USEPA: 10 mg/L



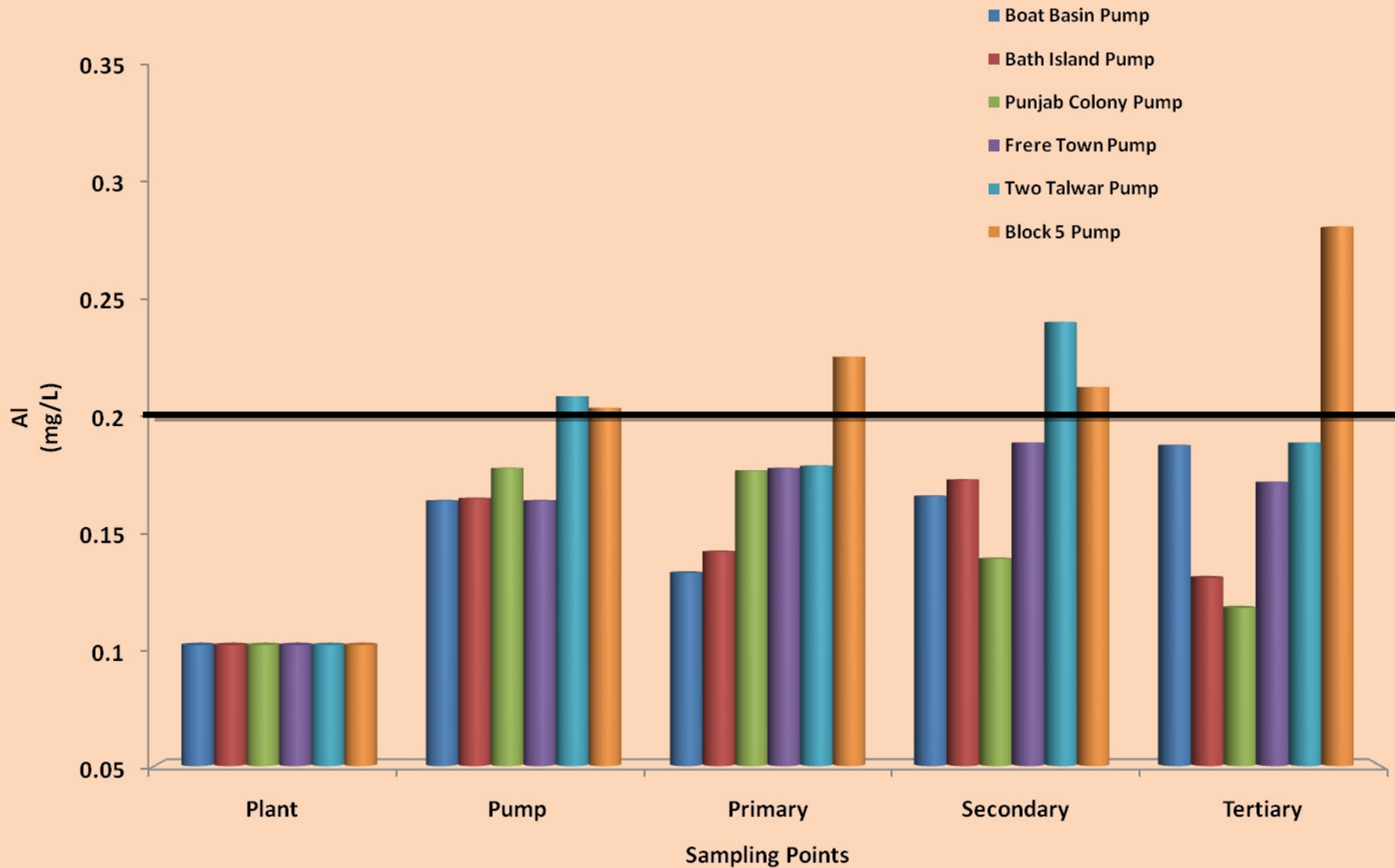
Variation of Sulfates ...Allowable Limit: 250 mg/L



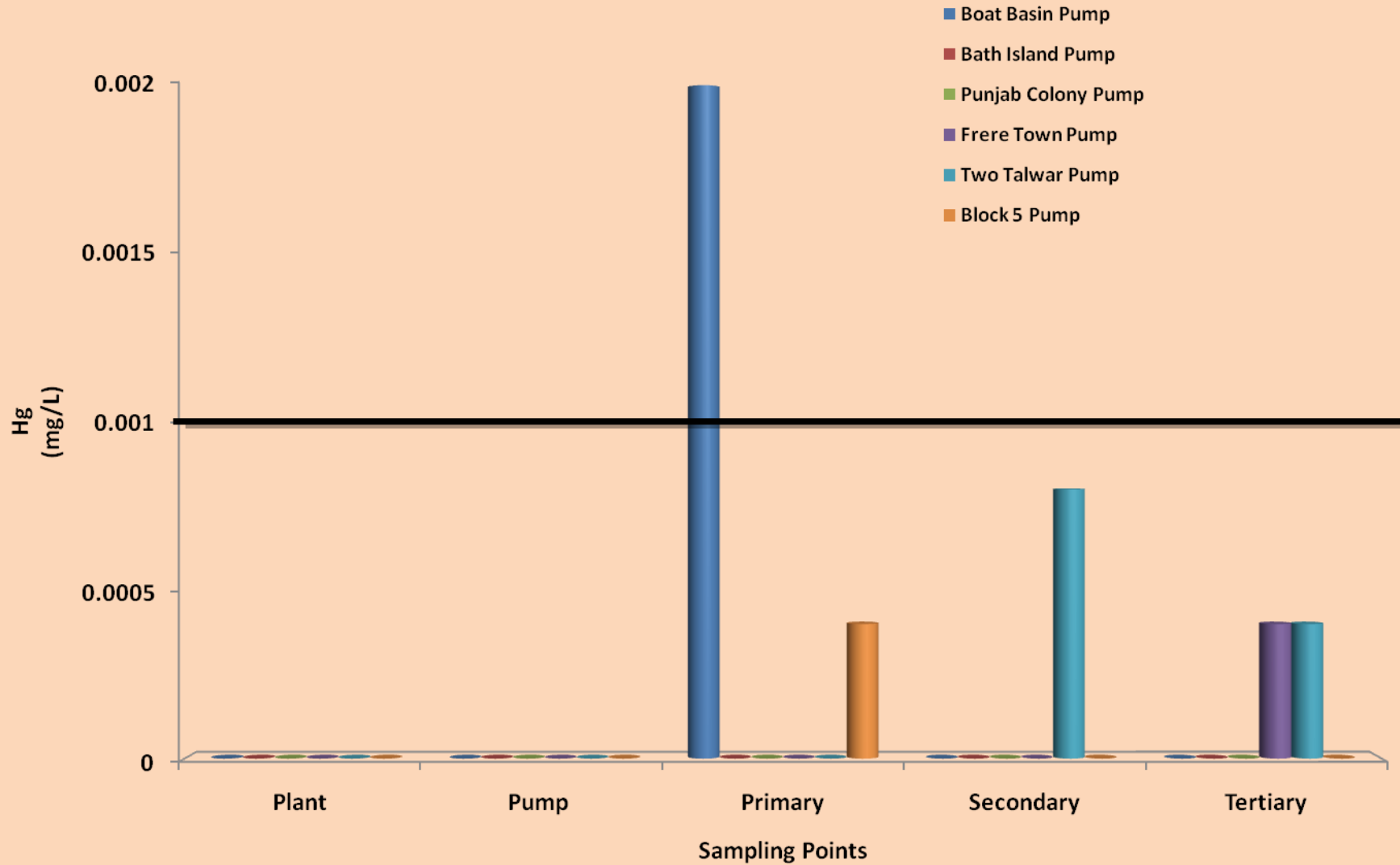
Variation of Iron... Allowable Limit: 0.3mg/L



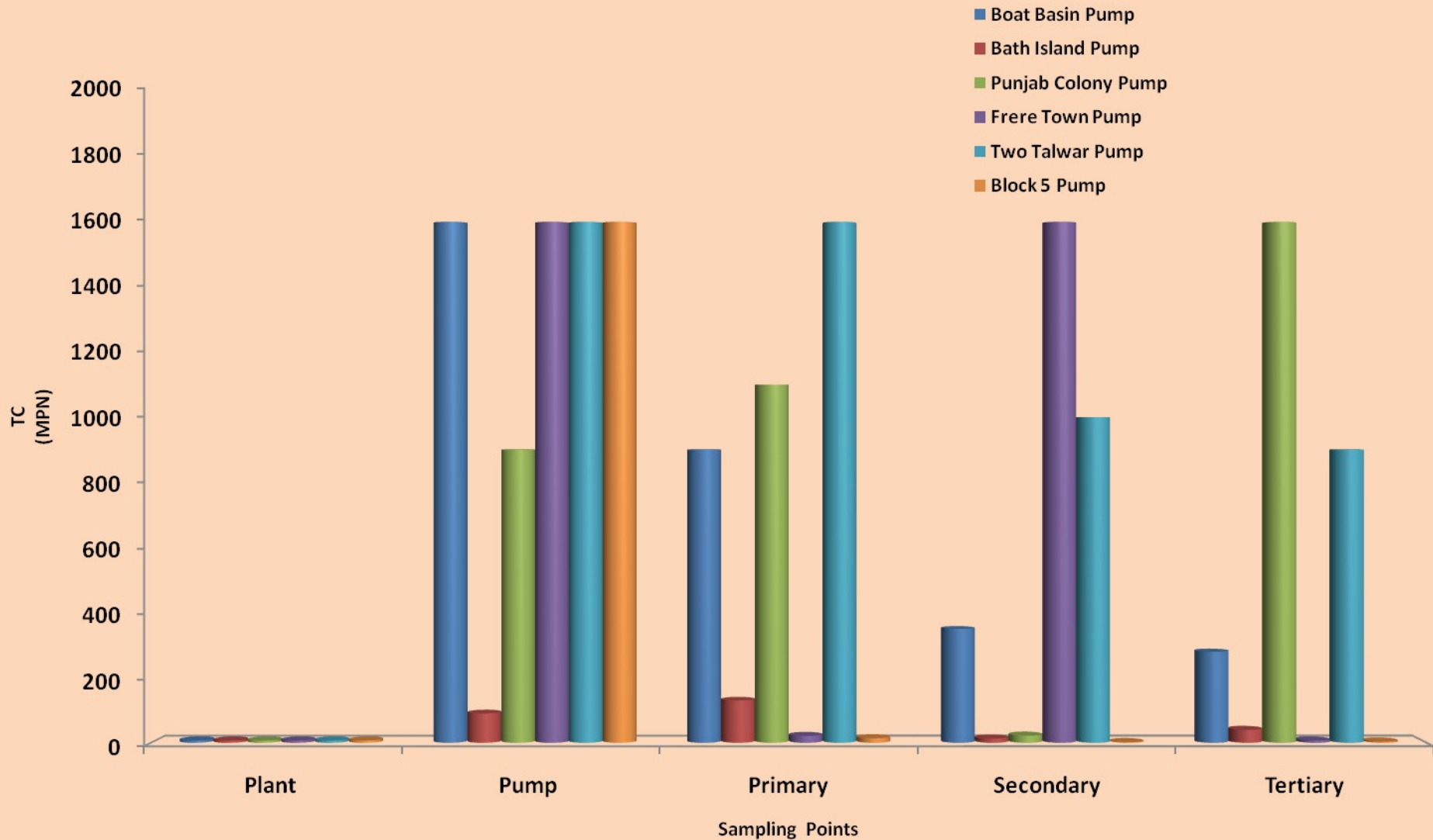
Variation of Al...Allowable Limit: Aluminium = 0.2 mg/L



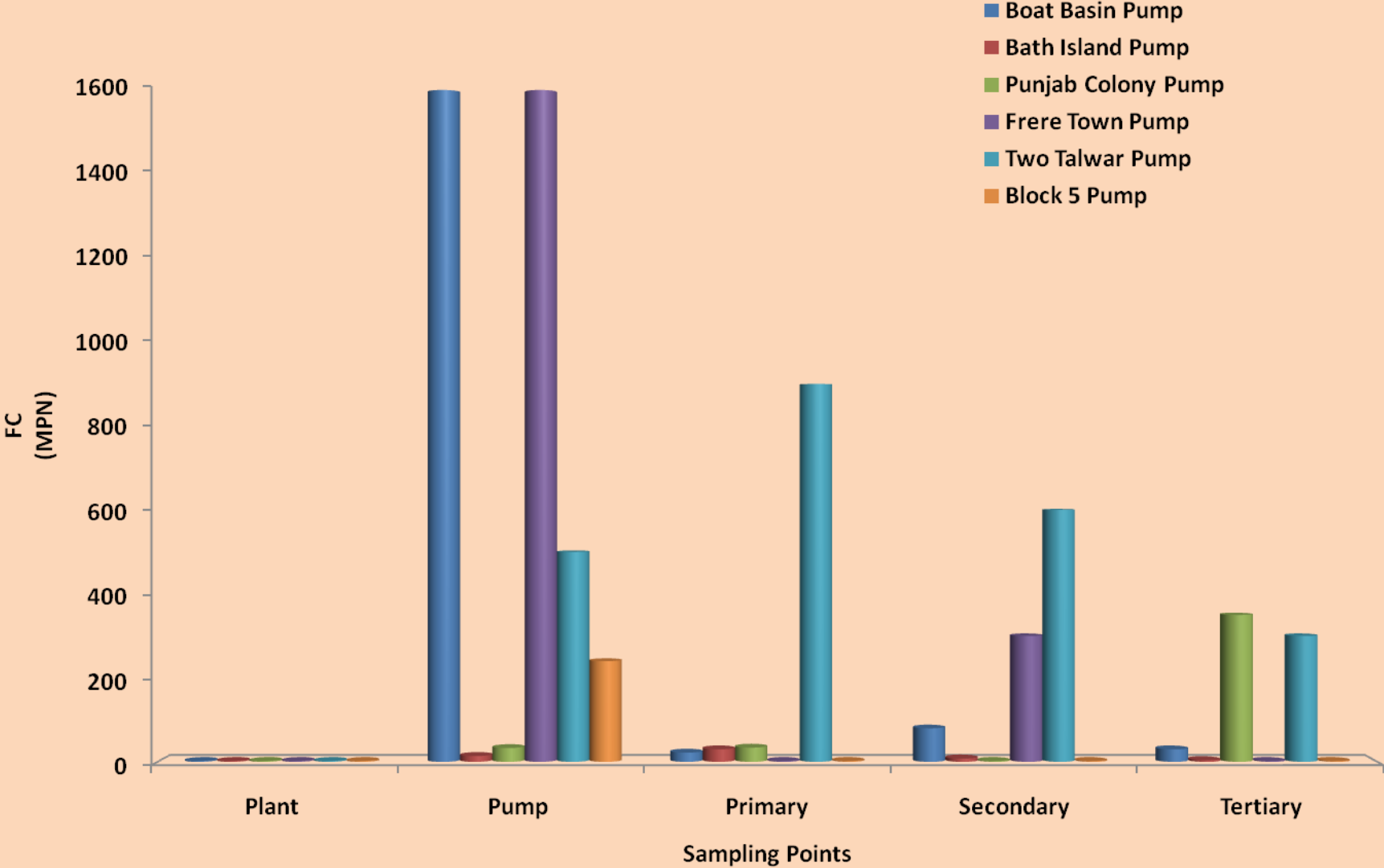
Variation of Mercury ...Mercury = 0.001 mg/L



Variation of Total Coliform...Allowable Limit = 0

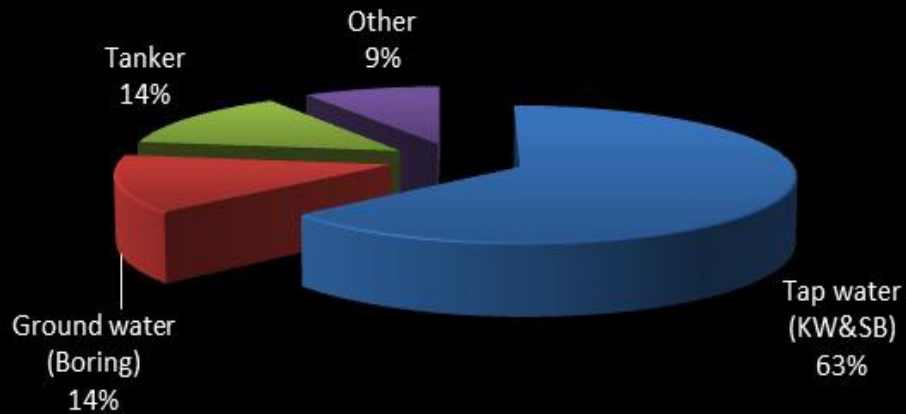


Variation of Fecal Coliform...Coliform...Allowable Limit = 0

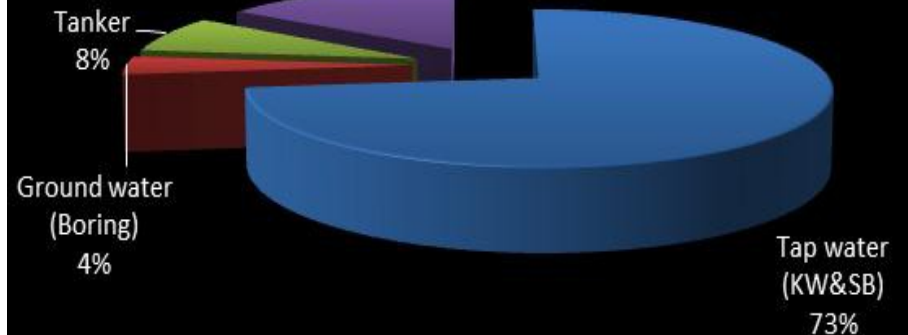


People's Opinion about the water supplied by KWSB ...

Potable Water Source



Municipal Water Source

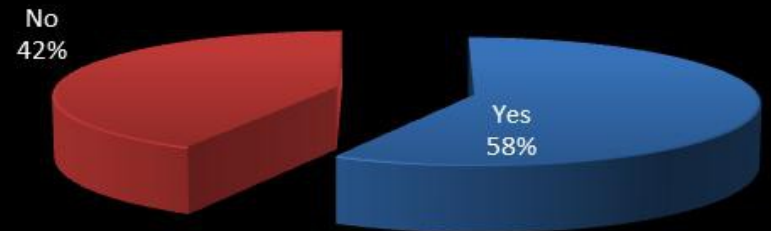


People's Opinion about the water supplied by KWSB ...

Water Quality Satisfaction

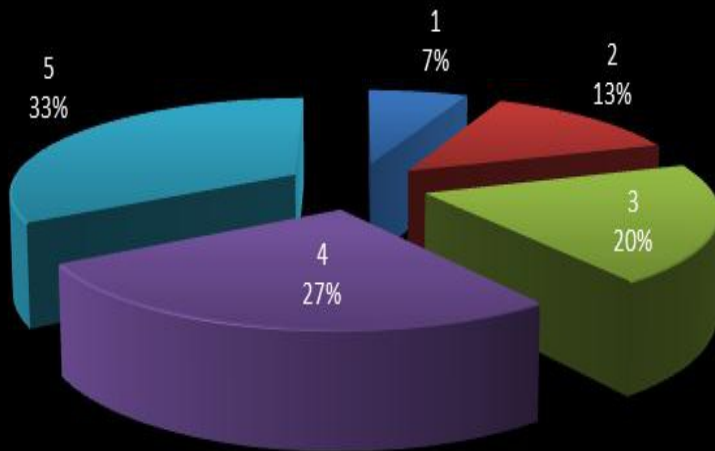


Water Quality Satisfaction

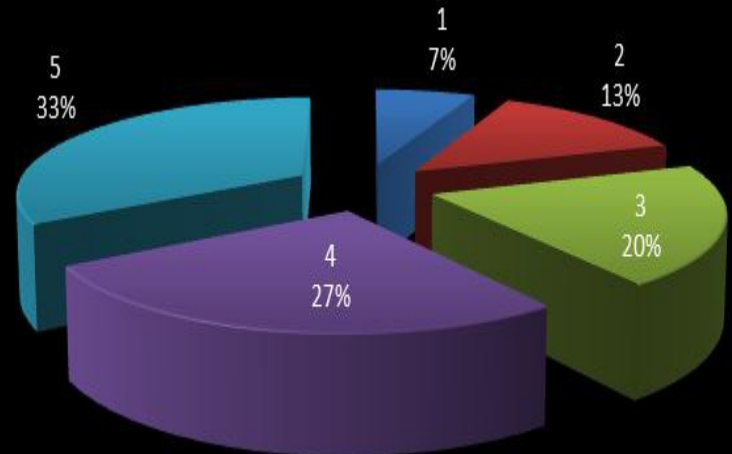


People's Opinion about the water supplied by KWSB ...

Water Color Rating

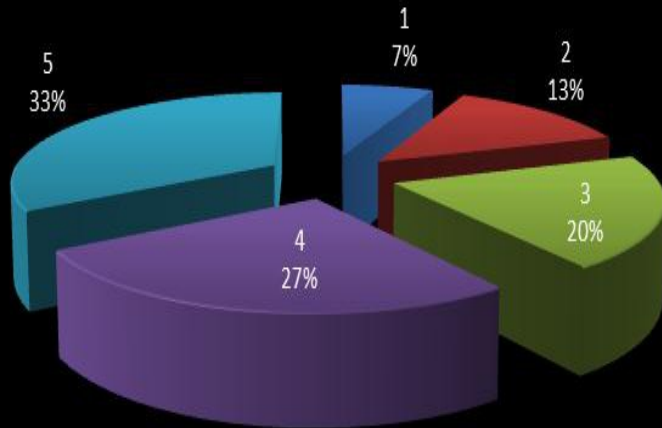


Water Odour Rating

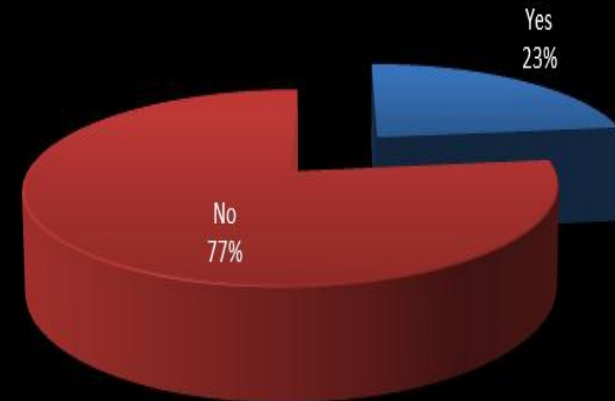


People's Opinion about the water supplied by KWSB ...

Water Taste Rating

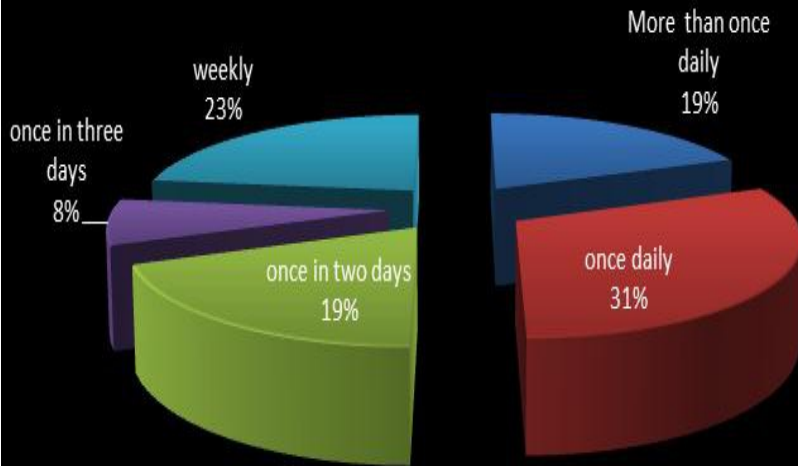


Rate of Water-Borne Disease.

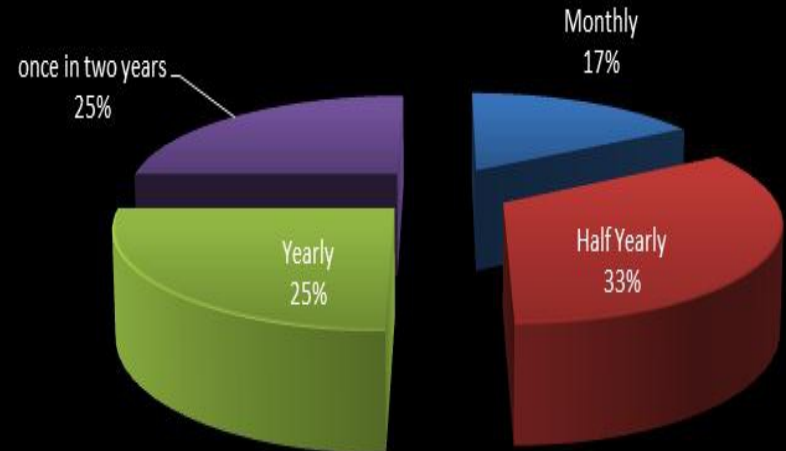


People's Opinion about the water supplied by KWSB ...

Frequency of water supplied by KWSB

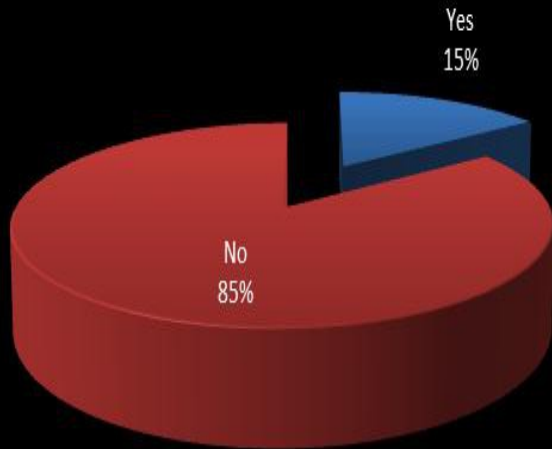


Tank Cleaning Frequency

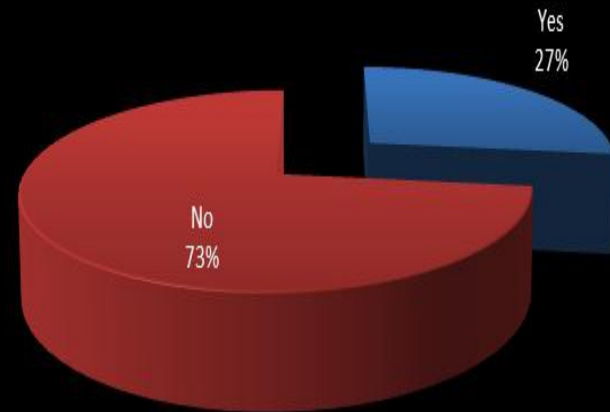


People's Opinion about the water supplied by KWSB ...

Rate of Complain Registration

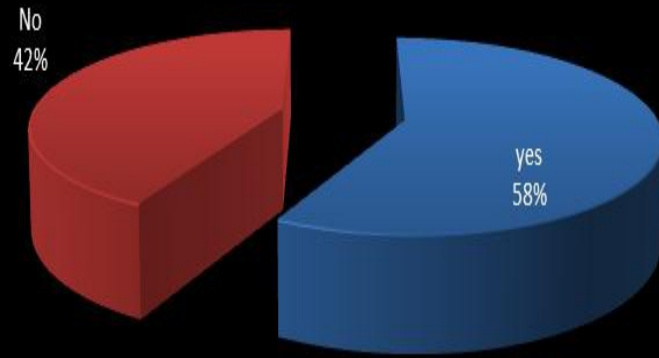


Reponse From KWSB

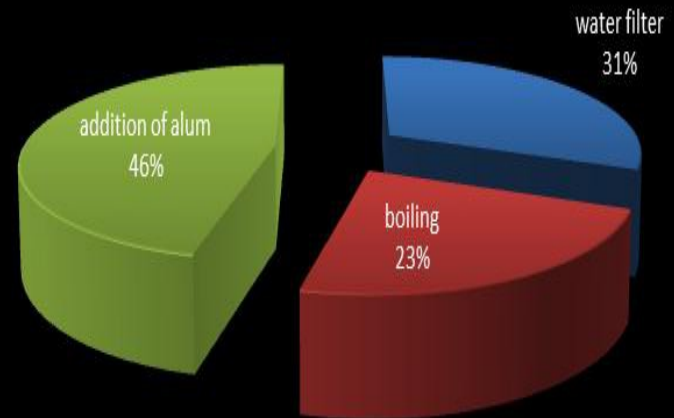


People's Opinion about the water supplied by KWSB ...

Treatment At Household Level



Household Purification Method



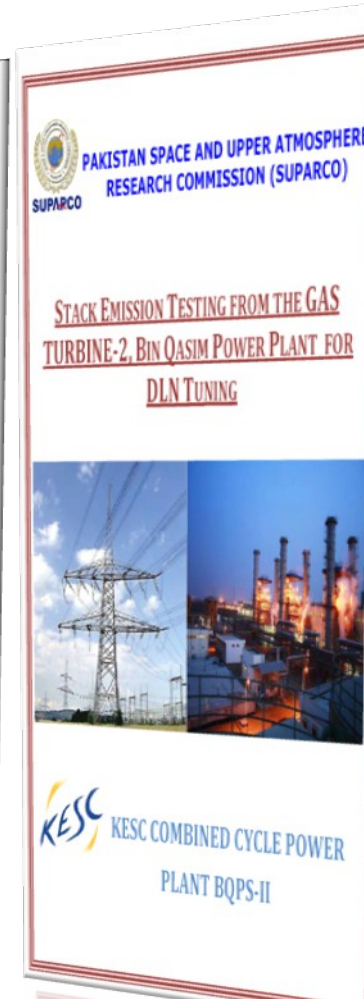
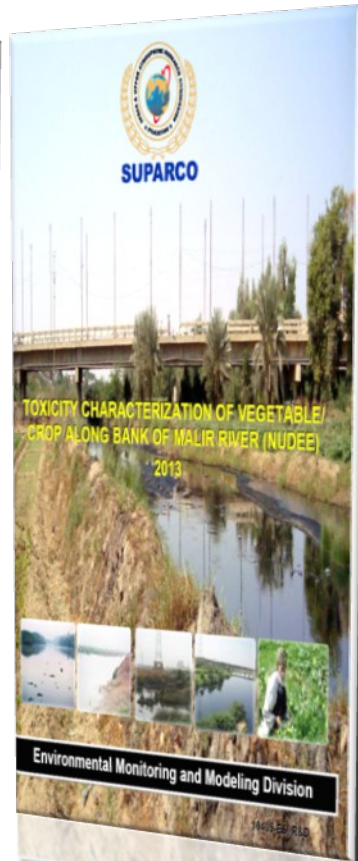
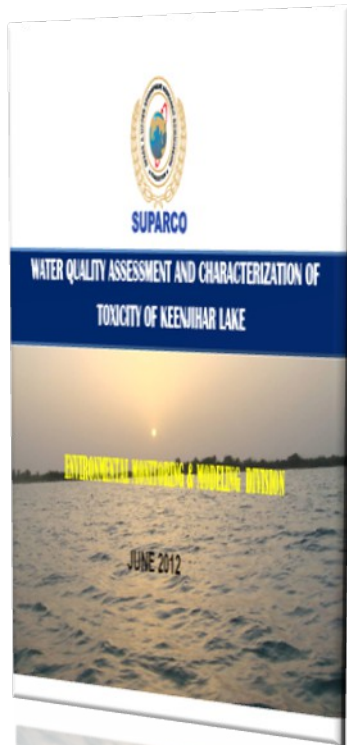
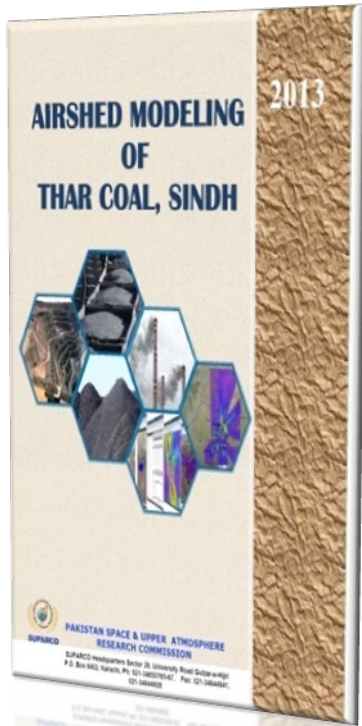
Causes of Contamination in Distribution Network ...

- Intermittent water supply due to general shortage of water.
- Leakages in water supply mains which have out-lived their effective life or have not been laid in accordance with the required specifications, resulting in infiltration of contamination of ground water during non-supply hours.
- In-discriminate disposal of raw-sewage and inadequate and defective sewerage system in the city.
- Installation of un-authorized suction pumps on water main by un-scrupulous elements for augmenting their water supply.
- Sub-standard construction of water storage tanks and sewerage system at individual premises.

Remedies Proposed....

WATER QUALITY PARAMETERS	REMEDIES
TDS	Reverse Osmosis
Calcium	Ion Exchange
Sodium	Reverse Osmosis, Ion Exchange, & Distillation
Potassium	Reverse Osmosis
Nitrates	Distillation, Reverse Osmosis, Blending, Ion Exchange
Residual Chlorine	Re-chlorination at Pump level, Boiling at Household level
Alkalinity	Lime Softening, Reverse Osmosis, Distillation, De-ionization
Turbidity	Filtration, Clarifier, Settling Tanks
Permanent Hardness	Soda Treatment, Softening Agent (soap, caustic soda, ammonia solution, etc.)

Studies in Environmental Assessment Studies (R&D) at SUPARCO





Thank You!

Questions/Comments