The ground water quality for drinking, domestic, irrigation and industrial application in District Ghaziabad, Uttar Pradesh has been assessed. Major ion chemistry was studied. A number of parameters have been analyzed in the study area as: pH, conductivity, Salinity, TDS, Resistivity, K, Na, Cl-, T. Hardness.Ca. Hardness, Mg Hardness, Ca, Mg, T. Alkalinity, CO$_3^{2-}$, HCO$_3^-$, Silica, Ammonical N$_2$, NO$_2^-$, SO$_4^{2-}$, PO$_4^{3-}$, Br$^-$, F$^-$, Cr$^{6+}$, NO$_3^-$ and Cu, B, Al, Be, Mn, Fe, Sn, Mo, V, Pb, Ni, Zn. Based on the results following points emerged:

1. The pH of the samples showed mildly acidic to mildly alkaline in both the season in the study area. The maximum number of samples showing the violation for the total dissolved solid with respect to the BIS desirable limit (500mg/l) during both season. The alkalinity also exceeded desirable limit of 200 ppm in majority of the samples. From the hardness view point 60% in pre and about 57% sampler in post monsoon season exceeded the desirable limit 300 ppm. The fluoride were found exceed the desirable limit 1.0 ppm in 31%, about 21% in both season. Nitrate was measured within the desirable in maximum number of samples during both the season. Anthropogenic activities may be responsible for the higher levels of these ions in the study area.

2. Iron concentration was significantly high in both the season. It was found beyond the desirable limit (0.3ppm) in 41 and 70% samples in both the season, moreover 15% sample and 46% samples exceeds the permissible limit 1.0ppm in pre and post-monsoon season respectively clearly showing its anthropogenic origin. The concentration of the Cr-VI has also been found in 6-7% samples beyond the desirable limit 0.05 ppm during both the season. Lead was analyzed in about 9 and 16% samples exceeding desirable level (0.1ppm) during both the season. Aluminum was found significantly beyond the desirable limit 0.03 ppm in most of the samples during both the season. Boron was also showing violation in respect of desirable level 0.3ppm in 17 and 22% samples during both the season. Manganese was found in 3.2 and 16% samples beyond the permissible limit of 0.3ppm in the two seasons respectively. Furthermore, post-monsoon season showing the Mo, Cu and Ni beyond their desirable limit in 18.4,4 and 16%
samples respectively. Ionic dominance order in the study region was Cl\textsuperscript{−} > Na\textsuperscript{+} > HCO\textsubscript{3}\textsuperscript{−} > Mg\textsuperscript{2+} > Ca\textsuperscript{2+} > SO\textsubscript{4}\textsuperscript{2−} > K\textsuperscript{+} > NO\textsubscript{3}\textsuperscript{−}.

3. According to classification of Soltan, maximum number of samples classified as Normal-sulfate, Normal-chloride and Normal-bicarbonate during pre-post monsoon season.

4. Base exchanges indices (r\textsubscript{1}) were calculated for water samples. Based on r\textsubscript{1} in pre-monsoon season 78\% samples were of Na\textsuperscript{+}-HCO\textsubscript{3}\textsuperscript{−} type and rest of samples were of type Na\textsuperscript{+}- SO\textsubscript{4}\textsuperscript{2−}, where as 56\% samples were Na\textsuperscript{+}- SO\textsubscript{4}\textsuperscript{2−} type and 44\% were of Na\textsuperscript{+}-HCO\textsubscript{3}\textsuperscript{−} type in post-monsoon season.

5. Based on meteoric genesis indices (r\textsubscript{2}), 81\% samples were of shallow meteoric and 19 \% of deep meteoric water-percolation type in pre monsoon season which was changed in post-monsoon season as to 45\% and 55\% respectively.

The ground water quality was evaluated based on BIS drinking water standard (for drinking) salinity, chlorinity, sodicity, RSC(for irrigation) and by Aggressivity Index( industrial uses).

For drinking and domestic uses majority of the area samples are not in accordance of BIS standards, whereas for irrigation purpose (~90\%, 92\% in two seasons) tested on the basis of indices showing moderate to high salinity, thus may be considered as suitable for irrigation. Moreover, maximum number of samples (82\%, 47\% in two seasons) of study area were found mordantly corrosive in nature and can be used for industrial applications.

In comparison to the commercial form, our synthesized (fly-ash based) zeolite was found more effective towards metals removal in mixed condition. Study reveals the removal dependency mainly on the metal-ions initial concentration and the solution pH values. Removal order was found as Cu-II>Cr-III>Zn-II>Co-II>Ni-II by using the FAZ and commercial form. Pseudo second order model was found best fitted with the experimental data for Ni\textsuperscript{2+}, Cu\textsuperscript{2+}, Cr\textsuperscript{3+}, Zn\textsuperscript{2+}, and Co\textsuperscript{2+} metal ion. Langmuir equation explained the metal adsorption isotherm more accurately. Synthesized zeolite can replace the commercial zeolite which is in accordance to its economic viability. Results also suggest the involvement of both the processes as the ion-exchange along with adsorption.
So the prepared zeolite may be an alternative to the activated carbon and the purchased zeolite towards waste-water treatment having a number of metals pollutants.

**Recommendations**

Research carried out and presented in this thesis has shown that synthesized zeolite has potential for mixed heavy metal solution. However, further research and studies are needed in this area if this technology is to be fully utilised on an industrial scale economically. There are several areas of research that could be pursued in the future, these are presented below.

Further activation/treatment of developed zeolite was not investigated in this study. This could result in an increase in the capacity and efficiency of FAZ in treating the water/waste water containing the complex metal ions such as chromate; arsenate and others negative charge bearing metallic species. There are a number of of pre-treatment methods that can be used for activating FAZ these include, chemical treatment using NaCl or NaNO$_3$ solutions, dilute concentrations of acid (HCl), NH$_4$Cl solution and cationic surfactants such as HDMTA-Br (hexadecyltrimethylammonium bromide).

However mixed metal ion solution was used in this study, in practice, Industrial waste water/ water not only contains metal cations but also anions such as SO$_4^{2-}$, HPO$_4^{2-}$, Cl$^-$ and NO$_3$$. Ion exchange of certain cations is strongly influenced in the presence of complexing reagents as above mentioned species. This research only focused on the removal of heavy metals and did not take into account the effect of these anions on the capacity and effectiveness of FAZ. Further, research could be carried out to determine whether FAZ was able to reduce the concentration of these anions from solution and how the anions affect the heavy metal uptake capacity of synthesized zeolite FAZ.

Another potential area of research is the determination of the best regenerating solution. It is important to optimise this process, since the effectiveness of FAZ for subsequent adsorption stages is influenced by the effectiveness of the regeneration process. The effectiveness of regenerating solutions such as HCl, EDTA, NaCl and CaCl$_2$ at various concentrations and temperatures could be investigated as well.

The disposal of solutions from regeneration of FAZ and the disposal of exhausted FAZ are potential areas of further study. This achieved the desired objective of reducing the volume of waste, but the problem of how to dispose this metal concentrated solution
was not dealt with. There are a number of potential solutions, these include the reclamation of metals from the solutions by processes such as electrolysis and electrodialysis; investigations could be carried out to determine the economic feasibility of the potential solution.