

MSc Theses Abstract

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Graduation Year 1999

**Thesis Title: APPLICATION OF CLEANER
PRODUCTION APPROACH IN A DIARY
INDUSTRY**

Submitted by: Shivendra Jha

**Supervisor: Mr. Manoj Kumar Pandey, Mr. Amar
Bahadur Manandhar**

ABSTRACT:

In Nepal, at present most of the industries are discharging their effluent or emission having pollution load more than the standards set by regulating agencies. In this situation application of cleaner production in industries will be more useful as it will reduce wastes and emission at their sources thereby reduce pollution load on the environment. The basic significance of cleaner production is quite simple: increase production efficiency while at the same time eliminate or at least minimize wastes and emission at their source rather than treat them after they have been generated. In this research work Kathmandu Milk Supply Scheme has been chosen as a model Industry for the application of Cleaner Production (CP). Milk and milk products are essential component in diet. Dairy Industry is one of the main water

polluting industries in Nepal. In the beginning a CP team was formed. Information about the industry was collected and process flow diagrams for milk, butter and ghee production were prepared. Material balance of various input and output streams (i.e. milk balance, plastic balance, water balance, steam balance) was prepared. Information on input material costs was collected. The various sources of waste generation was listed and the causes of waste generation such as milk loss, packing material (plastic) loss, wash water having milk, gas emission, chemicals and water/steam/heat loss were identified.

The analysis of each waste stream was thoroughly carried out regarding the pollution load in terms of Biochemical Oxygen Demand (BOD), Total Suspended Solid (TSS), and pH. A cause analysis was carried out to identify the reasons for waste generation from each unit. On the basis of list of sources of waste and cause evaluation, CP options were identified. Altogether there are seventeen CP opportunities including five CP opportunities of general area. These CP options have been subjected to detailed analysis covering technical feasibility, economic viability and environmentally benefit analysis respectively.

After completing the feasibility analysis the CP options are prioritized by ranking method for implementation. The CP measures have been rated as economic feasibility, environment feasibility and technical feasibility by assigning 50, 30, and 20 points respectively. Among these CP options, collection of milk wasted from damaged milk packets in filling section using steel pipe ranked number one, reuse of water used for cooling the heating rods of the filling and packing number two, have been implemented. After implementation of these two CP options there have been economic gain of Rs. 9,91,340 per year at investment of Rs. 27,000 only, and environmental gain in terms of reduction in BOD load 2299 kg per year, TSS 1088 kg per year and wastewater volume 2920 m³ per year. For rest of solutions implementation plan has been prepared.

It has been found that expected beneficial environmental impact will be significant on water media in terms of reduction of 53 percent BOD, 11.35 percent TSS, 37.2 percent chemical load and 23.1 percent wastewater volume. The reduction in solid waste (plastic loss) will be 50 percent. Similarly before CP options implementation, annual cost of chemical was Rs. 7,59,427, water Rs. 17,24,625, milk loss Rs. 1,24,53,070, plastic loss Rs. 18,41,206. Against this after implementation of CP options, annual savings will be for chemical Rs. 2,81,675, water Rs.

2,85,795, milk loss Rs. 62,26,535, plastic loss Rs. 9,20,603.

Overall expected saving after implementation of CP options will be Rs. 77,14,608.55 year against Rs. 1,67,39,600 investment in CP measures and 2.17 years payback period.

Thesis Title: ENVIRONMENTAL IMPACT OF MILK PACKAGING WITH PAPER AND PLASTIC MATERIALS: "A LIFE CYCLE ASSESSMENT"

Submitted by: Arun Kumar Simkhada

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Paper and plastic are the most widely used for all packaging materials. These packaging materials have significant impacts to the environment during its life cycle. The two systems under investigation are the milk packaging with paper material from its manufacturing process to waste treatment/recycle after consumption (system I) and the milk packaging with plastic material from its manufacturing process to waste treatment/recycle after consumption (system II). Life Cycle Assessment tool has been used for impact assessment of two systems.

The environmental problems caused by input of raw material and energy are depletion of energy and raw materials. Similarly environmental problems caused by the environmental output like air emission, water borne emission, solid waste emission and soil emission are Green house effect, Ozone layer depletion,

Acidification, Photochemical oxidant formation, Eutrophication, Ecotoxicity, Human toxicity, Nuisance (noise pollution) and Solid waste problem.

The reference quantity adopted for the study is 100000 litre of milk in 0.5 litre packs. The system boundary under investigation include the manufacturing process of packaging materials, its transportation to the consumer and disposal to landfill site or recycle as the raw materials. Bhrikuti paper mill and Pioneer plastic factory have been studied for the production process of paper and plastic respectively. The direct comparison of the environmental burdens across the life cycle phases have been done for:

- Fossil fuel depletion
- Material and Energy consumption
- Emission to air and water
- Heavy metal emission
- Emission to soil
- Solid waste emission

The characterization step reveals the paper has greater impact of Green house effect, Acidification, Eutrophication, Winter smog, Solid waste problem and Energy depletion. Similarly plastic has greater impact in terms of Ozone layer depletion, Heavy metal, Carcinogenic substance and exhaustion of raw materials. The normalization step reveals the solid waste problem is the most

important environmental problem among the others. The paper has more effect than plastic. Lastly the evaluation step reveal the most effective environmental effect is heavy metal and then acidification. The acidification is more for paper while heavy metal is much more for plastic. The overall score points for plastic is about 2.5 times more than that of paper.

The impact assessments at various recycling percentages of the packaging have been done. The marginal difference in overall environmental impact points for paper and plastic has been found lesser at larger recycling percentage. Finally the finding can be stated as the "Plastic milk packaging has a greater environmental effect than that of paper at all cases during its life cycle" under investigation.

**Thesis Title: PROSPECT OF SOLID WASTE REUSE
AND RECYCLING IN KATHMANDU
VALLEY**

Submitted by: Bishnu Prasad Timilsina

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

In recent years, the solid waste management is becoming a crucial problem in Kathmandu Valley. The current waste management system is faulty and so needs immediate improvement. The ever increasing volume of wastes is one of the major reasons behind the current mismanagement. At present, most of the collected wastes go for final disposal in landfill sites. The waste reuse and recycling is insignificant. This study assesses the potential for improving the solid waste management system in Kathmandu Valley by utilising the technique of solid waste reuse and recycling.

A small pilot study area was selected to conduct the field study. In order to assess the potential for reuse and recycling, a model based on the mass balance has been developed. The data and information required for solving the model were obtained both from the field survey and the existing literature.

The analysis considers different typical recycling schemes. While Scheme No. I represents the current practice of solid waste management in the study area, Schemes 2, 3, 4 represent the improvements over the existing practice. Input of source separation (biodegradable and non biodegradable) and separating the recyclable at recycling center define Scheme No.2. Higher participation rate of home composting has been considered in Scheme No. 3. Scheme No. 4 is the improved version of Scheme No. 3 with input of municipal composting plant. The outputs of Schemes No. 2, 3, 4 have been compared with the result of Scheme No. I. The comparison among different schemes showed that 21 % of total generated waste can be recycled, 62 % waste can be used for composting, and 17 % waste remains for final disposal. However, at present 72 % of the total generated wastes go for final disposal in landfill site.

The financial evaluation showed that the most economical recycling results in Scheme No. 4. A reasonable financial surplus can be achieved by implementing this recycling scheme as a pilot project in different clusters of Kathmandu Valley. Consequently, NRs. 111 million per annum can be saved in present waste disposal cost of Kathmandu Valley by utilising the potentiality of solid waste reuse and recycling.

The result reveals that the potential for solid waste reuse and recycling in Kathmandu Valley is very high. However, this potential can be tapped only by mobilising the public and private sectors involved in solid waste management. In this backdrop, a clear legal framework that provides economic incentives to the private entrepreneurs and scrap-based manufacturers is essential. The recycling and reuse of the wastes can be further promoted by peoples' participation through awareness campaigns.

**Thesis Title: MUNICIPAL SOLID WASTE
MANAGEMENT IN JANAKPUR TOWN**

Submitted by: Mahendra Lal Karn

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

This study attempts at resolving the MSW management problems of Janakpur town. The urban development of Janakpur town has been chaotic and unplanned. A frequent concentration of outsiders in huge number, considerable use of non-biodegradable materials and continuation of traditional habits and attitudes have led to unhealthy environment. Empty lands, streets and footpaths are used as scattered dumping sites due to lack of public awareness which has resulted in blocked drainage systems mostly. This way, the beauty of Janakpur is decreasing day by day and it has, also, hampered the tourism trade.

The conducted study shows more than half of the MSW is organic nature and recyclable potential seems to be less. The average MSW generation, average density of MSW, the average moisture content of MSW, the MSW collection efficiency and the capacity of the dumping site are included in this study.

After analyzing the above data a short-term extension with proper management of the present dumping site is recommended. A long-term solution for a twenty years period for the management of MSW in Janakpur town is recommended by considering managerial and technical aspects such as technique like; waste minimization, material recovery for reuse/recycle, composting and finally land filling. The out come of this thesis also recommended public awareness, people participation and formulation of appropriate rules & regulations to efficient MSWM in Janakpur town.

**Thesis Title: CHANGE IN RAINWATER QUALITY DUE
TO THE CONTACT WITH DIFFERENT
ROOFING MATERIALS AND STORAGE**

Submitted by: Phatta Bahadur Chetry

**Supervisor: Mr. Mahesh Prasad Bhattarai, Mr. Sharad
Adhikari**

ABSTRACT:

In the areas, where drinking water requirements are not easily met from the water supply systems developed with local water sources such as springs, wells and rivers, rain-water harvesting system might be one of the viable options to over come the problem, in order to validate the RWH system as a sound alternate, quality parameters of the water collected through the system need comprehensive study. This study has made an attempt to assess the change in physical, chemical and bacteriological parameters due to the contact with different roofing and gutter medium that are most widely used in Nepal and the change in the parameters in storage.

Change in color, odor, turbidity, pH, alkalinity, chloride, hardness and bacteriological parameters were examined through seven different roofing systems, which were RCC flat roof, CGI

roof with bamboo gutter, tile roof, thatched roof, CGI roof with HDPE gutter, RCC slope roof and CGI roof. The results from this study showed that all the physical and chemical quality of rainwater samples from these roofing systems were changed with respect to atmospheric rain. Except turbidity in the samples collected from thatch and tile roof all other physical and chemical quality of other samples were within permissible limit of drinking water recommended by WHO 1995. In bacteriological parameter only the samples collected from the CGI roof were found within the water quality standard set by WHO.

Water samples from three storage tanks in Tanahun District were analyzed for the analysis of stored water quality parameters. One of the tanks, Manungkot, was under construction during the period. Therefore the data obtained from other two tanks were only used for the purpose. The results obtained from stored rainwater in cement masonry tank showed that all samples met the physical and chemical drinking water quality guideline established by WHO in 1995 but failed in bacteriological quality.

The findings from this study indicate that any health risk evolving from the consumption of stored rainwater from RWH

system would be due to bacteriological contamination rather than the physical and chemical contamination.

**Thesis Title: THE PERFORMANCE OF PASSIVELY
AERATED HDPE HOME COMPOSTERS**

Submitted by: Amar Neku

**Supervisor: Dr. Shashi Shankar Rajbanshi, Mr. Mahesh
Prasad Bhattarai**

ABSTRACT:

A highly polluted city like Kathmandu should utilize its ubiquitous organic waste (ca. 70 % of total volume) as a valuable resource before the waste creates problems. In a country like Nepal, where there is no well-developed mechanism for integrated solid waste management, large-scale waste management systems are impossible in the immediate future. Nevertheless, there is a need for a system where private and individual initiatives can contribute to the management of municipal solid waste (MSW). In this context, it is a worthwhile experiment to evaluate the performance of home composters made of plastic tanks. The home composters considered here were designed by considering the different aspects of known composting ecosystems. The materials used for studying the composting process include organic fraction of municipal solid waste, garden waste, agriculture waste, and vegetable market waste. Their carbon to nitrogen (C/N) ratio and moisture content

were examined to determine the proportion of each of these wastes in the final mixture. The carbon to nitrogen ratio and moisture content of starting material (day 0) were adjusted to 24.3 % and 55 % (wet weight), respectively. The composting matrix was taken out from the tanks on day 125 and kept in a windrow system for further maturation.

The highest mean temperature reached 61°C on day 4. A gradual decrease in temperature was then observed until the temperature stabilized at 2.5°C above the ambient temperature on day 60 and thereafter. The carbon dioxide evolution rate (CER) reached the maximum average value of 13.5-gkg⁻¹ dry weight day⁻¹ on day 17, and decreased to 4.3 units on day 60. However, the CER slightly increased to 5.9-g kg⁻¹ dry weight day⁻¹ on day 150 due to the introduction of the windrow system on day 125. The carbon to nitrogen (C/N) ratio declined logarithmically to values 12.1 and 9.2 on day 60 and 150, respectively. The Five day biochemical oxygen demand (BOD₅) of water extracts of the compost decreased logarithmically from an average value of 49.5 g O₂ kg⁻¹ dry weight on day 1 to 7 g O₂ kg⁻¹ dry weight on day 60. Eventually, it reached to the value of 6.6 g O₂ kg⁻¹ dry weight on day 150. The germination index (GI) of fenugreek (*Trigonella foenum-graecum*) seeds on water extracts of the compost increased from 45 % of the control on day 1 to 71.6 % of the

control on day 60. Eventually, it reached 82.2 % of the control on day 150. The average pH increased gradually from 6.9 on day 1 to 8 on day 60. Then it stabilized at 7.9 on day 150. The electrical conductivity (EC) increased from 1.5 dS m⁻¹ on day 1 to 2.8 dS m⁻¹ on day 60. The EC then slightly declined to 2.5 dS m⁻¹ on day 150. The nutrient values in terms of NPK (Nitrogen, Phosphorous, and Potassium) of the compost were found as 1.3, 0.3, and 3.5 % of dry weight, respectively. A distinct positive correlation was observed between total carbon versus BOD₅. In contrasts to this, the C/N ratio versus GI was negatively correlated.

The composting process performance of the passively aerated home composters was satisfactory in terms of maintaining aerobic condition, removing heat through ventilation, and pasteurizing the pathogens inherent to the organic wastes. The time required for the active decomposition and maturation was approximately 60 and 115 days, respectively. The quality of the compost product met the ranges of standard NPK values given in the literature.

**Thesis Title: COMPARATIVE ANALYSIS OF VARIOUS
AVAILABLE RURAL WATER SUPPLY
PROJECT PROCEDURES FOR HILLY
REGION IN NEPAL**

Submitted by: Bhoj Bikram Thapa

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

Three different major agencies working in Rural Water Supply sector were selected for comparison of their project procedures. The major parameters of comparison among the projects were technical, social, environmental, capital and resource mobilization, time, and cost. All these parameters were divided in six phases namely: identification, preparation, appraisal and negotiation, implementation, operation and maintenance, and monitoring and evaluation of the project cycle, which were distributed in fifty-eight major activities. All the activities, phases of project cycle, parameters, and whole project procedures of these three agencies were compared by using Analytic Hierarchy Process (AHP) and Ranked Pair-wise Comparison Technique (RPCT). For the purpose of comparison nine completed rural water supply projects (three of each type) were selected in Kavrepalanchowk district. A questionnaire was

developed and ten household surveys were held in each project site. Average scores on each activities and parameters were taken for further analysis. Four different analysis were done for project procedure, project phases, project parameters, and individual activities.

Results of the analysis revealed that only a single project procedure is not highly efficient. It was found that, out of 100 score allocated for overall project procedures, RWSSFDB projects obtained 74.97 score, NEWAH projects obtained 70.28 score and DWSS projects obtained 61.53 score. Parameters like social, capital and resource mobilization, and time were found as the inferior parameters, which needs to be improved by DWSS. Whereas, technical, and cost parameters were the inferior parameters to be improved by RWSSFDB and NEWAH.

**Thesis Title: GROUND WATER CONTAMINATION BY
ON-SITE SANITATION PRACTICES**

Submitted by: Hari Prasad Timilsina

Supervisor: Dr. Chet Bahadur Pariyar

ABSTRACT:

An attempt has done to set a sanitary zone around the on-site sanitation facilities and pollution sources in Kathmandu and Janakpur town by assessing the ground water quality around them. Ground water samples were collected from thirteen shallow tube wells from three different places of Kathmandu, ten from Janakpur and one near Bagmati river. Pollution transfer mechanism is monitored on the basis of the selected parameters such as pH, dissolved oxygen, chloride, ammonia, biochemical oxygen demand, total coliform and faecal coliform.

After analysing the above parameters and assessing the ground water quality with respect to distance from the source of pollution and the depth of the tube wells, extent of sanitary zone is fixed. The out come of the thesis gives a safe sanitary zone of 15 m radius coinciding with conventional practices for shallow depth tube wells on unconfined aquifers in Kathmandu valley. The numerous ponds in Janakpur have no impact on the ground

water quality for high depth shallow tube wells on confined aquifers.

**Thesis Title: COMPARATIVE STUDY OF
CHARACTERISTICS AND
PERFORMANCE OF DIFFERENT LOCAL
SANDS AS FILTERING MEDIUM ON
RAPID FILTER**

Submitted by: Manish Shrestha

Supervisor: Dr. C. B. Pariyar

ABSTRACT:

This thesis focuses on evaluation of locally available sands as a rapid filtration medium for water supply treatment plants. So far, local sands are not used as a filtering media in Nepal, instead, they are imported. It is one of the reasons for high cost of water treatment facilities. So, to meet the objective of the thesis, four different samples of coarse sands from different sites were collected for performance evaluation. Two sets of filtering column of PVC pipes were fabricated with different sampling ports at different depths for the measurement of head loss as well as the quality of filtrate water. Grain size distributions, types of filter sample, sample collection time and filter run period were constant and experimental analysis was done. On the basis of head loss and filtrate water quality observed in the experiments, it is found that these four samples of sands can be used as a

filtering medium on rapid sand filter. Refinements and optimization has to be done by considering other variables, which are used to evaluate characteristics and performance of the filter media.

**Thesis Title: WASTE WATER TREATMENT THROUGH
GREEN VEGETABLES ON FLOATING
FOAM MEDIA**

Submitted by: Rajan Raj Pandey

Supervisor: Mr. R. K. Sharma

ABSTRACT:

This thesis attempts to use Hydroponic Culture system as a method of wastewater treatment. A concept of Resource Reuse was applied by using the nutrients of wastewater for the growth of green leafy vegetables. Altogether eight varieties of vegetable seeds were used in the experiment. Foam was used as a growing media, which was kept floating on the wastewater. Among the eight varieties of vegetables used; Garden Cress, Rape Leaves and Chinese cabbage were found most effective in the treatment process. The edibility tests of the produced vegetables showed the presence of Iron, Copper, Zinc, Nickel and Lead. However the concentrations of heavy metals were so less that they will pose no threat to human health. After four rounds of experiments in batch process, this system has been found to be feasible to treat wastewater of moderate strength. Furthermore, this system is environmentally friendly, because it helps check the groundwater pollution and the Eutrophication of surface water

bodies. This system is cheaper and more sustainable than other conventional methods, because it produces green leafy vegetables and is simple to operate, among others.

Graduation Year 2000

**Thesis Title: TREATABILITY STUDY OF DYE-BATH
EFFLUENT BY ANAEROBIC PROCESS**

Submitted by: Anil Bhadra Khanal

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

The study was focused on the possibility of using anaerobic digestion for the treatment of wastewater resulting from dyeing industries. Effluent from the Spectrome Dye Works, Ramshah Path, Kathmandu was used as the feed for anaerobic digesters and excess sludge of the biogas plant, producing bio gas from cow dung, was used as inoculums to test the treatability of dye bath effluent by anaerobic digestion. The experiments were conducted in lab scale reactors. Reactors were operated in semi-continuous and batch mode. In batch mode of operation two runs were conducted. In batch run-1 reactors were operated with or without addition of external source for carbon and nutrients. In batch run-2 reactors with different proportion of dye bath effluent and excess sludge of bio gas plant were used. COD removal for each reactor was observed. Removal rates of COD contributed by dye bath effluent were very low. The study

showed that the biodegradable fraction of dye bath effluent was very low. The groups of anaerobic bacteria present in the excess sludge of biogas plant producing biogas from cow dung were unable to degrade the dye bath effluent.

**Thesis Title: COMPARATIVE STUDY OF AERATION
(SPRAY AND CASCADE AERATOR)**

Submitted by: Binod Kumar Agrawal

Supervisor: Dr. Chet B. Pariyar

ABSTRACT:

Aeration plays an important role in water quality management and purification of polluted water. Higher concentration of Iron content in groundwater source (Roar Hand pumps) is one of the main undesirable water quality in Kathmandu valley and some parts of Terai Region as well. Therefore, an attempt was made to reduce higher concentration of Iron only by sedimentation followed by aeration. Aeration, though seems to be very simple and common physical unit of water treatment process, no research work has been done in our country.

In this thesis (research work) the effect of mesh sizes (water bubble sizes) and spray heights were determined in spray aeration. In cascade aeration, experiments were carried out for various Rise-Tread ratios.

The test data have been analyzed and curves have been plotted. Different WQ Parameter have been analyzed and experimental

data are processed. Various analytical and experimental results have been compared.

The experimental results indicate that DO increases with decrease in mesh sizes and increase in spray heights qualitatively. But discharge rate decreases in this condition. Therefore, quantitative value of DO decreases with the same condition. So, from such type of experimental study most effective mesh size can be determined for a desired spray height and vice versa.

In the case of Cascade Aeration, it was found that Increase in Rise of the cascade is more effective than increase in tread.

From this study it was found that Iron concentration can not be reduced only by aeration and sedimentation in suitable detention period.

Due to certain limitations and constraints, no relationships could be developed for both type of aerators. Still it is hoped that this experimental study would be of immense help for carrying out further research work in future.

Thesis Title: LIME ENCRUSTATION PROBLEM AND ITS REMEDY MEASURES IN RURAL WATER SUPPLY FOR SPRING SOURCES

Submitted by: Hari Prasad Pandey

Supervisor: Mr. Ram Kumar Sharma, Dr. C. B. Pariyar

ABSTRACT:

In rural water supply, lime encrustation is a serious problem leading to blockage of pipe with lime. People usually used to lay the pipe just out side the ground for their convenience. Due to cutting, hammering and exposure to the sun the working life of the pipe is decreased. Newly laid pipe will hardly run eight to ten years much below the estimated average age of the HDPE pipe ranging between thirty to forty years. Depreciation cost of pipes has been exorbitantly high. Due to this problem in water supply scheme there is hundreds of scheme being block each year.

In rural water supply schemes, due to the scattered settlement and small sources, advanced treatment process is not economical and feasible. From available water quality analysis report, sources available are within WHO recommended values. But due to lime deposit inside the pipes, schemes are not sustainable. The

rate of settlement of lime inside the pipe mainly depends on the water quality parameters.

Dissolved carbon dioxide used to be high in natural water, which prevents the formation of metallic carbonates at the sources. External environment and human activities disturb chemical equilibrium of carbon dioxide: as a result there is formation of metallic carbonates and lime settlement in the system.

The main aim of this research is to solve the lime encrustation problems by determining the equilibrium carbon dioxide values and preserve it in the system. For preservation of carbon dioxide values existing structural model should be modified considering the carbon dioxide kinetics. The efficiency of the modified models is greater than 98%. The cost of existing and modified system is same if we applied modification at beginning of project.

Final evaluation was done after seven month of its completion by cutting the pipes at different places. There was not any precipitation. This proves its success theoretically as well as practically.

This method of solution of the problem is environmentally friendly, economically viable and sustainable for rural

community. By the application of this research millions rupees can be saved in the nation.

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**Thesis Title: REUSE AND RECYCLING OF
NUTRIENTS (NPK) IN SOURCE
SEPARATED URINE WITH VEGETABLE
PLANTS**

Submitted by: Kedar Man Prajapati

Supervisor: Mr. Ram Kumar Sharma

ABSTRACT:

Human urine contributes 80% of nitrogen and 60% of phosphorous to the municipal wastewater. This thesis attempts to study the feasibility of reuse and recycling of nutrients NPK in source separation of urine with vegetable plants. For poor communities of rural areas, this reduces the dependence of chemical fertilizers. Hydroponic Culture system was adopted for the study so that nutrients present in the soil media do not hinder the transfer and uptake of nutrients NPK by the plants. The study do not cover the study on the heavy metal content in the wastewater as many literatures show source separated urine contains negligible amount of heavy metals in them. The study is conducted on the batch basis. Total of 5 cycles of experiments has been conducted. The various species of vegetable plant chosen were garden cress, spinach, tintel, mustard, two varieties of Rape (rayo), green pea, black gram and broad bean. The

wastewater was used with different dilution. In later cycles of experiment it was observed that broad bean and black grain were able to remove the NPK in the wastewater. This system of treatment was found feasible for removal of NPK in source separated urine. The application of this reuse and recycling technology can simple, environment friendly and sustainable treatment method for human wastewater which can also reduce the dependence on chemical fertilizers particularly in the rural areas.

**Thesis Title: IRON REMOVAL FROM HAND PUMP
GROUND WATER UNDER LIMITED
HEAD CONDITION**

Submitted by: Ram Chandra Devkota

**Supervisor: Dr. Chet Bahadur Pariyar, Mr. Mahesh
Prasad Bhattarai**

ABSTRACT:

This thesis is focused on performance evaluation of a conceptually developed Aeration Filtration Model for iron removal from hand pump groundwater under limited head conditions (i.e. maximum height of hand pump spout above ground was up to 1.00 m and maximum allowable head loss in the filter unit was 0.20 m). The experimental model was designed in such a way that it could be copied in full scale at household and community levels of Terai region and outskirts of the Kathmandu Valley. The Model had been tested on three different total iron concentrations of sample waters, 5.48 mg/l, 7.00 mg/l and 9.00 mg/l. The performance evaluation of the Model was done on the basis of two physicochemical water quality parameters (total iron concentration and turbidity) and hydraulic parameters (head loss, flow rate, detention time and filtration velocity). Due to limited vertical height the units of the

Model: Aeration cum Sedimentation Column, Contact Filter Column and Sand Filter Column were connected horizontally in series. Baffle Type Tray Aerator different from other water fall aerators, widely used in water supply systems was adopted in the design. Up flow contact filter and sand filter were also adopted in the design. Locally available filter media, after analyzing in the laboratory were used to evaluate the performance and cleaning interval of the Model.

The performance of the Model regarding iron removal efficiency, turbidity removal and cleaning interval was found to be satisfactory. For filtration rate $1412 \text{ l/m}^2\text{.h}$ and influent iron concentration 5.48 mg/l treated water iron concentration varied from 0.60 mg/l to 0.10 mg/l , which results iron removal efficiency 89 to 98 percent respectively. At filtration rate $1412 \text{ l/m}^2\text{.h}$ for sand sized 0.48 mm with uniformity coefficient 1.50 and filter bed depth 0.40 m , head loss developed after 80 hours filter run was found to be 0.20 m . Turbidity of treated water ranged from 6.5 to 1.00 NTU . Based on design parameters of the model a full-scale iron removal plant under limited head condition is introduced before users.

Thesis Title: USE OF WEED PLANT (LANTANA CAMARA) MATERIAL AS A BULKING AGENT IN MUNICIPAL ORGANIC WASTER COMPOSTING

Submitted by: Bharat Bahadur K. C.

Supervisor: Dr. Shashi Shankar Rajbanshi, Mr. Manoj Kumar Pandey

ABSTRACT:

A comparative study on the composting process of municipal waste (organic fraction) with Straw and *Lantana camara* (a common toxic weed) as bulking agents was carried out in dry brick cells (0.7*0.7*0.7 m.). The decomposition process was followed by measuring temperature, C/N ratio, BOD₅ of water extract, germination index etc. With complete manual turning and moisture adjustment (60%) at even, approximately two weeks all studied parameters exhibited a stable condition after 60 days of composting. There was no significant difference between straw variant and Lantana variant. In terms of important nutrient contents like N, P and K, Lantana addition resulted in relatively better quality end product. This demonstrates that a problematic weed plant Lantana can be used as a valuable resource, leaving straw for other alternative uses.

**Thesis Title: MANAGEMENT OF HOSPITAL WASTE
IN B & B HOSPITAL**

Submitted by: Binod Kumar Agrawal

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

An effective hospital waste management is an integral part of a hospital's infection control program. Hospital waste when ineffectively managed may compromise with the quality of patient care. Additionally, this poses occupational health risks to those who are involved in its generation, handling and disposal. When properly implemented and enforced, effective waste management can have distinct economic benefits. Hospital waste in present context is mixed with municipal solid waste and municipal sewer drain.

B & B Hospital, a private enterprise, established in December, 1997 is taken as a reference hospital to study the existing waste management practices in Kathmandu. The study, however, concentrates only on the solid form of wastes whereas liquid wastes and gaseous waste are not taken into consideration. A study of the process activities of every facility units of the hospital and existing waste management practices were

conducted. B & B hospital, having 100 registered beds with its occupancy rate of 78.39% per month generates 193.32 kg of waste (826.85 Lit.) per day with 82.27% domestic, 14.14% infectious and 3.60% other wastes by weight.

Waste handling system is manual and its collection is carried out thrice daily. Effective segregation of waste was not carried out as a routine procedure. Also, the identification of waste receptacles through color-coding mechanisms and their management for the collection of waste is yet to be improved scientifically. Besides, study revealed that the preventive measures against occupational health and safety were lacking.

B & B Hospital is one of the few hospitals in Nepal, which is facilitated with the locally manufactured pyrolytic incinerator with 85% efficiency in terms of volume reduction. However, incinerator is not equipped with air pollutants emission control devices. Study revealed that the effective segregation of waste alone can reduce the waste load to the incinerator by 19.81 kg and ultimately enhances the opportunities of their recycling and reusing. Better management of waste through effective trainings and different waste minimization options such as source reduction, segregation, recycling and reusing etc. assures B & B Hospital an annual saving of NRs. 290,392.25.

**Thesis Title: TOTAL CHLORINE ABSORPTION BY
LOCALLY AVAILABLE WOOD
CHARCOAL**

Submitted by: Iswar Man Amatya

Supervisor: Er. Mahesh Prasad Bhattarai

ABSTRACT:

The present study attempts at resolving towards treatment of drinking water. Out of the treatment options for total chlorine removal, physiochemical processes seem to offer the most optimal solution. The chlorinated water was used in the study. The removal of total chlorine by adsorption was attempted. Locally available adsorbent, like sallo wood charcoal was used to adsorb total chlorine, which was the product obtained by burning waste root of sallo tree for general purposes. Adopted adsorbent particle sizes were 0.150 to 4.75mm in granular and <0.075mm in powdered charcoal. It was compared with manufactured commercially activated charcoal.

The adsorbent was subjected to adsorption kinetics and contact time analysis in an agitated non-flow system. The rates of adsorption of total chlorine for different sized adsorbent were compared. Concentration of total chlorine was used 10mg/l for

powdered adsorbents and 1 mg/l for granular adsorbents. The contact time appears from 1 hr to 9hr as the adsorbent particle size increases.

The adsorption rate constants granular adsorbents, particle size from 0.150 to 4.75mm GC ranges from 2.124 to 0.253 at the concentration of 1.0 mg/l . At the same manner, the adsorption rates constant found 1.324, 1.068 and 1.147 in powdered adsorbents at specified 10 mg/l total chlorine concentration. Decrease in adsorption rate constant is significant in increasing particle size from <0.075 to 1.0 mm GC and slowly attains to non significant in increasing particle size. The rate of adsorption at initial is higher in the activated charcoal than non-activated. But rate is declined rapidly afterwards at the equilibrium stage in comparison with other.

The adsorption data appears to fit the Freundlich's isotherm. The intercept (roughly adsorption capacity) ranges from 0.0013 to 0.0002 mg/l from 0.150 to 4.75-mm size GC. The intensity of adsorption ranges from 0.9437 to 0.2771 for that GC sizes.

Fixed bed adsorption operation indicated that the service time of the bed is a function of depth of the bed and that service time can be predicted using "Bed -Depth -Service -Time" (BDST) model.

Column exhaustion rate with smaller, bed depth is much higher than with longer bed depth. Increase in charcoal for 8-12 gm in the column increases the percentage removal of total chlorine appreciably. The critical bed depth comes 7.43 to 7.54 cm as per flow variation 40-60 ml/min in GAC^C and 4.97-5.49 cm as per flow variation 30-50 ml/min in GC.

An economic analysis for the proposed fixed volume 1m³/day water treatment, the service time comes 64.47 hr for GC and 3.6 hr for GAC^C at proposed parameters. GC is 3.8 times cost effective than GAC^C at proposed column dimension (12-cm dia. and 30 cm-bed depth). The conducted study indicates that the locally available sallo wood charcoal is superior to commercial activated charcoal.

**Thesis Title: PERFORMANCE EVALUATION OF
HORIZONTAL FLOW COARSE MEDIA
FILTER**

Submitted by: Nanda Bahadur Khanal

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Horizontal Flow Coarse Media Filter (HFCMF) is a modification of horizontal flow roughing filter. It works as a composite unit for the replacement of sedimentation and filtration units. A detail study of HFCMF was conducted at laboratory scale model, consisting of a rectangular channel divided into four compartments. First and second compartments were filled with crushed stone of graded size 20mm-12.5mm and 12.5mm-4.75mm respectively and third and fourth compartments were filled with coarse and medium sand 4.75mm-2mm and 2mm-0.85mm respectively. Total length, width and height of the HFCMF were 4.4m, 0.2m and 0.45m respectively. Filter media was placed from coarse to fine in the direction of flow. The filter model was operated at filtration rates of 0.2 m/h to 2.0 m/h in Phase-I and 0.75 and 0.70m/hr in Phase-II. Turbidity of natural streams was analyzed and maximum turbidity level found was

200 NTU after 2-5 minutes settling. Raw water was prepared in the laboratory by using local pottery clay and kaolin clay.

The effect of various physical parameters on turbidity removal efficiency was studied. The study revealed that the turbidity removal efficiency of HFCMF depends on filtration velocity, run time, media size, filter length, particle size distribution of suspended solid, influent turbidity and solid loading rate. Particles responsible for the creation of maximum turbidity fall within the size range of 1-10 μm . The change in effluent turbidity is noticed, when influent turbidity was changed by more than 30 units and test was conducted up to 370 NTU. Time of termination was decided by the maximum allowable head loss. Filter run for the allowable head loss of 20 cm is about 1500 hrs. Required length of the filter media should be determined on the basis of solid removal efficiency. Using large number of media fraction with smaller length gives the optimum solid removal efficiency. Filtration coefficient for the laboratory model was calculated on the basis of measured turbidity and mathematical equation developed for horizontal flow roughing filter. Calculated values of filtration coefficient are compared with the value of filtration coefficient from best fit exponential equation derived from experimental data and values are found matched with 95% confidence level. Comparison shows that mathematical

models developed for Horizontal Flow Roughing Filter are equally valid for HFCMF. Bacterial removal efficiency of HFCMF is comparable to other sand bed filters. HFCMF is economically viable and users friendly for rural water supply treatment system.

Thesis Title: MODELING OF DECLINING RATE FILTER**Submitted by: Sudarshan Bhandari****Supervisor: Mr. Mahesh Bhattarai, Mr. Nawal Kishor Mishra****ABSTRACT:**

The objective of the research was to develop the mathematical model to predict the hydraulic behavior of declining rate filter (DRF). Orifice meters were used to measure the flow of the plant and to create turbulent head losses to control the flow through the filters. Experimental calibration curves were developed for each filter to calculate the filtration rate. Mathematical models were developed to predict the laminar head losses in clean bed and deposit and turbulent head losses in each filter. Backwashing of the filters was done by using effluent water from the outlet weir. The low head was sufficient to fluidize the filter media with bed-expansion of 33% during backwashing. On the basis of obtained data, a small program in excel sheet was prepared for calculation.

The main difficulties in the practical application of declining rate filtration are the complexity of the hydraulic calculation used to predict the flows and levels in each filter unit. It is expected that

the analysis presented in this study will lead to better understanding of the concept of DRF. Hopefully, this study should result in the wider use of the declining rate with inter filter backwash system in water treatment system in urban, semi-urban and rural areas of Nepal where, there is no electricity.

**Thesis Title: MANAGEMENT OF HOSPITAL WASTE IN
 B & B HOSPITAL**

Submitted by: Kabir Das Rajbhandari

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

An effective hospital waste management is an integral part of a hospital's infection control program. Hospital waste when ineffectively managed may compromise with the quality of patient care. Additionally, this poses occupational health risks to those who are involved in its generation, handling and disposal. When properly implemented and enforced, effective waste management can have distinct economic benefits. Hospital waste in present context is mixed with municipal solid waste and municipal sewer drain.

B & B Hospital, a private enterprise, established in December, 1997 is taken as a reference hospital to study the existing waste management practices in Kathmandu. The study, however, concentrates only on the solid form of wastes whereas liquid wastes and gaseous waste are not taken into consideration. A study of the process activities of every facility units of the hospital and existing waste management practices were

conducted. B & B hospital, having 100 registered beds with its occupancy rate of 78.39% per month generates 193.32 kg of waste (826.85 Lit.) per day with 82.27% domestic, 14.14% infectious and 3.60% other wastes by weight.

Waste handling system is manual and its collection is carried out thrice daily. Effective segregation of waste was not carried out as a routine procedure. Also, the identification of waste receptacles through color-coding mechanisms and their management for the collection of waste is yet to be improved scientifically. Besides, study revealed that the preventive measures against occupational health and safety were lacking.

B & B Hospital is one of the few hospitals in Nepal, which is facilitated with the locally manufactured pyrolytic incinerator with 85% efficiency in terms of volume reduction. However, incinerator is not equipped with air pollutants emission control devices. Study revealed that the effective segregation of waste alone can reduce the waste load to the incinerator by 19.81 kg and ultimately enhances the opportunities of their recycling and reusing. Better management of waste through effective trainings and different waste minimization options such as source reduction, segregation, recycling and reusing etc. assures B & B Hospital an annual saving of NRs. 290392.25.

**Thesis Title: ARSENIC CONTAMINATION IN GROUND
 WATER IN RAUTAHAT DISTRICT OF
 NEPAL AN ASSESSMENT AND
 TREATMENT**

Submitted by: Nirmal Tandukar

**Supervisor: Mr. Ram Kumar Sharma, Mr. Sharad
 Adhikari**

ABSTRACT:

The study has been conducted to explore the severity of arsenic contamination of groundwater in Rautahat district of Central Terai in Nepal. The overall survey to determine preliminary arsenic concentration in groundwater was carried out by using E-Merck and Akhtar-NIPSOM field kits. The field kit results were crosschecked in the laboratory by Silver Diethyl Dithio Carbamate method. The results show that some samples exceeded WHO drinking water quality standard and few of them exceeded India and Bangladesh standards. High arsenic is found to be associated with high iron content. However, not all the groundwater samples with high iron contain arsenic. Arsenic contamination is found to be higher in shallow aquifer than deep aquifer and most of the contaminated tubewells are located in active flood plain of River Bagmati. It is found that the concentration of arsenic in groundwater of the study area does

not remain constant throughout the year. In fact, concentration of arsenic in the tubewells installed in active flood plain of River Bagmati was found to have decreased during post monsoon period compared to pre monsoon period. It was observed that villagers were using arsenic contaminated water without taking any precautions and without having any knowledge about the severity and ultimate effects of arsenic. Hence people, especially women of the affected area, should be made aware of Arsenicosis, its prevention and precautions to be adopted. The potential arsenic contamination areas have also been identified within the study area. Arsenic removal techniques were also reviewed and best available method is suggested for use by the rural people.

**Thesis Title: PERFORMANCE EVALUATION OF
CONSTRUCTED WETLAND FOR
GREYWATER TREATMENT**

Submitted by: Dambar B. Subedi

**Supervisor: Dr. R. R. Shrestha, Mr. Manoj Kumar
Pandey**

ABSTRACT:

Constructed wetland (CW) with vertical flow bed usually provides high removal of BOD and nitrification. Performance evaluation of vertical flow constructed wetland was carried out for greywater treatment using two emergent plants (Reed and Canna species) at different Hydraulic Loading Rate (HLR). Greywater was fed intermittently in vertical direction and parameters that have been selected for analysis were pH, TSS, BOD, $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, P-PO_4 and F.coliform. Treatment efficiencies were evaluated under HLR of 0.0833, 0.0625 and 0.0416cu.m/sq.m.d. Result shows that treatment performance of Reed is better than Canna sp. bed for all pollutants under stated HLRs. Comparing two treatment beds the differences in efficiencies are not significant except on BODs and nitrification. Among selected HLR, the HLR of 0.0416cu.m/sq.m.d was observed most efficient in removing pollutants than others two

HLR. The average value of treatment efficiency on TSS, BOD₅ and NH₄-N were 96.58%, 96.165 and 97.91% for reed bed and 95.78%, 85.42% and 95.2% for Canna bed under HLR of 0.0416cu.m/sq.m.d.

Result shows that greywater in KTM valley has been polluted with high concentration of suspended solids and organic matter. So, pre-treatment before applying to vegetative bed is recommended. Based on avg. household size of 5.5 PE in Katmandu valley, quantity of greywater per HH is estimated 250lit/d. With due consideration of BOD removal, the size of treatment bed have been calculated 0.96sq.m/pE and 1.28sq.m/pE for Reed and Canna respectively (if effluent BOD standard is 10mg/l). Locally available coarse sand and gravel can be used for plant supporting media. The size of pipe ranges from 12.5mm to 75mm and size of tank ranges from 100lits to 500 lits capacities for the treatment system.

The tentative cost of treatment bed (Reed) for an avg. discharge of 250lit/d has been estimated Rs34200. Operation cost for this system may not be significant, it requires cost for pump operation. Whereas the quantity of greywater (treated) is estimated 202.4 lit / d.HH. Domestic proposes where greywater (treated) can recycle be considered toilet flushing, irrigation of

vegetables/flowers/lawn, cleaning of house and vehicles etc. The feasible numbers of household in relation to treatment system location are estimated approx. 89985 (population 494918). Quantity of supplied water that can be saved is estimated approx. 18.22 Million liter per day (MLD) (17.52% of present supply, if recycled total quantity of treated water) equivalent to cost Rs 437280 per day (157.5 million rupees/year). Similarly the quantity of water that can be saved is estimated approx. 10.72 MLD (10.31% of present supply, if recycled as per present situation) equivalent to cost Rs 257280 per day (92.65 million Rupees). Whereas cost of treatment system (Reed bed) for all feasible household is estimated 3077.4 million rupees. In terms of quantity of saved water and others numerous indirect benefits of greywater recycling, this treatment system (Reed bed) can be considered feasible in Kathmandu valley.

Graduation Year 2001

**Thesis Title: POTENTIALITY OF LOCAL
 EARTHWORM SPECIEC IN
 VERMICOMPOSTING PROCESS**

Submitted by: Dashain Mandal

**Supervisor: Mr. Manoj Kumar Pandey, Dr Shashi
 Shankar Rajbanshi**

ABSTRACT:

As an alternative waste treatment process, vermicomposting was carried out in special worm bins made of perforated plastic vessels with the earthworms found in local fields. The earthworms were identified to be *Amyntas hawayanus* from Kathmandu and *Lampito mauri* and *Metaphire posthuma* from Janakpur.

The waste consisted of paper, straw, poultry droppings, vegetable and mixed fruit waste with C/N ratio of 29.75. The moisture content was adjusted to 60% on wet-weight basis. In each worm bin, bedding of layer consisting of 2 mm sieved soil with 40% moisture was provided.

The vermicomposting was tried in both fresh and preprocessed (1 month long aerobic decomposition) waste. The vermicomposting process was followed by determining the change in temperature, total carbon (C), total nitrogen (N), BOD₅, seed germination index, pH and earthworm biomass as well as number.

At the end of 90 days of composting in both fresh and preprocessed waste temperature, BOD₅, pH, C/N ratio appeared to have stabilized. There was no significant difference between the products in *A. hawayanus* and *L. mauritii* + *M. posthumu*. Despite the stability of above parameters, seed germination index and earthworm biomass and numbers turned very poor. To practical sense, it indicates that the decomposition was not complete as exhibited by only 60-65% germination. This is perhaps because of incapability of the used earthworm species in vermicomposting process and is clearly reflected by very high mortality rates of the earthworms in the experiment.

**Thesis Title: APPLICATION OF CLEANER
PRODUCTION APPROACH IN A
PHARMACEUTICAL INDUSTRY**

Submitted by: Radha Krishna Chaudhary

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Nepal's current industrial production involves high consumption of raw materials, energy and water during production; use of outdated technologies and facilities; and poor management. At present, most of the industries are discharging their effluent or emission in water body and air having pollution ad more than the standards set by regulating agencies. In this context, it has become an urgent task to integrate cleaner production (CP) with industrial development. CP addresses industrial pollution problems by modifying industrial operations to reduce the generation of wastes. It requires a shift in thinking away from end-of-pipe treatment of industrial pollutants. Technologies for CP go beyond pollution abatement and waste disposal; they embrace within- factory changes in management, shop-floor operations, production process operations, equipment and products.

In this research work Royal Drugs Limited has been chosen as a model industry for the application of CP. A CP team was formed and the information about the industry along with manufacturing process, flow of medicines (Tablet, Liquid and Intra venous fluid sections) were prepared. Material balance of input and output streams of different sections was calculated. The various sources of waste generation and their causes such as product loss, water loss and steam loss were identified.

The identified sources of waste- stream were analyzed for assessment of pollution load in terms of BOD, TSS and pH. A cause analysis was carried out identify the reasons for waste generation from each section. On the basis of waste stream and cause analysis. CP options were generated. Altogether thirty-seven options were identified and classified using CP technique.

The most suitable and potential options were subjected to detail analysis covering Technical feasibility, Economic viability and Environmental benefit signing overall feasibility as high, medium or low for each feasibility. After completing the feasibility analysis, the C.P measures have been prioritized by ranking method for implementation.

After implementation of proposed CP options, it has been found that the expected beneficial environmental impact will be significant on water media in terms of reduction of 45.37% BOD, 19.31% TSS and 37.92% waste water volume. Before the implementation of CP options the annual cost of water is Rs. 6,48,093, annual product loss of all the three sections amounts to Rs. 73,29,828.13, annual cost of fuel is Rs. 6,73,750 and annual investment for purchase of IVF bottles is Rs. 29,18,256. Against this cost, after implementation of CP options annual saving on water is Rs. 4,48,680, on fuel Rs. 2,02,125, on Product loss Rs. 36,64,914.07 and on IVF bottles Rs. 11,38,336. Total estimated saving after implementation of CP options will be Rs. 54,54,055.07 per year against investment of Rs. 59,65,140 in CP measures with 1.10 year pay back period.

**Thesis Title: A STUDY OF CADMIUM ADSORPTION
ON ACTIVATED CHARCOAL**

Submitted by: Mahesh Bhattarai

**Supervisor: Mr. Mahesh Prasad Bhattarai, Poorna
Prasad Manandhar**

ABSTRACT:

Separation of cadmium from synthetic sample prepared from Cd (NO₃)₂.4H₂O dissolving in distilled water through surface accumulation on activated charcoal is the major objective of this work. The charcoal of size (1.18 - 1.00 mm) thermally activated at a temperature of 900 ± 25°C for 15 minutes was derived from pinewood (sallo). The activated charcoal reduced Cd more than 50% in case of influent concentration of 4 mg/l, but adsorption was more in much concentrated sample. The distribution ratio of cadmium between solid sorbent and aqueous solution had been found as function of equilibrium aqueous concentration. The cadmium removal rate was:

$$C_t = C_0 e^{-0.02057}$$

Equilibrium had reached in 20 hours and the adsorption rate followed the first order kinetic equation. The Freundlich isotherm was in better agreement than the Langmuir and the relationship was:

$$X/M = 0.00967C_e^{0.671}$$

The breakthrough volume of cadmium solution was measured by dynamic column experiments so as to determine 80% saturation capacity of sorbents. The adsorption of carbon for different flow rates at different carbon bed depth resulted the following relationships:

$$t = 9.5353x - 0.7355 \quad (1 \text{ gal/ft}^2 \cdot \text{min})$$

$$t = 6.9998x - 1.3232 \quad (1.25 \text{ gal/ft}^2 \cdot \text{min})$$

$$t = 5.0412x - 1.1387 \quad (1.5 \text{ gal/ft}^2 \cdot \text{min})$$

The diameter of the column was 2.66 cm and influent Cd concentration was 3.77 mg/l. These observations are believed to constitute a database for the treatment of industrial effluent through surface on activated charcoal.

**Thesis Title: TUBE SETTLER MODELING AND IT'S
USE IN WATER TREATMENT PROCESS**

Submitted by: Nam Raj Khatri

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Latest models commonly used for design of circular tube settler, developed by YAO (1973), consider surface overflow rate based on full depth (diameter) only and focus on coagulation sedimentation. This study has been carried out for tube settler modeling with focus on plain sedimentation.

A new tube settler model useful for design of circular tube has been developed based on assumption of variations in velocity profile and depth inside tube and expressed as

$$Te = aV_s^b (3/(3b + 4) + 0.25)$$

Model requires simple settlement test of sample in a 500ml beaker considering 5 cm depth for deriving relation between remaining turbidity and settling velocity. Here a and b are constant obtained from beaker test ($Te = aV_s^b$) Te is effluent turbidity, V_s settling velocity for tube settler given by

$$V_s = 4/3V_o/(\sin\theta + L\cos\theta) \quad \text{YAO (1973)}$$

To evaluate the validity of the model for predicting the effluent turbidity an experimental study was conducted in the laboratory. Main variables in the experiments were tube size, lengths, turbidity and flow rates. A Correction Factor (CF) defining ratio of experimental value and model value was analyzed for evaluation. Statistical analysis of experimental data indicated that model prediction is valid with slight deviation in the data. Deviations in CF values were presented in terms of various parameters such as T_0 , D , L , Re , Fr , V_0 , and V_s , and noticed that only pipe size and relative length predicted some correlation. To incorporate experimental error and deviation due to other parameters, CF equal to 1.1 has been recommended for practical use. There is scope for further study for predicting exact effect of size of pipes and relative length on CF.

A comparative analysis showed that tube settler is better than conventional tank in terms of cost and surface area for all capacity and surface overflow rates.

**Thesis Title: COMPARATIVE ANALYSIS OF PUBLIC
AND PRIVATE SECTOR INVOLVEMENT
IN SOLID WASTE MANAGEMENT**

Submitted by: Lakshmi Nath Nepal

**Supervisor: Mr. Manoj Kumar Pandey, Mr. Mukunda
Neupane**

ABSTRACT:

This study was carried out to determine, suitable option for solid waste management (SWM) in Kathmandu. The current available waste management approaches of public sector and private sector were selected for comparison. The methods procedures, and approaches of four agencies and their management practices were assessed. The work procedures of management practice of these organisation's and beneficiary view were listed in forty-two activities and activities were grouped in successive pair. Score of activities are statically calculated to identify, level of service and beneficiary's view.

Using Analytic Hierarchy Process (AHP) and Rank Pair Wise Comparison Technique (RPTC) the whole procedure of the activities of various organizations were compared. For the comparison four communities in Kathmandu and one community in Lalitpur were selected. The area is chosen in such a way that

public and private sector separately managing primary level of solid waste .Two set of questionnaires were developed one for household survey and other for organization survey.

This thesis reviewed the existing legislative framework and its drawbacks concerning the conventional solid waste management. For better management, people's support, privatisation, as well as the support and coordination from the central government is required otherwise it is not possible by the municipality alone.

The study recommends certain activities according to the degree of community involvement and types of organisation involvement. This can be achieved through, involvement of NGO's and community to make them more practical and promotion of private sector. Environmental sound management practice can solve municipal solid waste problem.

Thesis Title: A COMPARATIVE STUDY OF ENVIRONMENTAL IMPACTS OF LEAD-ACID BATTERY RUN (SAFA) AND LPG TEMPOS: A LIFECYCLE ANALYSIS

Submitted by: Him Prasad Gautam

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Among the popular means of public transport existing in Kathmandu, the three wheeler tempo is a widely used small-sized vehicle suitable to the city. At present there are about 600 stored electric energy (Lead-Acid Accumulator) run Safa tempos and about 700 LPG run tempos in the valley.

A comparative study of environmental impact of these different modes of energy user systems by Life Cycle Analysis Approach is conducted on a single tempo unit basis. The methodological procedures followed of this research are the Inventory Assessment (planning, screening, and data base activities) and Impact Assessment (classification, chracterization of normalization, and. evaluation) steps.

The impact of material and energy input and output in the form of emissions and waste disposal in operation, transportation and maintenance of the system were investigated. The issues of environmental problems analyzed are human Toxicity, Respiratory Effects, Eco-toxicity, Terrestrial Toxicity, Soil Acidification, Global Warming, and Acidification.

In analysis it was observed that Safa tempo is more polluter for human toxicity, Eco toxicity , terrestrial toxicity and soil acidification. In all the categories Lead is found predominant contributor followed by the acid . In case of LPG it is found harmful from the angle of respiratory and carcinogenic diseases, global warming, acidification and resource use. Classifying the categories into Health aspect, Eco system Quality and resource use and owing their resource accordingly it was observed that Safa tempo is ahead in the first two sectors whereas LPG is seen as excess resource user.

On normalizing these three groups and overall scoring showed that Safa tempo is polluter double than LPG. In case of LPG the pollution is governed by many pollutants but the lead and acid are sole role player in Safa tempo. It should be kept in mind that the numerical figure is based within the boundary of limitation of

study and may vary in other conditions but it is well enough to conclude that which system lags where.

**Thesis Title: EMISSION INVENTORY FOR
KATHMANDU VALLEY FROM
TRANSPORT SECTOR**

Submitted by: Gopal Krishna Prajapati

Supervisor: Dr. Bal Krishna Sapkota

ABSTRACT:

Vehicular pollution in Kathmandu valley has become the pressing issue these days. There are 305095 vehicles in operation in Nepal in year 2000/01. 57.61 percent of that vehicle population is operating in Bagmati Zone and 84.82 percent of the operating vehicles (Bagmati Zone) are operating in Kathmandu Valley. The Valley has motor density of 118 vehicles per kilometer road and fifty vehicles share by thousands people of valley.

The Motorbike has highest share (69 %) in valley vehicle composition. Car/Jeep/Van are the second in position with 23 % share in the valley vehicle composition.

The valley has pollution emission of 25109.9 tonnes in total from transport sector alone in the year 2000/01.

Motorcycle is the most polluting vehicle for the Valley. It has highest share in TSP, CO, and HC pollutants having percentage share of 28.0 %, 52.0 % and 60.0 % respectively. The second in the rank of most polluting vehicle is Heavy Truck with pollution share of 16.0 %.

Pollution by transport sector will be curtailed by 66.7 % on implementing the EURO -1 vehicle emission standard to all valley vehicles. Fuel switching from gasoline to LPG for light vehicle will have 21.74 % benefits in pollution curtailment. This option is feasible in terms of technology and economy. It has good scope and perspective in curbing vehicular pollution in long-term basis in Valley.

Upon resuming the Trolley bus service in the existing route and extending to Ring Road will have further emission curtailment by 0.88 %. By augmenting the present average valley vehicle speed (18-22 KPH) to 45 KPH, pollution reduction upto 43 % be achieved.

Thesis Title: ANALYSIS OF POT CHLORINATION

Submitted by: Parikshit Kumar Shrestha

Supervisor: Mr. Mahesh Bhattarai, Mr. Ram Kumar Sharma

ABSTRACT:

The Pot Chlorination, a safe and economical method to disinfect well water is analyzed. The quantity of bleaching powder used governs the days of effectiveness in inactivation of bacteria and other microorganisms.

The experimental pot chlorinator was made with plastic jar and charged with bleaching powder and sand at the ratio of 1:2 by weight and sodium hexametaphosphate @ 5 % of bleaching powder. The pot was suspended in the natural well more or less at the same level of hand pump screen. 2- holes of 10 mm diameter were placed at 40 mm above the base of the pot. Free and combined residual chlorine was monitored at 12 hours interval. The result from the natural well shows that the residual chlorine varied even in the morning and evening. It did not even follow a definite path. Combined residual chlorine was not even up to the level that inactivates bacteria but free residual chlorine was beyond the desired limits in the first few days. The decrease of free chlorine residual was also not uniform with time.

Furthermore, the data suggests that diffusion through out the well is not uniform; it depends on the degree of mixing. At the water surface, molecular diffusion was dominant as the concentration was low there whereas the concentration was high at the hand pump signifying the diffusion due to advection at the screen area. This was due to the turbulence created by the suction of the hand pump so the mixing was better there. Thus there is effective disinfection in the vicinity of the pot but decreases towards the surface.

The lesser amount of bleaching powder (125 g) provided better range of free residual chlorine than generalized amount of 500 g. The double pot system did not provide minimum chlorine residuals for inactivation of bacteria indicating low diffusion rate. Thus the 2- hole, single pot chlorinator was better chlorinator.

The drip chlorination was also not found practical for rural environment because of frequent clogging and regular supervision required. The mass balance of chlorine suggests that high loss due to unseen and unpredictable factors. Chlorine consumption pattern and quantity is almost constant irrespective of dose. The chlorine remaining linearly decreases with time at the withdrawal area near the screen.

**Thesis Title: TREATABILITY STUDY OF DAIRY
EFFLUENT THROUGH UPFLOW
ANEROBIC SLUDGE BLANKET SYSTEM**

Submitted by: Suman Kumar Kunwar

Supervisor: Mr. Mahesh Bhattarai

ABSTRACT:

Dairy effluent from the dairy industry located at Balaju, Kathmandu, was treated anaerobically in five lab- scale Upflow Anaerobic Sludge Blanket (UASB) reactors. The first two reactors were operated at 25° C room temperature and Hydraulic Retention Time (HRT) of 9 hours but the remaining three reactors were operated at 35° C and HRT of 8 hours. The average COD and TSS removal efficiencies that were best results in reactor-4 were found to 83% and 71% respectively.

Dairy effluent characteristics were highly dependent on the presence of organic matter. In spite of that a stable operation of working at a hydraulic retention time of 8 hours was maintained. Total alkalinity was maintained within the range of 1000 to 5000 mg/l by using sodium bicarbonate 0.40 g per liter diluted effluent.

In order to improve granulation conditions, upward velocity was always maintained below 0.5 m/h. The highest values caused the washout of non- granulated biomass from the reactor.

During the primary start-up period, the removal of organic matter was mainly due to interception in reactors. The second start up period was expressed by release of biogas. An intermediary period between these two start up periods was characterized by a slight drop of pH and increase of volatile fatty acid in the effluent. The more time to reach the second start up period seemed to be responsible for the large discrepancy between removed COD and recovered biogas (35ml/g COD removed). It is thus suggested that process optimization should focus on shortening the needed to reach the second start up period. The methane gas produced in ml per mg average COD removed ranged from 0.03 to 0.36. This value was increasing slightly with operational time.

**Thesis Title: ENVIRONMENTAL IMPACT OF
HOSPITAL WASTE: A CASE STUDY OF
BIR HOSPITAL**

Submitted by: Bidya Nath Bhattarai

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Hospital waste is a source of contamination and pollution. The waste carries a higher potential for infection and injury causing diseases and illness either through direct or indirectly through the contamination of soil, ground water, surface water, and air. Adequate and appropriate handlings of waste have distinct public health and environmental benefits.

Bir Hospital one of the major Government Hospital is a central referral hospital of Nepal was established on June 1890. The hospital provides quality and affordable health services to the entire population of the country. The hospital is becoming a complex modern institution having number of independent departments with modern medical facilities.

The amount of waste produced from the hospital is increasing each year. Expansion of hospital facilities to satisfy the health

needs of people is one of the reasons of increased waste volume and another reason is due to increased use of disposal items. At present Bir Hospital alone produces 416.68 Kg. of waste daily. The waste is disposed without proper treatment is causing threat to the environment and public health.

The outcome of the thesis is to develop a better waste management practice. So that waste from Bir hospital will have less environmental impact and healthy and safe environment will be available to their patients, employees and communities.

Thesis Title: A COMPOSITION STUDY OF ENVIRONMENTAL IMPACTS OF TAIL-PIPE EMISSIONS FROM PETROL AND DIESEL FUEL COMMERCIAL VEHICLES IN KATHMANDU VALLEY: A LIFE CYCLE ASSESSMENT

Submitted by: Suresh Harsha Bajracharya

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

With population, the need of commercial vehicles for public transportation is also growing rapidly in Kathmandu valley. Most of the commercial vehicles operating in Kathmandu valley have uncontrolled emission although some new models are less polluting. The main environmental burdens of vehicular tail-pipe emission are greenhouse effect, acidification. heavy metal, winter-smog and summer-smog.

For uncontrolled vehicles, acidification is the most serious effect for HD-diesel vehicles and petrol taxi. In case of tempos, summer smog is crucial, followed by heavy metals. For Euro-I vehicles, acidification is the most serious impact for diesel

vehicles and petrol taxis. In case of tempos, summer smog is the most serious impact.

Among uncontrolled vehicles, route tempos are the cleanest media on per passenger kilometer basis while taxis and hired tempos are approximately eight and five times more polluting than route tempo respectively. Similarly, among Euro-I vehicles, route tempos serve as the cleanest vehicle while diesel minibus and bus are approximately fourteen and eleven times more polluting respectively.

By switching emission standards from uncontrolled to Euro-I, environmental impacts of vehicles can be reduced by 57% to 93%. Similarly, increase in average vehicle speed from 30 to 60 km/hr can reduce the impact by 15% to 51%. Appropriate emission standard, appropriate vehicle use and efficient traffic management are the key points to reduce the environmental impacts of commercial vehicles.

**Thesis Title: PRIVATE SECTOR PARTICIPATION IN
WATER SUPPLY AND SANITATION
"OPTIONS AND RECOMMENDATIONS"
A CASE STUDY OF LARGE TERAI TOWN
BIRATNAGAR**

Submitted by: Dinesh Nath Chalise

Supervisor: Mr. Mukunda Neupane

ABSTRACT:

Standing at the threshold of twenty first century, the urban water supply and sanitation sector in developing countries faces a numbers of major challenges. Continuing population growth and rising standards of living mean safe water and adequate sanitation to be supplied to ever increasing numbers of households in ever increasing quantity. This task will not be easy to accomplish. The depletion and deteriorating quality of fresh water resources, already a problem, will increase in the near future.

The water and sanitation sector in many developing countries including in Nepal is characterized by unreliable and inadequate services, poor cost recovery, insufficient upkeep of infrastructure, a high percentage of unaccounted for water,

absence of a feedback mechanism for consumer interest into management-level decision making, lack of autonomy of the operator and extreme dependence on government subsidies. The result of this is inadequate services to the already disadvantaged population groups, and sub-optimal levels of service to those within the operational limits of these systems. The impact of this state of affairs in terms of health cost, loss of productivity and poor quality of life is immense. Further, many water supply and sanitation systems are in deplorable state due to inappropriate choice of technology, poor quality of construction, and years of under maintenance. Finally, water utilities are in a state of perpetual receivership and so cannot avail of the capital they need to rehabilitate and upgrade infrastructure and expand service provisions.

In a number of sectors, HMGN is moving towards Private Sector Participation to provide certain public services that were traditionally supplied entirely by HMGN, including water supply and sanitation. Water at present can no more be considered as social goods and has to be considered as economic goods.

The present study attempts to prepare the basis for the development of long-term sustainable, adequate and affordable water supply and sanitation system of one large Terai town at Biratnagar through Private Sector Participation.

The option of PSP for Kathmandu Valley has already been decided and the tendering is in the process. Therefore, Kathmandu Valley was excluded for the study. Biratnagar is the second largest town after Kathmandu therefore, Biratnagar has been chosen as the study area.

Private Sector Participation is a general term covering a range of options for involving the private sector in service provision which are given below:

Service Contract

Management Contract

Lease Contract

Concession

BOT/BOO

Divestiture

The method of research has been collection of primary and secondary information and analysis of available information.

The following activities were employed in the study:

Secondary data collection,

Critical review of the literature,

Primary data collection and field study,

Processing and analysis of information.

In order to arrive at a conclusion on the type of Private Sector Participation arrangement appropriate to local circumstances and responsive to local problems general water and sanitation issues including local technical, regulatory, political and financial conditions were analyzed.

It was concluded that the government is ready for the PSP and accordingly has already initiated action. However, the government faces big challenge to convince the public and the private sector that the government will be able to create an enabling environment for the private operators.

People do not oppose PSP as long as service level improves with the present tariff level or service level significantly improves with a small rise in the tariff.

There are two main conflicting factors on the choice of the contract. At one hand there are significant benefits to the Government and consumers in transferring commercial risk and responsibility to the private sector and at the other hand the a private operator is reluctant to take such risk now, due to inadequate information and uncertain political environment and insufficient commitment to privatization.

The most appropriate PSP option to suit in the present context of Biratnagar was concession or divestiture. The divestiture is highly advanced form of privatization therefore, was not considered. Further, there are unsatisfactory past of privatization of most of the industries in Nepal. The other attractive option was the concession. If the concession could be implemented this contract will transfer operating and investment risk and responsibility to the private operator and would maximize the benefit in the present context. Private investors, however, would have several reservations about the risks involved in a concession in a country like Nepal. Thus the risk is that if the Government invites bid for a concession reputed private companies might not respond. Further in case of Biratnagar a reputable private company may not be interested because of the small size of the city.

In this scenario there are two ways to respond to this problem:

- calling for bids for the ambitious concession contract and running the risk of not receiving any response,
- implementing a low-risk-transfer contract (management), but with a plan to move to something more ambitious (concession) in the future.

The second option had been recommended considering the followings:

- the uncertainty of the functioning of the regulatory body to be formed;
- absence of clear set up of responsibility for service among national, regional and local governments;
- other related rules and regulations in favor of Private Sector Participation yet to be formulated;
- political instability;
- low level of trust on government institutions of people and international community;
- reluctant consumer/customer to pay more without showing the improvement in service delivery

The recommended option was checked against the cases in international context and a preliminary financial viability analysis was carried out. For the concession contract to be successful the Internal Rate of Return (IRR) should be at least greater than Marginal Average Rate of Return (MARR). The financial viability analysis showed IRR was 8.8 % through financial analysis. This range of IRR is in par with the existing other water supply system in developing countries. This percentage of return is not attractive for the private sector to invest. To overcome this problem there is a need to increase the tariff. However, the people of Biratnagar are not ready to pay more than what they are paying at present. During the field visit to the study area there was pure indication that the people will be

ready to pay more only after the increment in the service level has been clearly demonstrated. Therefore, one option is to stick to the second option with the plan to increase tariff during the management contract phase.

Under this option the government can use the first contract to generate better information and improve its own creditability, and subsequently facilitate increased private participation afterwards.

Upto now, the international and bilateral lending agencies have provided generous funds for water supply and sanitation under "soft "terms and grants. They have expressed their willingness to continue to support the sector, provided certain conditions are met. We can assume that these funds would be available from these sources or others on terms that are more attractive than could be offered by the private sector. If the private sectors are not being asked to provide substantial funding for rehabilitation and expansion then the concession option will not be adequate.

Finally taking into consideration the results of financial viability analysis the Management Contract followed with Lease Contract has been recommended. This has been recommended because the following objective and interest of each stake holders are balanced:

- Consumers -will have improved water supply, especially once additional water sources are used. They should not

pay more per cubic meter but will have a system with better reliability they will save on in-house facilities such as storage tanks, suction pumps and roof tanks.

- HMG/N will have a system that is operated effectively and efficiently, which will be paid for by consumers without increment in present tariffs. No operational subsidy will be required.
- Municipalities will have an opportunity to represent consumer's interests of those living in their areas through water user groups.
- NWSC staff will benefit from the opportunity to work outside the public sector with better job prospects and higher salary levels that reflect the contribution made by staff members.
- Donors will be reassured that the operation of the system is making best use of the water available, with proper cost recovery from consumers.
- The private sector will earn a profit and enhanced reputation.

Other most relevant conditions for the recommendation is to utilize "soft" term loans and grants provided by different lending agencies such as the WB, ADB, DFID, JICA and others.

**Thesis Title: ROLE OF NI AND CO MICRO -
NUTRIENTS IN THE ANAEROBIC
DIGESTION OF DISTILLERY SPENT
WASH**

Submitted by: Braj Kishore Chaudhary

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

The start-up and optimisation of complete mix reactors with Nickel and Cobalt micronutrients treating wastewater from a distillery was carried out. At the beginning of the operation Ni and Co loading (as existing) were 0.19 and 0.23 mg/l. Then the load was gradually increased in steps beyond the final capacity of the system till the system was ceased, using removal of organic load, as mg/l or COD, as leading parameter. The best removal of COD (46.53%) was achieved at Ni and Co concentrations of 0.49 and 0.53 mg/l respectively with the hydraulic retention time of 10 days. Generally Ni and Co are found in deficit in distillery waste. The supplement of these micronutrients at little cost enhance the COD reduction and consequently production of energy yielding methane gas.

**Thesis Title: BIOGAS PRODUCTION FROM A WEED
PLANT (EUPATORIUM ADENOPHORUM)**

Submitted by: Purna Bahadur Jwarchan

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

Biogas provides an alternate source of energy in *rural area*. *Using local* resources *viz.* Cattle waste and other organic waste; energy and manure are derived. Biogas is produced from organic wastes by concerted action of various groups of anaerobic bacteria. An attempt has been made to explore alternate feedstock in biogas production using Banmara weed (*Eupatorium adenophorum*), which is found growing luxuriantly in rural Nepal.

Anaerobic digestion of Banmara leaves (C:N adjusted to 25) was carried out in batch and semi continuous mode in 2.0-liter capacity digester at a temperature of $35\pm 2^{\circ}\text{C}$. Hydraulic and solid retention time for the digestion process was chosen as twenty days. The first and second batch experiments were very much acidic due to inadequate inoculum in the reactor. The performance of the reactor with 20% substrate concentration by volume was stabilized in the third batch of experiments. Wheat

straw was used as an external carbon source to maintain carbon to nitrogen ratio. The effect of influent solids in the range (6-12 percent) on the gasification was studied. The total solids in the influent did not affect the maximum biogas production. The maximum methane gas produced was 0.20 m^3 per kg VS added per day at the loading rate of $3.65 \text{ kg VS per m}^3$ of digester per day. The optimum organic loading was found to be $4.57 \text{ kg VS per m}^3$ digested slurry per day.

The outcome of this study is expected to be beneficial to biogas digester designer, policy maker and planner.

**Thesis Title: AIR QUALITY MONITORING
PROGRAMME DESIGN FOR
KATHMANDU VALLEY**

Submitted by: Dwarika Phuyal

Supervisor: Dr. Bal Krishna Sapkota

ABSTRACT:

Kathmandu, the capital city of Nepal is an economic & trade center of nation. Severe air pollution is threatening human health and the gains of economic growth in largest cities like Kathmandu. This study aims to assist policy makers in the design and implementation of policies, monitoring and management tools to restore air quality in Kathmandu Valley.

Kathmandu Valley's population grew by 44percent from 1981 to 1991 and 57 percent from 1991 to 200LParticulate pollution is a growing problem in Kathmandu Valley. The Brick industries, Himal Cement Plant, vehicle emissions are the main sources of particulate pollution. World Health Organization air quality guidelines for TSP and PM₁₀ are often substantially exceeded. Number of vehicles operating in the Valley is rapidly increasing, number of Brick kilns is in operation in different parts of the Valley and also other industrial sectors are increasing.

Technically, it is crucial that pollution from brick kilns and the cement industry should be better monitored in addition to the vehicular pollution. The air quality at residential site having dense population should have to be known.

The study will be helpful for vast improvements over data gathering and processing capabilities. The number of monitoring stations established within the Valley floor will suggest about the air quality status of the Kathmandu valley representing the each land use category.

A systematic Air Quality Monitoring Program is thus essential to know the existing air quality, analyze and evaluate long term effect of air pollution on human health and environment, also to develop& plan control mechanism, policy or strategy etc.

**Thesis Title: NUTRIENT REMOVAL BY
"ALTERNANTHERA PHILOXEROIDES"
IN WASTE WATER SATURATED BRICK
PARTICLE MEDIUM**

Submitted by: Dhrub Deo Prasad

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Wet land growing *Alternanthera philoxeroides* plant was used in the present study to treat municipal wastewater. Batch experiments were conducted in aquariums of sizes 45 cm * 30 cm * 30 cm. The aquariums were filled with brick pieces of size 5-10 mm to a height of 17 cm from bottom. Upper 8 cm of aquarium was filled with 2-5 mm brick pieces in which the plant was planted. Wastewater was applied up to 17-cm height. Four cycles of experiments were conducted each cycle covering a period of 33 days. Result showed N removal up to 74% and P removal up to 80% in planted aquariums. Plant uptake was 35% of total N removal 30% of total P removal. Iron up take by plant was 27% of total removal and zinc uptake was up to 16% of total removal. BOD₅, removal in planted system was slightly higher than control. Total organic carbon of brick media increased significantly at the end of the experiments. Therefore it is

assumed that part of the nutrient is absorbed by the biofilm developed in the brick media. A comparison of nutrient uptake by the test plant in natural environment (soil base) and brick medium of the experiment revealed higher removal efficiency in the later. A dense growth of *Alternanthera philoxeroides* in the brick medium would remove 8.66 g N, 742 mg P, 86 mg Fe and 4.18 mg Zn from a square meter of treatment area.

**Thesis Title: WASTE WATER TREATMENT USING
CLADOSPORIUM RESINAE****Submitted by: Dhruva Majagaiyan****Supervisor: Mr. Mahesh Prasad Bhattarai****ABSTRACT:**

Water pollution because of disposal of untreated wastewater is a burning problem in the cities of developing countries. To minimise this problem and create healthy environment of rivers and other water bodies, treatment of wastewater before its disposal is an important aspect. Different wastewater treatment methods can be applied as conventional methods. Though these conventional methods of wastewater treatment have very good efficiency on removal of the contaminants but they require high capital investment, energy and operation costs. This may be a major constraint for the developing countries to adopt these processes of wastewater treatments. Thus, these processes have been found unsustainable in the context of under developed countries like Nepal.

Therefore, many engineers and researchers have experienced the need of alternate treatment systems, which would require low capital investment and minimum operational cost. In this context,

the fungus named '*Cladosporium resinae*' as an enzyme was used to treat domestic wastewater. Five rounds of experiments were conducted and the appropriate condition and dose of fungus inoculum for the treatment was explored.

Though the two rounds of experiments did not show positive results, but they were very helpful to identify the suitable condition for the fungal treatment. Third round of experiment gave the positive results. In this round, the fungal treated reactor was found more effective than the untreated reactor. After getting positive results in third round, fourth round of experiments was conducted with varying the volume of fungus inoculum in different reactors. In this round, the optimum dose of fungus volume was determined. Further confirmation of the treatment process was conducted in fifth round of experiments.

In the first three rounds of experiments, one blank or untreated reactor and another reactor treated with fungus were kept and compared their performance for 2 weeks. Whereas in fourth and fifth round, one reactor was blank or untreated and the other three reactors were treated with different volume of fungus inoculum. The major parameter studied was reduction of BOD₅ which was monitored for 14 days at an interval of 2 days. Removal of the other parameters like SS, VSS, Turbidity, NH₃ -

N, coliform counts etc. were also studied by comparing initial data before treatment and final data after 2 weeks.

Maximum difference of BOD₅ removal for treated and untreated wastewater was found on 10th day. For example, BOD₅ was reduced by 93% in the reactor treated with fungus, whereas it was reduced by only 80% in the untreated reactor at the same time. Other parameters like SS, VSS, Turbidity, NH₃-N, Coliform count were also reduced significantly more than the blank (Untreated) reactor.

Furthermore, this system of wastewater treatment is environment friendly, cost effective, simple to use and feasible for small towns in the developing countries like Nepal.

**Thesis Title: NUTRIENT REMOVAL FROM WASTE
WATER BY ALGAE (HYDRODICTYON
SP.) CULTURE**

Submitted by: Chandeshwar Prasad Sah

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

This study is an attempt to use algal culture (*Hydrodictyon sp.*) for wastewater treatment. A concept of resource reuse was applied by using the nutrients of wastewater for the growth of algae. Altogether three species of algae were used in the experiment. Among, three algal species, *Hydrodictyon sp.* was the only one which survived and bloomed till the end of the treatment process. The other two algal species *Oscillatoria* and *Spirogyra* died during the experiments. It was ensured from the results that the nutrients (nitrogen and phosphorus) are the limiting factors for the growth of algae and the nutrient uptake rate of these algae increased with the increasing concentration of initial N and P content in the wastewater. Under this condition, nitrogen, phosphorus and iron removal were averaged between 85 % to 95 %, which is better than the other algal species used in the wastewater treatment so far.

All the experiments were carried out on laboratory scale with low technology approach to keep apparatus and procedure as simple and reliable as possible. After four rounds of experiments in batch process, this system has been found to be feasible to the primarily treated wastewater. Furthermore, this system is environmentally friendly because it helps to check the ground water pollution. From this approach not only the nutrients are removed from the wastewater but also important commercial by products (algae) are produced. This system is simpler, cheaper and more sustainable than other conventional methods; hence it is more suited in country, like ours, Nepal.

**Thesis Title: STUDY OF GROUND WATER
CONTAMINATION TRANSPORT
AROUND MANOHARA WELL FIELD
FROM GOKARNA LANDFILL**

Submitted by: Ram Krishna Bhattarai

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

The role of groundwater is very important in the management of water resource. With the increasing demand, it becomes very difficult to make groundwater pollution free. So the knowledge about the contaminant and its transport phenomenon under the subsurface is necessary. A comprehensive study for the contaminant transport within the ground water is much needed to protect subsurface system.

The Manohara well field and the Gokama landfill are taken as a model area for the study. The Gokama landfill site is considered as the source of contaminant and it contaminates the surrounding well field. A two-dimensional flow and transport model is used to calculate the contaminant from the landfill site. The study is carried out for the single species. It is found that there is minimum impact of landfill around the well field. The maximum

impact is found in well MH4 and MH5 where as in the well MH2 and MH7 the impact is almost nil.

**Thesis Title: ENVIRONMENTAL IMPROVEMENT
ASSESSMENT OF AUTOMOBILE
WORKSHOPS IN "SATUNGAL" AREA**

Submitted by: Ashok Singh

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Industrial development has led to increase in industrial pollution in and around urban areas of Nepal too. There are large number of small-scale industries operating in Kathmandu and other cities of Nepal. Most of these industries are discharging their emissions and wastes without any pre-treatment to the natural bodies and air having pollution load more than the standards set by regulating agencies. It has become an urgent need to integrate cleaner production (CP) with industrial development. CP addresses industrial pollution problems by application of an integrated preventive environment strategy to processes, products and services by increasing efficiency and reducing risk to human and to environment.

In this research work nine automobile workshops located between "Thankot and Naikap Pul" has been chosen for the application of CP approach for waste minimization and

environmental improvement of the workshops. Information about the workshop's repair and maintenance services, processes, inventory of inputs and outputs were prepared. The various sources of waste generation and their causes such as oils & cleaning solvent losses, water losses, collection losses of used oils etc. were identified.

A cause analysis was carried out to identify type of waste, its sources for generation and its causes. On the basis of this cause analysis, CP options were generated. Altogether thirty options were identified and classified using CP techniques.

The most suitable and potential options were subjected to feasibility analysis covering technical feasibility, economic viability and environmental aspects. The environmental feasibility study is based on simple evaluation on the reduction in toxicity and quantity of waste emission and energy losses. The economic viability was calculated on simple pay back period. Technical feasibility analysis and overall feasibility was done assigning high, medium or low. Ranking method assigning suitable value made prioritization of the feasible options.

CP options will control 54.68 % of environmental toxic impact and save 57.77 % of energy loss in the present context of present practices followed by automobile workshops. From the detail

economic analysis of the six CP options it shows there is an estimated investment of Rs. 4,76,000 /'- and saving of Rs.6,19,600 /- per year with a net profit of Rs. 1,43,600 /- per year. The overall pay back period of these six options comes to be nine months.

Graduation Year 2003

**Thesis Title: RISK ASSESSMENT OF TANKER WATER
IN KATHMANDU VALLEY**

Submitted by: Samar Bahadur Khanal

Supervisor: Mr. Mukunda Neupane

ABSTRACT:

Some one third of Nepal's population does not have access to safe drinking water. Acute problem of adequate drinking water in Kathmandu valley has been seen since 1970s. Present water demand in Kathmandu Valley is 275 MLD where as the supply is only 170 MLD in dry season and 228 MLD in wet season (NWSC 2003). Rest of the water demand is fulfilled through private dug wells, spouts and private tankers. Registered filling stations and private tankers were started to supply water from tankers since 1993. Prior to this period some unregistered filling stations and tankers were in operation. But still now there is no one study about tanker water. At present there are 15 private filling stations at different locations in Kathmandu Valley. In average all private tankers supply 2.78 million liter of water per day in Kathmandu valley, which occupies 1.4% of municipal water supply. Non-star hotels and restaurants are the

predominant users of tankered water followed by residential houses, industry and institutions.

The physical as well as chemical quality of tanker water was fairly satisfactory. In Himchuli filling station of Balkumari arsenic concentration of 0.08 mg/L has found.

But the bacteriological quality of water was found worse. Surface water sources were contaminated at source and the contamination rate is significantly increasing at different transmittal stages. Although contamination of ground water at source was almost nil but contamination took place at filling stations and tankers. Investigation showed that half of the sources and filling stations were in intermediate risk whereas nearly half of them were in very high risk.

Contamination of water at source was mainly due to the unfenced intakes, human habitation, agricultural farming in upstream of the sources and lack of surface water diversion ditches. Contamination took place in filling stations (collection tanks) due to the leakage of transmission pipes, lack of covers in collection tanks and lack of routine maintenance of filling stations. Contamination of water at tankers was mainly due to the transportation of water from multiple filling stations by the same

tankers and lack of routine maintenance of tankers. Some two filling stations were unregistered. Investigation showed that urgent and high action priority should be taken to minimize hazards from tanker water.

**Thesis Title: APPLICATION OF CONSTRUCTED
WETLAND TECHNOLOGY FOR WASTE
WATER TREATMENT IN NEPAL**

Submitted by: Keshav Raj Bista

Supervisor: Mr. Mahesh Bhattarai

ABSTRACT:

In developing countries, the water pollution problems are mainly created by direct disposal of untreated wastewater. In Nepal, constructed wetland technology has been used since 1997. It is basically a biological process, where a number of biochemical transformations take place as a result of the activities of plants, microbes and other physical factors. Due to the rising trend in the application of this technology, further research in optimizing the design is needed. The objective of this study was to evaluate the performance of COD and nutrient removal, and determine the reaction rate constant in the horizontal flow bed (HFB).

This study was carried out in two existing full-scale treatment plants, which were treating 34 m³/d (average flow) in the Dhulikhel Hospital and 16 m³/d in the Kathmandu University. These are hybrid subsurface flow systems with horizontal flow bed followed by a vertical flow bed with local reed (*phragmites*

karka) has been used. The treatment plants of Dhulikhel hospital and Kathmandu University were in operation for 5 years and 6 months respectively. Samples were collected at 6-hour and 4-hour intervals in the Kathmandu University and Dhulikhel Hospital respectively, while flow was measured at 2-hour intervals. The major parameters measured in the study were chemical oxygen demand (COD), dissolved oxygen, ammonia, nitrate, orthophosphate and Faecal colliforms.

Experimental results showed that the horizontal flow bed is suitable for degradation of organic matter and phosphorous. The vertical flow bed is capable of removing organic matter, ammonia and pathogens. This study showed 85 to 93 % removals of COD for ranging organic loading rates 121 to 381 Kg. BOD₅/ha.d respectively.

The porosity of the filling material in the wetland varied due to the roots and rhizomes of the aquatic vegetation before and after plantation. Experimental analysis showed a porosity-reducing coefficient (PRC) less than 3%. The reaction rate constant of organic matter removal in the wetlands ranged from 1.1 to 2.5 per day.

**Thesis Title: STUDY ON CAUSES OF FOAMING IN
GUHYESHWORI TREATMENT PLANT**

Submitted by: Narayan Prasad Khanal

Supervisor: Mr. Mahesh Bhattarai

ABSTRACT:

Guhyeshwori treatment plant is the first public based extended aeration type of treatment plant in Nepal, which has passed its one-year operation period. In the early stage of operation, excess foaming in Oxidation Ditch was observed. This problem got importance at that period and various assumptions were made by the professionals at the different level. So, to identify the probable causes, this study was initiated.

The study was carried out on the basis of three approaches in existing treatment plant's operational conditions. Firstly, analysis of various physico- chemical and microbiological parameters such as pH, Temperature, BOD₅, COD, DO, MLSS, MLVSS, TKN and Phosphorous were taken in to account by collecting the six cycles of composite and one cycle of grab samples, during the study period. Process controlling parameters such as F/M ratio, MCRT, MLSS, DO, recycle and wasting rate of sludge were used for interpretation and correlation of the problem.

Secondly, microscopic study of foam was conducted to identify the filamentous microorganism during the foaming period. Thirdly, study of possible foam enhancing substances in the effluent from wool dyeing and carpet washing industries had been conducted.

The study showed that soaps and detergents, which are used in the carpet and wool industries, were mostly biodegradable and their impact on foaming in OD was temporal. Filamentous microorganisms were not observed during the foaming period. Analysis of physico-chemical and microbiological parameters showed high F/M ratio during the period of foaming.

The study revealed that occurrence of foaming phenomenon on the treatment plant was due to process overloading. At high F/M ratio partial degradation of organic matters in particular surfactants caused this type of phenomena. But, after gaining the maturity by treatment plant foaming on OD gradually disappeared. In the winter season, due to slow metabolic rate of microbes biodegradation efficiency was lower than summer. In average hydraulic and organic loading, it was observed that, when MLSS in the OD reached in the range of 23 00 mg/l to 2500 mg/l, average F/M ratio decreased up to 0.3/day, foaming phenomena which disappeared completely. For normal operation of the plant, the minimum DO level should be 2 mg/l in OD and 3000 mg/l to 3500 mg/l of MLSS to be maintained.

**Thesis Title: INSTITUTIONAL ARRANGEMENT FOR
SERVING WATER SUPPLY TO THE
URBAN POOR IN KATHMANDU VALLEY**

Submitted by: Deepak Kumar Amatya

Supervisor: Mr. Mukunda Neupane

ABSTRACT:

Water and poor is supplementary word today, distribution of potable water to the poor is a world wise challenge and it is more challenging issue for developing countries. The number of slum and squatter in Kathmandu Valley is increasing day by day. the identified poor population was 2.134 and distributed in 17 communities in 1985 but it is 17,051 populations in 65 communities today. The exact number of poor, living as a renter are not known, but it is estimated that there are 64000 households and interwoven with high-income groups. This study was conducted with the following objectives:

- To suggest appropriate Institutional arrangement to handle drinking water services delivery for urban poor in Kathmandu Valley, which will cope with existing legal constrain, affordability in house connection charge, monthly tariff and its modification requirements.

- To suggest Institutional building of community to get access in municipal water supply services.

HMGN is also seriously thinking for private party involvement in water supply system. A Private Sector Participation High Level Committee (PSPC) was constituted in 1997 with financial assistance of World Bank for creating an environment to attract the private sector participation in management of NWSC services in Kathmandu Valley. The most important opportunity for urban poor can find from NWSC networks such as private tap connection. Basically existing system has heavy subsidies allocated in 1/2" connection in first block through progressive block system. The other free services provided for poor are public stand post, shared / super shared connection and tanker services, whose services are, either free of cost or paid by municipality. Except that, there are other sources such as stone spouts. Shallow well/ tube well, river and ponds available for poor and squatter. Organizations are also providing services on the basis of humanitarian ground for poor and squatter. Government has given commitments for service delivery through their long-term plan and policies and has adopted decentralization policies reflected through self-governance act 2055 (1999) and its regulatory act 2056 (1999). Special provision made for involvement of private sector in service delivery

through legal reform and sector strategy development for Kathmandu Valley.

This study has made conclusion after analysis of survey data and the hypothesis that Government agencies alone cannot give efficient services to the poor. It required intermediate organizations in close cooperation with Government agencies. Function of intermediate can be made sustainable only after commitments and cooperation made by Government and necessary environment providing to them. That environment may be in the form of economical environment, social environment or political environment. After the whole study, it shows that service delivery can be made efficient and sustainable through the implementation of:

- Creating environment for partnership development among the stakeholders for serving to the poor.
- Emphasize on development of secondary sources thus reducing reliance on NWSC networks.
- Role of intermediate organization also focused on institutional building of community organizations through awareness building.
- Provision should make for issuing license to intermediate organization / PO for pre identified poor communities with subsidies in tariff and change in present block tariff structure.

**Thesis Title: TREATABILITY STUDY OF EDIBLE OIL
AND GHEE REFINERY EFFLUENT BY
UASB WASH**

Submitted by: Somraj Gurung

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

The feasibility of the upflow anaerobic sludge blanket (UASB) process was investigated for the treatment of edible oil and ghee refinery industry wastewater. After removal of suspended solids by simple gravity settling, edible oil and ghee refinery effluent was used as a feed. Start-up of three reactors R1, R2 and R3 of volumes 0.778 L, 2.16 L and 0.778L respectively and with a feed of 1452-2459 mg/L chemical oxygen demand (COD) was accomplished in about 7-8 weeks. The three reactors were performed in two cycles of experiments. The seed sludge was prepared after the acclimatization of edible oil and ghee refinery effluent with cow-dung.

The organic loading rate of 5.17-19.45 kg COD/m³/d was maintained during the reactor operation period. The upflow velocity was tried to maintain at about 0.15-0.20 m/h for the reactors R1 and R3 and at 0.20-0.25 m/h for the reactor R2. The

varying influent COD was found to reduced to a effluent COD of 362 mg/l. COD conversion efficiencies >80% and gas productivity of 214-9792 ml/L/day were obtained. These results indicated that the removal of Soyabean oil and Vanaspati ghee refinery effluent by UASB process was sufficient to obtain a satisfactory performance.

**Thesis Title: THE EFFECT OF SORPTION ON
REMOVAL OF HUMIC SUBSTANCES IN
WATER PURIFICATION SYSTEM USING
SOIL**

Submitted by: Gyanendra Prasai

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

This study was conducted to evaluate the effect of sorption on removal of humic substances (HS) in water purification systems using soil. The affinity of soil samples, used in the multi-layered soil water treatment system, towards fulvic acid (FA, one of humic substances) and phosphorous acid was studied using batch sorption technique and the results were compared with those obtained for various types of soil, mineral and organic samples. Batch sorption experiment with sterilized soil samples was conducted to study the effect of microbes on sorption of FA. Biodegradable dissolved organic carbon (BDOC) measurement technique was established and was applied to the various water samples like solution from sterilized batch sorption experiment, and the influent and effluent of the multi-layer soil water treatment system, for the characterization of the samples in terms of dissolved organic carbon. The mechanisms of removal of

pollutants in the water purification system were ; discussed based on the obtained results.

The sorption coefficient K_d (ml/g) of FA showed that charcoal and zeolite used for multi-layered soil system had high affinity towards FA among the 30 samples tested. The zeolite exhibited faster kinetics with sorption equilibrium achieved within 24 hours. The charcoal exhibited slower kinetics showing that it can be effective for sorption after longer retention time.

Batch sorption experiment was also conducted on the sorption of sterilized and non-sterilized FA using sterilized charcoal, which had the highest sorption capacity of FA among the material used in the water purification system. Also tested was sterilized limonite, which was one of the best samples among the materials tested last year. The results showed slight (ca. 10% for limonite, a few percent for charcoal) increment in the K_d values for non-sterilized FA in both samples compared with that of sterilized FA, suggesting that there is not much, but some effects of microbes on sorption of FA.

BDOC measurement technique was established using standard solution (glucose-glutamic acid solution) and FA, with standard microbes (commercial BOD seed) and soil microbes (extracted from humic soil) as inoculum. BDOC measurement and XAD

fractionation for the batch solution of both soil samples showed that the charcoal sample used in the water purification system was superior to limonite, in removal of HS. It probably is the cause of the high removal ratio of HS observed in multi-layer soil water treatment system, which was more than 70%.

BDOC measurements of influent and effluent from the multi-layer soil water treatment system showed that 40% of influent and 21% of effluent DOC were biodegradable, which was 9.0mg/l DOC of influent and 1.0 mg/l DOC of effluent. The removal of ROC (refractory organic carbon, estimated by subtracting BDOC from DOC) during treatment (9.7 mgC/l) was slightly higher than the removal of BDOC (8.0 mgC/l). The sorption of 75% BDOC and 99% refractory organic matter (ROC) by charcoal, as clarified by batch experiment, strongly suggests that the system removes the dissolved fraction through a physico-chemical sorption rather than by biodegradation.

On the other hand, the soil microbes consumed more organic carbon in the influent than standard microbes, whereas, OC in the effluent showed the same degradability for both soil and standard microbes. The possibility exists, therefore, that organic materials which can be metabolized only by soil microbes (3.6 mgC/l) could have been consumed in the system.

Further study is necessary to conclude on the effect of sorption in the treatment system using soil. Such work may include sterilized batch and column test combined with application of mathematical model, sorption test of BDOC and ROC to zeolite and scolia (materials other than charcoal used in multi-layer soil water purification system).

**Thesis Title: EFFECTIVENESS OF COPPER AS A
DISINFECTANT****Submitted by: Sagar Gnwali****Supervisor: Mr. Manoj Kumar Pandey****ABSTRACT:**

Safe and clean drinking water has become a luxury for majority of people in the developing countries. Water adequate in quantity and safe in quality, is essential for the very existence of human life. Diseases caused by contaminated water are among the ten most prevalent diseases in Nepal. Diarrhea, which is caused by poor sanitation, hygiene and water quality, is one of the most prevalent water borne diseases in Nepal. During 1995/96 the incidents of diarrhea among the children below five years of age was 131 per 1000. the mortality rate due to diarrhea was 0.34 per 1000 children under five years of age, while the case of fatality rate was 2.56 per 1000.

Copper pots have been in use since time immemorial in different civilizations and also in Nepal for storing drinking water. The use of water stored in copper vessels is considered hygienic since ages. The germicidal action of copper pots due to oligodynamic properties, which makes it so useful in the part of life of all

people. The findings derived after the analysis and discussions from the present study can be stated as follows:

- As the temperature raises the copper release increases during that time. "The oligodynamic action of copper has bactericidal effect in liquid medium up to a distance of 4.0 cm.
- With the increase in surface area by volume the action of copper increases on the bacteria present in the water.
- Copper release was found to follow a cyclic pattern The increase in the cyclic process might be due to the increase in copper concentration resulting from the corrosion and oxidation reaction and the decrease might be the result from the reaction of the dissolved Cu" with the metal leading to the formation of a layer of cuprous oxide. Thus forming a cycle in nature and independent of time.
- The analysis of the copper concentration with respect to storage time was done irrespective of the surface area by volume ratio for different samples of water to find out the relation between pattern of copper release and Coliform counts. The analysis showed that higher the initial Coliform count more systematic is the nature of copper release. Thus it can be concluded that with the increase of Coliform count more systematic is the copper release from the copper container.

**Thesis Title: ASSESSMENT OF WATER SERVICE
DELIVERY AND TARIFF STRUCTURE
FOR URBAN POOR IN KATHMANDU
VALLEY**

Submitted by: Murali Gopal Ranjitkar

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Water and sanitation are the essential component for the development of the Nation. Since last few decade water supply sector is considered as highly prioritized sector. But once we think about the situation of urban poor water service in our country is very vulnerable and need importance for the improvement of urban environment. Kathmandu valley is facing a great problem to serve urban poor with required quality and quantity of water. There are different poor communities in Kathmandu valleys among them 64 urban poor communities are settled with in the Kathmandu valley. The urban poor settlement exist in three distinct forms i.e. squatters, slum and scattered. Assessment of water service delivery and tariff structure for the urban poor in Kathmandu valley 24 urban poor communities is selected from different location and situation.

The objective of this study is to find out the approaches and methodology for provision of appropriate level of service in meeting the basic need of urban poor community. Study is based on the present situation and practice in service delivery practice and tariff structure applied by NWSC in Kathmandu valley. There are very few study undertaken focusing to urban poor in our country. Methodology applied for the research work in field study, consultation meetings with concern organization, discussion and data collection in related line agencies and NGOs working in urban poor sector selected.

Generally study is focused on general study about the urban poor and existing water supply situation in urban poor communities. Situation analysis is work out with the help of identification of urban poor, estimation of urban poor, growth of urban poor in Kathmandu valley.

Existing water tariff adopted by the NWSC in Kathmandu valley is explore and analyzed. Tariff used at the most metered domestic connection is a "Block Tariff. A new tariff was introduced in early 2002. It is estimated that 29% of the population of Kathmandu valley is not connected to the NWSC network. Among them 14% poor are having NWSC connection. To improve the water service delivery and adopted suitable tariff

structure four type of connection is proposed during the willingness to pay study. They are private connection, shared connection; super shared connection and community stand post. Analysis of the study found that 50% of the urban poor people are willing pay NRS 50 per month for shared connection.

With all these study, finding, and analysis of research study found that water service delivery practice in urban poor community is vulnerable. To improve the present situation, it is essential to identify the each and every urban poor community problems related to water service delivery. It is too late to apply the suitable measure to upgrade the life standard of urban poor. The research study had recommended various issues regarding urban poor in Kathmandu valley. There is no doubt that without consideration of urban poor issues it is almost impossible to improve the urban environment.

**Thesis Title: PERFORMANCE EVALUATION OF
OXIDATION OF DITCH AT
GUHYESHWORI**

Submitted by: Dhundi Raj Dahal

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

Bagmati Area Sewerage Construction / Rehabilitation Project has constructed an Oxidation Ditch at the right bank of Bagmati River near Guhyeshwori and it is in operation for more than a year. Since it is the first of its kind, performance study and evaluation will help to establish other treatment units in future.

From the very beginning the performance of the treatment plant was monitored. Study was included the analysis of the physico - chemical and biological parameters. BOD₅, COD, MLSS, MLVSS, TKN, Ortho Phosphate, DO, TSS and SS were analyzed and these parameters were used for the evaluation of the performance of the grit chamber and biological units. During the eleven months, five cycles of two to four hours composite samples were analyzed.

Study revealed that average removal of Grit chamber was less than 10 percent on mass basis. Whereas average influent TSS to

the Grit Chamber was 318 mg/l, which was slightly higher than the designed average value of 216 mg/l.

Based on the analysis of five cycle data, BOD₅ and COD removal efficiencies of the treatment plant were 86 and 74 per cent respectively which satisfy the design objectives. Nutrients and pH for bacterial growth were observed within the normal range during the study period. Influent temperature varied from 14 to 25° C. In the cold climate, slow maturity of treatment plant was due to low metabolic rate of microbes. F/M ratio in the range of 0.15 to 0.20 per day was effective and MCRT was efficient in between 15 to 25 days. Nitrification process was observed in the second and third cycle of analysis in May and June, when MLSS and DO were in the range of 3000 to 3500 mg/l and around 2 mg/l respectively. Whenever MLSS was found more than 3500 mg/l, DO in the reactor decreased and creating unfavorable environment for nitrification. MCRT increased to 34 days and F/M ratio decreased to 0.1 per day. DO in the centre portion of the Ditch was always observed low with compare to vicinity of aerators. Because of this accumulation of mixed liquor was observed in central area. For normal performance of the treatment plant it is recommended that, MLSS should be in the range of 3000 to 3500 mg/l for maintaining adequate DO level in the OD so as to create the favourable environment for

nitrification and denitrification with the removal of BOD₅ and COD.

Thesis Title: NITRIFICATION EFFICIENCY IN RAW WATER USING LOCAL FILTER MEDIA

Submitted by: Narayan Basnet

Supervisor: Mr. Ishwar Man Amatya

ABSTRACT:

Scarcity of the safe drinking water is the common problem for the context of Nepal. So here in this thesis, an attempt is made on evaluation of nitrification efficiency in raw water using local filter media. Site was selected at Bhaktapur Lokanthali. Model plant including four sets of nitrification columns and two sets of denitrification tanks were fabricated with sampling ports in each of them.

After preparing the model, ground water containing ammonia was passed through filter media and filtrate water from different columns and tanks were tested in different parameters especially for ammonia, nitrate, pH, alkalinity, iron, turbidity, EC and chloride. After analyzing the data obtained from the test results, it was compared with guidelines values. It is concluded that, after nitrification pH is changed from acidic to alkaline in range of 6.5-7.9 within the column. Iron concentration in raw water is about 4.6 mg/l. After nitrification concentration is reduced up to

0.10 to 0.04 mg/l. So, iron removal efficiency is 98 %. Similarly alkalinity in raw water was found in the range of 400-450 mg/l. After nitrification concentration is reduced approximately up to 280 mg/l So, average efficiency in alkalinity consumption is 60%. Similarly, turbidity in raw water was in the range of 40-90 NTU. After nitrification turbidity is reduced up to or less than 5 NTU. So, during nitrification average turbidity removal efficiency is 94 %.

In influent raw water ammonia concentration is found in the range 40-95 mg/l. After nitrification, ammonia concentration in different nitrification column is found in decreasing order such as 59.1 mg/l in raw water, 26.9 mg/l in first column, 10.3 mg/l in second, 5.1 mg/l in third and 4.2mg/l in fourth column. In the nitrification process, ammonia is converted to nitrite and nitrate. So ammonia concentration decreases and nitrate concentration increases. However nitrification rate is not constant. In general nitrification efficiency is 15- 20 % in column first, 20-25 % in column second, 20-30 % in column third and 10-15 % in column fourth. Average nitrification efficiency of the model is about 80 %.

So, in briefly speaking, efficiency of process used for nitrification is satisfactory.

**Thesis Title: A STUDY ON THE RISK OF BACTERIAL
CONTAMINATION TO GROUNDWATER
BY ON -SITE SANITATION**

Submitted by: Niranjan Khanal

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

The natural soil has been recognised as effective system for the purification of human wastes. The purification process normally includes the removal of faecal micro organisms and the breakdown of many chemical compounds.

Improper design, construction of on-site sanitation systems can lead to a serious pollution to groundwater, and thus to local water supply. It is important to identify the main hydrological factors involved in the pollution of groundwater. Groundwater pollution relates primarily to unconfined aquifers and, to a lesser degree to semi-confined. Where groundwater supplies are drawn from deep and confined aquifers, on-site sanitation is not a problem. It is essential that the relationship between groundwater quality and on-site sanitation be investigated to ensure that improved sanitation does not cause excessive ground water pollution. So, the effect of different hydraulic loading by on-site sanitation practices to groundwater in different soil formations are studied.

**Thesis Title: APPLICATION OF FOG WATER
COLLECTION TECHNOLOGY TO
HIGHLAND COMMUNITY WATER
SUPPLY SYSTEM**

Submitted by: Mohan Bahadur Karkee

Supervisor: Mr. Mukunda Prasad Neupane

ABSTRACT:

It is an accepted fact that water is one of the scarcest, fast depleting and most limiting basic natural resources. In Nepal, only 71.8% of the total population has access to safe drinking water at present. People living at high uplands suffer more, because they have very limited water sources at right places. They have to fetch water from several hundred meters downhill, which costs them two to three hours a day. Most of the conventional sources have been exhausted, whereas the few remaining have dispute of rights. Such conditions pose an urgency to look into other viable alternatives like fog and rain water collection. Many ethnic communities are located in such areas. If these locations were provided with safe drinking water, their hardships could be minimized.

The fog water collection technology is very simple, and demand less operation and maintenance works. A fog collector screen

made up of polypropylene mesh is mounted vertically on two or more posts. The screen is placed perpendicular to the direction of wind where the tiny water droplets present in the fog are trapped. Several droplets combine to form a large drop that fall by gravity into the storage tank through a collector placed along the bottom of the screen. From the storage tank the water is fed into the distribution system which is the same as in the gravity flow system.

The results had been very promising at Danda bazaar. A maximum daily yield of 118 LW/d was recorded. The daily average yield was $6.75 \text{ L/m}^2/\text{d}$. For analysis, rain water has been included into the system. A typical prototype model was then designed to provide a family of 5 to 8 members with 15 Lpcd water, having 12 m^2 mesh screen and 8 m^2 roof areas.

The quality of fog water as observed was good and accepted by the local community. The water quantity was found enough to meet the community demand. The geographical and meteorological conditions were also quite favorable at this site. Nepal is one of the 22 countries that have been identified as the potential area for fog water harvesting. It is a low cost and community manageable system.

**Thesis Title: DETERMINATION OF MIXING HEIGHT
AND STABILITY CLASS OF
KATHMANDU VALLEY**

Submitted by: Rajesh Kumar Das

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Ambient air composition over any area has undergone several changes. Anthropogenic pollutants generated locally often have regional air quality affected significantly. In addition to the short-term episodic effects, atmospheric pollutants are known to generate long term adverse effect, which are difficult to forecast statically. The air pollution dispersion Modelling exercise forecasts fairly accurate air quality for a given emission scenario, incorporating geographical and meteorological conditions. Among the meteorological inputs for most of the dispersion models, such as mixing height, stability class, wind characteristics, temperature etc., the assessment of mixing height determination throughout the year has not been done before due to lack of radio sonde data. In this thesis the temperature above valley ridge boundary extrapolated by drawing contours of temperature datas from Indian meteorological stations for upper data and correlated local surface temperature for lower data to

obtain vertical temperature profile for determination of mixing height of Kathmandu Valley. Determination of Stability class was made according to insolation-based classification, for which local hourly meteorological data were taken in consideration.

In conclusion, the findings are:

1. The nighttime atmosphere of Kathmandu Valley was found with low mixing height and highly stable atmosphere throughout the year, signifying poor dispersion of pollutants both in horizontal and vertical directions.
2. In winter the trend of mixing height was seen directly proportional to temperature and inversely proportional to the pollution level (PM_{10}), i.e. decreasing rate of temperature trend from October to January resulted the increasing rate of the pollution level (PM_{10}).

So, during winter the high humidity, low temperature and low wind speeds may cause strong surface inversions and to cause episode, if the situation of industries- design of industrial stake height, emission regulatory measures are not implemented properly.

**Thesis Title: ARSENIC REMOVAL BY ADSORPTION
 ON RED SOIL**

Submitted by: Indra Vilas Khanal

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

Evidence of arsenic contamination in ground water which are detected in neighboring countries, has also been found in the southern plains of Nepal. In some arsenic affected areas, substitution of drinking water source by a safe and easily available ones may not be possible. Arsenic removal may be an appropriate option in these areas.

Arsenic removal by adsorption on red soil is the main theme of this study. Locally available red soil has been used as an adsorbent. Natural red soil was burnt, crushed and then sieved for the required sizes.

First of all, equilibrium analysis was conducted using powdered red soil. Time of shaking in the shaker was varied from 15 minutes to 10 hours. After several observations, it was concluded that the removal of arsenic (TO) increases with time and attains equilibrium within 75 minutes.

Batch tests were performed using powdered and granular products of red soil as an adsorbent. At least three observations were made on varying sizes. The tests were also carried out on varying pH values by adding acid or base.

Observations from the batch test showed that the adsorption processes of the adsorbents fitted well to both Freundlich and Langmuir Isotherms. But the isotherms of smaller particle were more close to Freundlich model whereas the isotherms of larger particle were close to Langmuir model. Values of all the constants of Freundlich (k , n) and Langmuir (a , b) isotherms indicated the favorable adsorption. Separation factor ' r ' obtained was also less than one, which indicate the favorable adsorption. The adsorptive capacity of the media was comparatively higher in the finer particle. The adsorption of As (III) was favorable on basic aqueous solution. pH values, 7 - 9 of arsenic solution were favorable.

Column studies were also carried out using 0.3 to 0.84 mm granular red soil. Bed depths of column were varied using 60gm, 40 gm and 25 gm of soil to treat the 10, 15 and 20 ml/min of flow rate. Unfortunately, the tests showed that the removal of arsenic were minimum. But it made clear that the bed depth had to be increased and the flow rate had to be maintained very low.

Batch test has already proved that red soil can be used as an adsorbent to treat arsenic contaminated water. The adsorptive capacities obtained in both Freundlich and Langmuir isotherms shows that the red soil is not a strong adsorbent. But, it can compete against the adsorbents such as red mud, hematite, activated bauxite and activated alumina.

Red soil is easily available to the adjacent of arsenic affected communities. Further study is needed to explore the economic viability.

**Thesis Title: EXPLORATION OF THE CONCEPT OF
DRY SANITATION**

Submitted by: Megha Raj Regmi

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Justifiable and reasonable use of water resources is the call of the day. While many countries in the world are facing chronic shortage of water, waterborne sanitation has become an unrealistic option. Use of water for flushing excreta is not only a senseless matter but also a crime, because 40% of the World's population is deprived of the drinking water facility whereas the urban populace uses excessive quantity of water to flush the excreta. This has in turn become a cause for the water pollution in rivers and streams and ultimately degradation of the environment as a whole. To overcome this problem, dry toilet is the only available solution. This is an approach where human excreta are not treated as a waste product but recycled safely to improve soil productivity. It minimizes the use of water as compared to the recent use of water for sanitation purposes.

Dry sanitation is feasible in the rural and semi-urban areas to reduce the consumption of costlier water that is required for

flushing which later contaminates the ground water. It is also feasible to manage the excreta disposal into the watercourses and the use of excreta as a resource.

This research work basically deals with dry toilets, with and without sunrays, constructed in peri-urban area. The work has used appropriate technology and studied their performances in the context of Nepal, based on complete laboratory analysis and the regular monitoring. The result advocates the implementation of dry toilets to save the water wasted in flushing.

The dry Sanitation concept integrates sanitation and safe management of excreta by using it as fertiliser and soil conditioner. A model of dry toilet is designed such that urine and faeces get separated. These valuable nutrient sources are then dehydrated and decomposed by solar radiation. A comparative analysis was carried out to see the effect of solar radiation on the degradation of faeces in the vault and reduction of pathogens. Two Lab scale reactors, one exposed to sunrays and the other without sunrays were constructed to replicate the vault to collect the faeces.

The rate, time of decomposition and the pathogen reduction were studied. In sunrays model, it was found that in 48 days of

observation the faecal coliform presence depleted to 610 cells per gm from the initial value of 7×10^6 and the volatile organic matter came down to 70.18 % from 98.09 %. Similarly, in the other model the destruction of faecal coliform in 65 days was found to be 920 cells /gm while the destruction of organic matter took 75 days. The faeces got decomposed in one and a half month's period compared to the general case of 3 to 4 months. Also from the observation on 313 people of a cluster of the pilot project; annually recovered value of N, P and K. was found to be 1565kg, 125Kg, 344 K.g, respectively.

The research work, thus found the dry toilet to have a clear advantage over the traditional water borne sanitation.

**Thesis Title: REMOVAL OF ARSENIC FROM IRON
CONTAINING GROUNDWATER BY
AERATION FOLLOWED BY
FILTRATION**

Submitted by: Shankar Mani Jnawali

Supervisor: Mr. Ram Kumar Sharma

ABSTRACT:

An experimental investigation was carried out to study the different aspects of removal of arsenic from iron containing groundwater by aeration followed by filtration. The model consists of an aeration tray, a sedimentation column, a gravel contact filter and a sand filter column in series. Locally available gravel of size 5-25 mm and sand with effective size 0.45 mm and uniformity coefficient 1.5 were used in contact and sand filter column. Experiments were conducted on six types of ground water containing different arsenic and iron concentrations with the flow rate of 1528 L/m²h (12 L/h). Water from deep well of IOE (sample A) and shallow tube well of Dhumbarahi (sample B) were selected to prepare the synthetic solutions and for the natural arsenic, four different sources (S-1, S-2, S-3 and S-4) of Ramgram Municipality of Nawalparasi were selected, where arsenic concentration was already identified. The model had been

tested on above water samples for 24 hours run length and effluent water samples were collected in 2-4 hours interval for the laboratory test. All analysis of arsenic and iron were conducted on AAS in IOE, Pulchowk.

The performance of the model regarding arsenic removal efficiency was found to be satisfactory. Influent arsenic concentration of 0.107 mg/L was reduced to 0.043 mg/L after 8 hours run of S-1, similarly, influent arsenic 0.155 mg/L was reduced to 0.045 mg/L after 20 hours run of S-2, 0.192 mg/L reduced to 0.041 mg/L after 24 hours run of S-3 and, 0.241 mg/L reduced to 0.064 mg/L after 24 hours run time. Iron removal efficiency was found excellent (100 %) within 8 hours run time of all samples (S1-4) of influent iron 2.07, 2.17, 2.28 and 1.55 mg/L respectively. Similarly, in synthetic water B-3, influent arsenic 0.500 mg/L (with high iron 12.16 mg/L), was reduced to 0.050 mg/L within 16 hours run after treatment. However, in synthetic water sample A (1-3) with arsenic 0.200 mg/L, removal was found less as 0.083-0.074 mg/L (58- 63 %) even by increasing iron 5.06 to 10 mg/L. after 24 hours run time. Turbidity and pH values were found within the limit of WHO guideline values.

**Thesis Title: TREATABILITY STUDY OF MUNICIPAL
WASTE WATER IN UP FLOW
ANAEROBIC FILTER AND UP FLOW
ANAEROBIC HYBRID REACTOR**

Submitted by: Dhruva Mani Paudel

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

The fast growing urban, semi-urban and rural bazaar areas are facing a great problem of wastewater management. In urban and semi-urban areas, traditionally constructed septic tanks are less effective to treat the domestic wastewater due to the inappropriate design and construction and poor operation and maintenance. Conventional type of treatment plant like stabilization pond, oxidation ditch may not be feasible because of high construction cost as well as high operation and maintenance cost and the country needs an economical as well as simple technology.

In connection with the country scenario mentioned above, this research focuses on the feasibility study of the treatment of municipal wastewater UAF and UAH reactor. Study was carried out in real field condition in ambient temperature without

external source of heat. Two UAF and one UAH reactor used in this research work were made up of 19.20 mm diameter PVC pipe. Height of UAF and UAH was 1.20 and 1.50 m respectively. One UAF reactor was packed with 9.50 -19.00 mm-sized stone aggregates and another with the brick aggregates of the same size. Lower part of UAH was filled with flocculent sludge. All reactors were made airtight. Biomass used in the research was the sludge from matured septic tank.

Research was conducted on different condition of HLR, HRT, temperature and pH. Anaerobic process required eight week long maturation period to reach on steady state condition. No significant difference in COD removal was found between brick and stone aggregate of equal size. Treatment process was more efficient for high strength wastewater.

UAF had removed 57.40, 64.67. and 75.40 % COD corresponding to 15.5, 19.0 and 24.2°C temperature and in 8 hours of HRT. Similarly, UAH had removed 52.85 and 68.94 % COD respectively in 8.10 and 12.10 hours of HRT. Likewise, UAF and UAH reactor had removed 97.88 % and 50.15 % COD_{sus}; and 50.60 % and 55.42 % COD_{dis} respectively in 24.2°C temperature and 7.20 hours HRT. Hence UAF was more

efficient in removal of COD_{ss} while UAH was marginally efficient in removal of COD_{dis}.

Out of the COD removed, 60 % in average was converted into methane. Effect of temperature and pH in anaerobic process was significant. An increase in temperature by 1°C resulted 2% increase in COD removal. Similarly, an increase in pH from 6.7 to 7.0 resulted 7.50% increase in COD removal.

Outcome of this research indicates that primary sedimentation followed by UAF reactor of shallow depth with lower organic loading rate would be an alternative technology for on-site treatment of domestic as well as municipal wastewater in household and community level of urban area.

Graduation Year 2004

**Thesis Title: ARSENIC, IRON AND COLIFORMS
REMOVAL EFFICIENCY OF
HOUSEHOLD LEVEL BIOSAND FILTERS**

Submitted by: Prem Krishna Shrestha

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT:

Experimental investigations were carried out to study the removal of Arsenic, Iron and Coliforms in drinking water by Bio-sand Filters using Iron nails. Three cycles of experiment were performed using two Household Filters. The experiments were carried out using different quality of waters such as arsenic spiked ground water, tap water and natural arsenic contained ground water. The filters under study consist of two parts combined in a single unit. The top part of the filter consists of iron nails for the adsorption of Arsenic, while the bottom part of the filters is basically a small size slow sand filter, which removes the suspended materials present in water. At the same time it also removes the micro organisms present in water by biological action.

Both the filters showed moderate results regarding the removal of As, Iron, and Coliforms during the first cycle of study. First cycle of study was carried out for 32 days using arsenic spiked ground water of Pulchowk Campus complex, containing very high concentration of phosphate (31 mg/l).

The performances of filters were found satisfactory in second cycle of study, in which arsenic spiked tap water was used. Average removal of Arsenic in Filters A and B was 85% and 76% respectively. Both filters produced water with acceptable concentration of Arsenic (50 ppb), when the As concentration of raw water was up to 400 ppb and 200ppb in Filters A and B respectively. When raw water concentration of Arsenic exceeded 400 ppb, the treated water exceeded the interim standard of Arsenic for Nepal. The average removal of Arsenic is found about 91%, when tested at Sunawal VDC of Nawalparasi district.

The efficiency of filters to remove Iron and Turbidity is satisfactory. Iron removal is about 50% in both the filters. But, maximum concentration of 1.75 mg/l of Iron was reduced to 0.2 mg/l. Average turbidity of 12 NTU was reduced to value of less than 1NTU.

Efficiency of filters to remove coliforms is found moderate. Although the coliform removal percentage is about 94% in both the filters, the quality of water is still doubtful by public health point of view.

**Thesis Title: EFFICIENCY OF HORIZONTAL FLOW
 ROUGHING FILTER IN TURBIDITY
 REMOVAL**

Submitted by: Ram Krishna Sapkota

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT:

The provision of safe and reliable water supply remained a challenge in our country. We are facing political turmoil, economic regression, and institutional and socio-cultural problems for the last couple of years. Under such conditions, the importance of self-reliant, sustainable and community-based water supplies cannot be over emphasized.

Laboratory level study accompanied by practical experience has shown that Horizontal - flow Roughing Filter (HRF) has high process stability and ease of operation, and remarkable efficiency in turbidity removal.

In this study, a model of four compartments was used. The filter media used are gravel /aggregates of 4 mm to 25 mm size in the first three compartments and sand of 0.4 mm to 1.0 mm size in the last compartment. The study involved measuring the turbidity

and the total suspended solids at specified sampling ports at certain hours of filter run.

Filtration through HRF, at filtration rates between 0.5 and 2.5 m/hr, produced water with low turbidity and turbidity removal is found to be more than 90%. Regeneration efficiency of HRF was very high when compared with the head loss before and after the hydraulic cleaning.

Horizontal flow roughing filter is particularly appropriate for application in Nepal because of its high removal rates for turbidity and suspended solids without addition of coagulants. The large solids storage capacity at remarkably low head loss, and long filter runs between regenerations makes this filter particularly useful for the treatment of stream and river waters in drinking water projects in the country.

**Thesis Title: AN ASSESSMENT ON PERFORMANCE
OF VARIOUS HOUSEHOLD TREATMENT
SYSTEMS USED IN KATHMANDU
VALLEY**

Submitted by: Rabindra Nath Shrestha

Supervisor: Mr. Padam Sunder Joshi

ABSTRACT:

Iron and manganese removal by various household treatment systems used in the Kathmandu Valley was studied in this thesis work. Basically, six types of water treatment systems have been found during the field visit. Most of the household surveyed in Koteshwar and Sinamangal area have a treatment system with tray aerator, slow sand filter and a storage tank. Removal performance of each type of system has been studied in general. The average removal percentage of the treatment systems is found to have lying between 20 to 90%. However, the finished water from the household treatment systems have iron and manganese concentration found to be above the WHO guideline value.

This study focuses mainly on the treatment of ground water for other use than that for drinking purpose. That is why the study

does not emphasize on the ultimate treatment of the ground water up to drinking water level standard. However, this study will facilitate to improve the existing household treatment systems to remove iron and manganese.

Out of six different types of treatment systems, only Type-I system with multiple tray aerator and slow sand filter was assessed. A model was developed replicating the field system and little modification were made to incorporate the theoretical aspects of iron and manganese removal. A detention tank was added to Type-I system having multiple tray aerator with bio sand filter. The height of water fall of tray aerator was increased to 1.2m for proper aeration and 5-12 mm aggregates were kept in the tray to expedite the reaction rate by catalytic action of deposited hydrated oxide of iron and manganese on it.

Iron and manganese concentration of raw water and treated water was analyzed in the laboratory with various pH condition and detention time. A detention tank was necessary for effective removal of the iron and manganese. Contact time of 1 hour is necessary to reduce iron concentration to 0.3ppm while contact time of 12 hours is necessary to reduce manganese concentration to 0.05 ppm, without adding lime.

By increasing the pH of water the contact time can be reduced. A trade off between lime addition and detention time can be made for optimum result. The existing household water treatment system can be modified easily and economically to match with the model for higher iron and manganese removal efficiencies.

**Thesis Title: DENITRIFICATION USING SAWDUST AS
CARBON SOURCE**

Submitted by: Tiresh Prasad Khatri

Supervisor: Mr. Ishwar Man Amatya

ABSTRACT:

Nitrate has become a common water contaminant in both industrial and developing countries. Nitrate contamination is increasingly due to the widespread use of fertilizers containing nitrate, and from poorly or untreated human and animal wastes. Consumption of nitrate is considered to be harmful. Two of the most commonly used water treatment methods - activated carbon and water softeners - are ineffective in removing nitrate from water.

Biological Denitrification involves the use of bacteria that can live on nitrate as an energy source. It is a natural process by which specific bacteria turn nitrate into environmentally benign nitrogen gas. This study describes the operational aspects of biological denitrification through laboratory scale experiment. The experiments were conducted in three cycles with fluidized bed reactors using sawdust as carbon source and wood charcoal as media.

The operating conditions and results of this study indicate satisfactory performance in removing $\text{NO}_3\text{-N}$ from the ground water below the permissible level of 10 mg $\text{NO}_3\text{-N}$ in drinking water as recommended by WHO. Up to 99.70% nitrate removal was achieved during the course of the study in the laboratory for a hydraulic retention time of 3.0 hours, loading rate of $4\text{m}^3/\text{m}^2\text{-day}$, at $25\pm 1^\circ\text{C}$. The corresponding effluent ammonia, nitrite-nitrogen and nitrate-nitrogen concentration was 2.19, 2.71 and 0.13 mg/l respectively with the influent concentration of 2.22, 151.27, and 43.68 mg/l respectively. The effluent quality based on other parameters was variable. The treated water showed, rise in total alkalinity, increased turbidity and color and high elevation in COD. No significant variations were ascertained in the pH, and hardness data. Mass balance calculations indicate that carbon consumption during the period of denitrification used was only 9.07 to 10.07% of the initial carbon mass. The results of this study suggest that a biological denitrification using sawdust as electron donor can be used for efficient removal of nitrate from groundwater.

**Thesis Title: REVIEW OF PREDICTION IN EIA FOR
HYDROPOWER PROJECTS IN NEPAL**

Submitted by: Umesh Babu Marahatta

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

Development becomes incomplete without giving priority for the protection of environment. Development without damaging the environment becomes sustainable. EIA is one of the major tools adopted with the aim of making development projects more compatible with environment. It is the process of identifying the future consequences of the current or proposed projects. EIA also provides the different alternatives of the proposed projects and recommends the best alternatives among all of these alternatives.

EIA practice in Nepal is relatively new and yet to be matured in terms of its applicability and effectiveness. Key to the process is the identification of major impact areas and its prediction. Use of prediction tool and quantitative approach lack seriously in the process. Therefore this study tried to evaluate the effectiveness of impact prediction. Qualitative approach used and while

making prediction along with inadequate monitoring data and weak audit report made the study difficult and rather subjective.

Three hydropower projects with low medium and high capacity were selected for this thesis work. The EIA reports along with monitoring and audit reports were analyzed. Based on the EIA, monitoring and audit reports the effectiveness of the impact prediction for the different projects were tabulated. Conclusion and recommendation were given based on the analysis of the three projects and study of various other related literatures.

Construction of hydropower projects involve series of environmental issues like air pollution, noise and vibrations, water quality and quantity, muck disposal and slope stability. For many of the projects it is found that the excavated mucks were not disposed properly leading to the serious slope failure problem and loss of valuable land. For most of the projects no any quantitative measurement were employed for the prediction of impacts, which leaded difficulty for the implementation of the mitigation measures. In Puwa Khola and Kali Gandaki "A" hydroelectric projects, people claimed that blasting damaged their houses. Detail water quality analysis found being done before, during and after construction of the project. The main

non-compliance issue regarding to this is the release of minimum riparian.

The EIA report should try to document the main environmental issues to a quantitative format so that many problems regarding during implementation of the projects can be solved. For the prediction of air quality emission inventory method seems sufficient. Noise can be predicted by equivalent sound level (L_{eq}) and drawing contours showing different levels of sound in the affected areas. Vibration problem can be solved by inspecting prior to the surrounding buildings before and after blasting works. Mass balance approach is found sufficient for the prediction of water quality. For the calculation of the erosion problem USLE is recommended. This also helps to calculate the turbidity level of river.

Thesis Title: REMOVAL OF ARSENIC BY PHOTOCHEMICAL OXIDATION

Submitted by: Chakra Pani Sharma Acharya

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT:

Solar Oxidation and Removal of Arsenic (SORAS) is a simple Arsenic removal process by solar oxidation in the presence of photo catalyst. Previous studies laid an emphasis on the batch system using 1-1.5 liter polyethylene terrephtalate (PET) bottle as the reactor at household level. It is tedious to treat and handle 30 liter of water for a family in 30 PET bottles everyday. The present study developed an appropriate household level model to treat at least 30 liters of water at a time. The model proved very effective in removing iron and Arsenic simultaneously, by photochemical oxidation.

The study showed that 6 to 7 hours exposure period with average UV radiation intensity of 4-6 w/m^2 in the presence of lemon photo catalyst and iron concentration of 5-6 mg/l removes 80 to 90% of Arsenic from ground water. This method is applicable for the reduction of Arsenic concentration from 300-500 ppb to below Nepal interim guideline value of 50 ppb from the ground

water containing excess amount of iron. The good correlation was found between the removal of iron and Arsenic.

The model proposed in this study is an appropriate and low cost technology of treatment method for the removal of Arsenic, iron and pathogens from groundwater at household level. It may be a natural gift for Arsenic havoc people of Terai.

**Thesis Title: EFFECT OF PAPER MILL EFFLUENTS
ON IRRIGATION WATER AND SOIL**

Submitted by: Sanjay Kumar Mishra

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

The pulp and paper industry is one of the leading polluting industries in Nepal. The paper mill wastes characteristically contain very high COD and color. This study mainly focuses in finding the effects of Paper Mill effluents on agriculture. The study area, Everest Paper Mill, is located in Dhanusa Mahendra Nagar at the bank of Bighi River. The majority of wastewater from different manufacturing units is discharged after simple pretreatment directly into the river. Then the same river water is utilized for irrigation through Bighi irrigation project.

Three soil samples from previously irrigated area, currently irrigated and non irrigated area were collected and tested for EC, pH, Ca, Mg, Na, K, N and P. Electrical conductivity and pH in previously irrigated soil sample which used to receive undiluted effluent as irrigation water contained very high values than currently irrigated soil which receives effluent after getting diluted with river water and non irrigated soil. Sodium

adsorption ratio and nutrients (N, P, K) also followed the same trend.

Result of germination index test on fenugreek and bean seed was found better in non-irrigated soil followed by currently irrigated soil than previously irrigated soil. Chemical oxygen demand, EC, pH, Ca, Mg, Na, Cl, N, P and K tests were conducted on effluent and also on irrigation water sample mixed with effluent on the month of Oct and Nov. Results showed that the effluent is not suitable for irrigation purposes directly. However, diluted effluent with river water found within acceptable quality for the purposes. Four-time dilution of effluent showed good results on germination index test. Therefore use of water during rainy season or with appropriate dilution can be used for irrigation. In dry season the conductivity and sodium adsorption ratio were found slightly high in irrigation water. So, in this season only common crops like (paddy, wheat, maize, sugarcane, Jowar) could be grown.

Key words: effluent, chemical oxygen demand, electrical conductivity, germination index, nutrients and sodium adsorption ratio.

**Thesis Title: INTERFERENCE OF PHOSPHATE ON
ARSENIC REMOVAL BY ARSENIC BIO
SAND FILTER**

Submitted by: Jaya Raj Pant

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT:

A laboratory study was conducted to evaluate the performance of arsenic bio sand filter (ABF) under phosphate rich conditions and to evaluate the performances at various filtration flow rates. ABF is designed on the principle of adsorption and filtration mechanism. Ferric hydroxide produced from iron nails adsorbs arsenic in the process. Phosphate being competitive with arsenic for adsorption onto ferric hydroxide, interfere the removal mechanism. Arsenic problem of Nepal is concentrated to Terai region and aquifers of this region are vulnerable to phosphate contamination, mainly due to application of fertilizers and use of detergents. Study was conducted at laboratory of Institute of Engineering with three arsenic bio sand filter models and at field level with one arsenic bio sand filter model. Laboratory study included the testing of forty one sets of water samples with various combination of arsenic and phosphate concentration, eighteen sets of water samples with no phosphate and various

arsenic concentrations and another twenty eight sets of water samples with no phosphate and various arsenic concentrations for various flow rates of filter. Field study included the testing of eight sets of natural water samples with various arsenic concentration and phosphate concentration below 0.5 ppm. The study revealed that presence of phosphate greatly hinders the arsenic removal mechanism. The removal efficiency of ABF was found above 80 percent in each filter when phosphate concentration below 1 ppm and efficiency decreases with increase in phosphate concentration. Arsenic removal efficiency of ABF was found at the range of 15 percent when influent phosphate concentration level is 10 to 20 ppm, which indicates non effectiveness of ABF under such condition. Phosphate concentration below 1 ppm did not significantly interfere the removal process. The optimum flow rate of filter was obtained 15 liter per hour and arsenic removal efficiency significantly decreases above filtration rate 25 liter per hour.

**Thesis Title: REMOVAL OF ARSENIC BY IRON OXIDE
COATED SAND**

Submitted by: Namu Prasad Chaulagain

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT:

Arsenic, a common toxic element is mainly transported in the environment by water. Arsenic in drinking water is of major concern to many of the water utilities in the world. Numerous studies have examined the removal of arsenic from drinking water through treatment processes such as coagulation-precipitation, reverse osmosis and ion exchange.

This research works was carried out to study the Arsenic Removal Efficiency of Iron Oxide Coated Sand (IOCS) from groundwater by using filter column model made of Galvanized Iron (GI) sheet. The model consists of a 200 mm diameter cylindrical column and 380 mm filter height. Study was conducted both in synthetic water as well as in arsenic contaminated natural groundwater of terai tubewell. The experiment on As (III) and As (V) was carried out at 6 l/hr and 10 l/hr flow rate with 212 ppb As concentration in the laboratory using deepwell water of IOE. The flow rate of 6 l/hr and existing

As concentration (86 ppb) was used to study on total As removal efficiency on natural groundwater. About 212 ppb of As was reduced to less than national guideline value of 50 ppb for 400-500 litres of As contaminated synthetic water using IOCS. So far, more than 2600 litres of natural groundwater having influent concentration of total arsenic 86 ppb was treated using the same media.

It has been observed that increase in flow rate increase the concentration of As in effluent. Similarly, the media shows significant effect for treating As (V) containing water than water containing As (III) compounds in term; of quantity of water treated. However, the media is found to be effective for removal of As from natural groundwater of terai treating more and more quantity of water.

Sorption to iron-oxide coated sand (IOCS) is a promising technology for the removal of the dissolved heavy metal from water. Iron Oxide Coated Sand is a medium for use in small systems or home-treatment units in the developing areas of the world, for removing Arsenic (III) and Arsenic (V) from ground water. It is a simple and low cost home arsenic removal unit.

**Thesis Title: PERFORMANCE EVALUATION OF
HETAUDA INDUSTRIAL DISTRICT
WASTE WATER TREATMENT PLANT**

Submitted by: Shalik Ram Paudel

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

Hetauda Industrial District Wastewater Treatment Plant was constructed in technical and financial assistance of Danish Government in 2003-04 and put into operation since December 2003. It consists of series and parallel combination of eleven waste stabilization ponds, as a common treatment plant to HID industries.

The performance of the treatment plant was studied on the basis of water quality-parameters; BOD₅ COD and TSS at the treatment plant laboratory. Performance study (July -November), showed that the plant was running with an average flow of 337m³/day. which is 31% of the design capacity 1100m³/day. It was running with an average load of 341kg BOD₅/day, 41% of the design capacity 840kgBOD₅/day in terms of organic load. Average influent BOD₅-. COD and TSS at the inlet were found to be 1011 mg/l, 1344 mg/l and 412 mg/l respectively. The

average BOD₅, COD ratio was 0.78. This ratio shows that the wastewater can be treated by biological methods.

Average effluent quality parameters in terms of BOD₅, COD and TSS were found to be 43 mg/l, 245mg/l and 211mg/l respectively. Though, average BOD₅ and COD values are below the maximum limits, these are not sufficient to meet the present Nepalese Effluent Standards. On statistical basis, not-to-exceed limits specified in the Nepalese Effluent Standards: BOD₅ (50 mg/l) and COD (250 mg/l) were found to be achieved within 58 percent and 40 percent confidence limits respectively. The TSS criteria of 50mg/l (maximum) have never been achieved.

Management of odors and control of insects were found to be the major issues for long-term sustainability of the treatment plant. Since the treatment plant is not operated to its full capacity and pre-treatment systems are not established by industries the real scenario of the plant is not clear yet. To improve the quality of effluent further and to manage the odor problem, (a) construction of a sludge digester (b) covering of anaerobic ponds (c) conversion of the treatment plant to a dual-powered flow-through lagoon system and (d) conversion of few sludge-drying beds to constructed wetlands for polishing the effluent can be some of the possible options which need further study.

**Thesis Title: SURVIVAL GROWTH AND
REPRODUCTION OF EISENIA FETIDA
DURING DEGRADATION OF DRIED
HUMAN FECES**

Submitted by: Hari Sharan Bhandari

Supervisor: Prof. Dr. Vinod Tare

ABSTRACT:

In traditional sanitation system human excretions, particularly urine and feces, are generally collected and transport from the point of generation to the point of treatment and/or disposal using huge amount of safe drinking water which pollute the downstream water bodies and failed to complete the resource loop. Ecological sanitation is one of the solutions to overcome the problem of water crises, downstream water pollution and nutrients recycle. Eco-San Prevent disease. Protect the environment, return nutrients, culturally acceptable, reliable and convenient.

Vermicomposting of dried human feces could be a viable option as the effect of the composting worms' community on the composting process has been remarkable. Compared to conventional composting, the vermicomposting is the rapid process to higher potential for pathogen reduction that requires

less energy and care. It produces homogeneous and more aesthetic product i.e. vermicompost. The vermicompost holds nutrient over a longer period without impacting the environment. However, not much work has been done to explore this concept and the feasibility of using earthworms (composting worms) in processing human excreta is yet to be demonstrated. It is to satisfy this end that the research work described in this paper was initiated.

There is no chance of survival of earthworm in human dried feces fed vermicomposter due to presence of ammonia and heat generation in rehydration process. These substances are objectionable to earthworms and may cause mortality. This research attempts to find the survival growth and reproduction of composting worm in dried human feces vermicomposting, with different combination of material.

Experiments were done on laboratory scale in the transparent bins of diameter 18 cm and 9 cm depth. The exotic species *Eisenia Fetida* and indigenous species *Pheretima posthuma* were used in the experiment. Soil or sand layer was provided for worms to protect from adverse environmental condition. Diversity and enrichments of the microbial population in the bins was facilitated by applying vermicompost. The experiment were conducted considering fifteen different sequences of the material soil (S) or sand (Sd), vermicompost (V), and dry feces (F). This

research incorporated the dry feces loading 100g in each bins (for 28 days), and worms stocks are 8 number in 13 bins, 14 number in one bin and 8 number of *Pheritima posthuma* in one bin. The dry moist feces applied in three different ways - at the center, along the periphery and scattered in many small lumps in the experimental bins. It was observed that after initial acclimatization period the earthworms could process the material and make compost. The survival of the earthworm more than 90% in different sequence of layer combination and the individual mass growth rate in the range of 269.72% to 634.94% was observed in case of *Eisenia fetida* when VFS, VSF, FVS, and SVF combination of material used. The maximum ranges of cocoons production in 45 days obtain 5.28 to 6.23 per worm and maximum hatchling production in reloaded sets obtained 14.6 per worm. Overall the study reveals that *Eisenia fetida* survive growth and reproduce in human dried feces, that the vermicomposting may prove to be a viable option for stabilization of human feces.

**Thesis Title: AN APPLICATION OF HELP MODEL FOR
WATER BALANCE AND LEACHATE
PRODUCTION STUDY OF GOKARNA
LANDFILL SITE**

Submitted by: Suresh Mahaju

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Water management in sanitary landfill in sub-tropical countries is utmost important. In the case of Gokarna landfill site where there is no leachate pond to collect and treatment of leachate, it is very important to minimize the leachate production so that its ill effect to the ground water be least. For this the water balance study is essential with different options on leachate minimizing factors. The HELP model, computer software is very helpful in the water balance study because it permits different options to play along with different parameters for the best result.

The water balance study of Gokarna landfill site was done with the application of HELP model (Hydrologic Evaluation of Landfill Performance). GL site is a completed landfill; hence there are limited options on minimizing leachate production economically. The model has been applied and basic

understanding of the leachate production in terms section devised and the effect of various parameters of the components on water balance have been studied. Leachate generated in the landfill and its response to the cover soil thickness as well as the intermediate drainage system has showed that need of leachate management based on the quantity produced.

The study showed that control of leachate production could be done with ease, even during postoperative activities. It showed how importance the inclusion of geomembrane, however it may be 500 micron HDPE sheet with intermediate drainage network in minimizing leachate production. The HELP model is very sensitive to certain input parameters such as hydraulic conductivity, runoff curve number and evaporative zone depth. However a good estimation of leachate production on long-term basis has been found effective to suggest the controlling measures for leachate production.

**Thesis Title: SEMI-CONTINUOUS SYSTEM FOR
SOLAR DISINFECTION OF WATER**

Submitted by: Surya Raj Kadel

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

Solar Disinfection (SODIS) is a simple water treatment method using solar radiation to inactivate pathogens commonly found in contaminated drinking water. This technology involves simply filling transparent PET bottles with contaminated water and exposing them to direct sunlight. Previous studies laid an emphasis on the batch system of solar disinfections using 1-1.5 liter PET bottle as the reactor. Though there was not any socio-economic study for the adoption of this technique in the society, it is considered to be time consuming and tedious for the communities. A new system of disinfections, semicontinuous system for solar disinfection, has been developed based on the continuous flow of contaminated water throughout the exposure period of sunlight but the treated water is available only after the required exposure period in the same quantity as that of raw water. The experiments were conducted with the model size designed for meeting two-day average drinking water demand for a single family of size six. The hourly survival rates of fecal

coliform were observed along with the hourly recordings of UVA radiation, pH, and ambient temperature. Experiments were conducted by using the actual size model in November, December and January 2004 with different contamination levels of water. The sample water (piped water supply by Nepal water supply corporation with sufficient iron content) was artificially contaminated by adding 1 to 1.5 litres of Bishnumati river water with sewage contamination.

The study showed that 10 hours exposure of sunlight with 4.3 W/m^2 Ultraviolet radiation intensity (UVA) or 585 W/m^2 solar radiation intensity was necessary for the complete removal of fecal contamination of 30 litres water. The flow rate of 6 l/hr for 6 hours continuous exposure per day was found as the optimum condition for treating 30 litres of contaminated water.

When hot water from solar panel of temperature ($< 34^\circ\text{C}$) was fed to the reactor, there was not increased in temperature enough (50°C) for the synergistic effects of temperature and UV. It was found that there was no further improve in inactivation rate of fecal contamination. So the connection of solar panel with the system for feeding heated water is no more advantageous in the winter season.

Experimental model was found optimal for treating 30 liters of water in 6 l/hr flow at the rate of six hours exposure period per day for the continuous exposures of ten hours. The inactivation kinetics was formulated as $S=100e^{-0.147IT}$ for the removal of fecal coliforms under the optimal conditions of study.

A comparative analysis showed that semi-continuous systems is better than batch system in terms of cost, space requirement and time value.

**Thesis Title: KNOWLEDGE, ATTITUDE AND
PRACTICE ON ECOLOGICAL
SANITATION TOILET AMONG THE
COMMUNITIES IN NEPAL**

Submitted by: Ganesh Bahadur Thapa

Supervisor: Mr. Mukunda Prasad Neupane

ABSTRACT:

The ecological sanitation, which is economically feasible and environmentally sustainable based on, a close loop approach is promoting in different parts of the world. In that connection, the double vault urine diverting toilet, one of the options of Ecological sanitation toilets, had constructed in different peripheral communities of capital city. The beauty of EcoSan toilet is assessed in terms of social acceptance in this study. Eighty-two EcoSan toilets and same number of households in control area are taken for the study. The settlements in control areas are fixed adopting stratified sampling technique. The households in the control area and respondents in the study areas are selected adopting random sampling technique. The field staffs/motivators, household and direct observation are main sources of primary information. Check list, household questionnaire, interview schedule, interview, direct observation,

technique of scaling are the main instruments used in the study. Out of ninety, only eighty-two toilets including one self-constructed is found functional. The knowledge and attitude are found promising but practice is lagging behind especially in the liquid separation and urine use as manure. EcoSan toilet is found superior to conventional options of sanitation in terms of cost, social and technical acceptance, and environmental benefit. Moreover, acceptability is found higher in agro-based settlements due to its manure value and also suitable in low land settlements, because of its water tightness of collection tank and constructed above the ground. In the same way, it is found accepted as improved approach over their traditional unhygienic practice of defecation. Self-modification in design and construction incorporating "Naugal" with EcoSan, its replacement in some cases, and use of the unit constructing inside the dwelling with satisfaction can be taken as an evidence of cultural acceptance. Non-parametric test is performed considering different associated parameters of toilets. The result of test is found significant. However, few of the respondents are found reserved toward acceptance of EcoSan toilet. It is due to constructional defect, shortcoming in design, mishandling of units etc. We need additional efforts for massive replication, addressing such reservation, correcting defects and exploring benefits.

**Thesis Title: EFFECTS OF FEEDING HUMAN FECES
ON THE SURVIVAL, GROWTH AND
REPRODUCTION OF EISENIA FETIDA**

Submitted by: Deepak Puri

Supervisor: Prof. Dr. Vinod Tare

ABSTRACT:

Human excretions, particularly urine and feces, are generally collected and transported from the point of generation to the point of treatment and /or disposal using water. This practice has led to (i) exploitation of limited fresh water resources for domestic uses, (ii) consumption of energy for degradation of organics, (iii) most unfavorable conditions for microbial yield and nutrient recycling, (iv) leakage of nutrients through surface runoff or water percolation resulting in degraded lands for agriculture and contamination of water resources, (v) additional power consumption, depletion/degradation of natural resources, and (vi) additional pollution problems to compensate nutrient loss through application of fertilizers.

Eco-sanitation uses the concept of minimum water use for collection and transport of human excretions and visualizes processing of organics in moist solid medium. Traditional

composting methods, as a terminal step in processing organics and recycling nutrients have several limitations. Composting with earthworms had always seemed a good idea, yet use of earthworms in processing human excreta is a matter of concern.

Vermicomposting of human feces could be a viable option as the effect of the redworm community on the composting process has been remarkable. Compared to the conventional microbial composting, the vermicomposting is a rapid process with higher potential for pathogen elimination that requires less energy input and care. It produces homogeneous and more aesthetic product i.e. vermicompost. The vermicompost holds nutrients over a longer period without impacting the environment. However, not much work has been done to explore this concept and the feasibility of using earthworms in processing human feces is yet to be demonstrated. It is to satisfy this end that the research work described in this thesis was initiated.

There are chances of no or less preference of earthworms to human feces due to presence of volatile organics and ammonia. These substances are objectionable to earthworms and may cause mortality. This research attempts to find out feasibility of feeding source separated feces to earthworms and its effects on their survival, growth and reproduction.

The experiments were carried out on laboratory scale in the transparent plastic bins of diameter 18 cm and depth 9 cm. The exotic species *Eisenia fetida* and indigenous species *Pheretima posthuma* were used in the experiments. Diversity and enrichment of the microbial population in the bin was facilitated by applying vermicompost. The experiments were conducted in three phases (i) preliminary, (ii) detailed, and (iii) post-experiment. The detailed experiments were conducted considering fifteen different sequences of the materials - soil or sand, vermicompost and fresh feces. The feces as feed stock were provided in a single batch for entire experiment period. It was observed that after initial acclimatization period the species *Eisenia fetida* could process the material. The average survival rate of the species *E. fetida* was more than 90% in VSF, FSV, FVS, FV, SFV and SVF combinations. These combinations also demonstrated good result in the individual worm-mass growth. But in terms of cocoon and hatchling productions, VFS, FVS, FV and SVF yielded good results. Among all the combinations provided, FVS, FV and SVF combinations appeared to be the best for the survival as well as growth and reproduction of the species *Eisenia fetida*. Overall, the study reveals that the processing of human feces is feasible employing earthworms. This possibility may prove to be a viable option for stabilization of human feces.

**Thesis Title: STUDY OF WATER CONSUMPTION
RATE AND PATTERN IN TYPICAL
TARAI - TOWN (A CASE STUDY OF
KAKARVITTA WSSP AND
SANISHCHARE WSSP)**

Submitted by: Nanda Lal Banjade

Supervisor: Mr. Mukunda Prasad Neupane

ABSTRACT:

The population in the newly developed urban centers has been increasing rapidly in the past Decade mainly due to rural migration. As a result, growing small towns are facing inadequate water supply. Small Town Water Supply and Sanitation Projects are being launched to address the water demand of such towns.

The inadequate water supply and sanitation systems in these newly formed small towns have adversely affected the quality of life and health condition of the people. However, the water consumption rate and the pattern in such emerging towns have not been studied yet.

The study of water consumption pattern and rate of water demand in typical Tarai towns like Kakarvitta and Sanishchare has been done. The first town has almost no alternative source of water except the supply from the Kakarvitta Water Supply and Sanitation Project, but the latter one has shallow tube wells and dug wells as conventional alternative sources. Both projects have continuous supply system with adequate supply of water.

In Kakarvitta, monthly water production records and the monthly meter reading records of the last two fiscal years were compared to assess the unaccounted for water. To analyze hourly consumption pattern and the peak factor, the hourly supply was recorded from the bulk meter in both the projects.

To find out the average consumption rate in both the projects, the consumption of the month of *Bhadra-2060* was timely and precisely recorded. During this recording, the numbers of consumer in that month, their ethnicity and plumbing status were also noted down for each household.

For the sample study. In Kakarvitta, 120 residential consumers were selected. The socio-economic status, family size, plumbing facilities etc of those users was determined by the socio-economic survey. To assess the influencing parameter, the water

consumption rate against these social parameters were calculated and analyzed. Three Hourly meters reading for about 12% of total households were recorded for a week. The data were used to determine the water consumption pattern of different category of users (Residence, Lodged, School etc) and daily fluctuation of use of water.

It is found that considerable amount of water was consumed during early morning and late evening hours in case of continuous supply through house connection. As a result, the peak consumption in such systems was found lower compared to intermittent supply system through community taps. Daily and seasonal variations of water consumption rate are significant and should be taken into account for design purpose. Plumbing system and sanitary facilities were found the most influencing factor in water consumption rate. People, in general, are not inclined to conventional alternate sources for domestic use as long as there exist enough supply of piped water at a price that only meets the cost of operation and maintenance.

A well-managed water supply system with negligible unmetered supply points can limit the unaccounted for water maximum up to 15%. The mean value of water consumption rate, in the month of this study, has found as 86 and 100 Lpcd in Sanishchare and

Kakarvitta respectively. Incorporating the seasonal variation, overall Lpcd as 125 and overall peak factor as 2.3 are suggested for design purpose.

**Thesis Title: STUDY OF WATER CONSUMPTION AND
CONSUMPTION PATTERN IN TYPICAL
RURAL WATER SUPPLY SCHEMES OF
NEPAL**

Submitted by: Narayan Bahadur Shrestha

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Safe water to drink is one of the most basic of human needs. Access to water and sanitation plays a crucial role in the overall social and economic development of a community. Therefore, this sector should be given a high priority for development, in a sustainable and socially acceptable manner, with the use of appropriate technologies. Women in particular are often deprived of opportunities to engage in income generating activities because of the need to spend hours in fetching water. A minimum of 30 per cent of the total time saved could be used for other economically productive activities. Per capita water demand and consumption pattern are the concern issues and to be reviewed due to the changed social status and economic activities of the present scenario.

In this research work water consumption and consumption pattern in selected rural hill schemes and rural terai schemes are

studied. All the selected schemes are continuous supply systems and gravity systems. For analyze the hourly consumption pattern and peak factor, the depth of the service reservoir was measured for seven days at the interval of two hour from 5 a.m. to 7 p.m. The socio-economic survey was also conducted among 25% households of the communities and determined the household size, literacy rate, ethnicity and occupation of the communities. The socio-economic data was also used to determine the water consumption pattern for different purposes.

It is recorded that in well metered water supply system such as Laxmibazar, the minimum consumption is in June/July (1514 m^3 /month) due to the sufficient water nearby the community in rainy season. Similarly, the maximum consumption is in February/March (2282 m^3 /month) as there will be no alternative sources in this season. From the study the average hourly peak factor was calculated 2.6, in compare the present practice of 3 which is less than the guideline value. Hence, the reduced hourly peak factor can help to reduce the cost of the schemes.

From the study it is also concluded that peak hour in all the schemes are in 5 to 7 a.m. except in Dhaneswor w/s scheme of Terai where the peak hour is in 3 to 5 p.m. due to the hot climate of the Terai. From the study, it has been established that the overall mean value of water demand in the six schemes ranges

from 54 to 61 liters per capita per day (Ipcd) consumption in compare to the present practice of 45 Ipcd. The weighted average is also calculated 58 Ipcd. So the per capita consumption for the studied rural communities are recommended to be 60 Ipcd.

The socio economic study also revealed that maximum quantity of water (27%) has been consumed for domestic purpose (cooking, drinking and washing dishes) while the minimum (8%) has been consumed for latrine cleaning. The study also concluded for the location having inadequate source of water, having other source of water near by for washing, bathing and livestock can be design for only 25 Ipcd which is also sufficient to meet domestic demand. Based on this preliminary investigation and research, further study is recommended focusing the seasonal demand, daily demand, socio-economic activities, health and sanitation behavior, and livestock needs etc for considering different geographical regions and socio-economic set up.

**Thesis Title: PERFORMANCE EVALUATION OF
KODKU WASTE STABILIZATION POND
AT BALKUMARI**

Submitted by: Pradip Kumar Mudavari

**Supervisor: Mr. Mahesh Prasad Bhattarai, Mr. Mukunda
Neupane**

ABSTRACT:

It is ironical that only 5% of the world's wastewater ever receives treatment. In developing countries, least priority is given to the treatment of wastewater. In the past, with the financial and technical assistance of donor agencies, some waste stabilization ponds were installed in Kathmandu valley. The Kodku WSPs at Balkumari, Lalitpur was selected for the study. The objective of this study was to evaluate the performance of Kodku WSPs at Balkumari.

The Kodku WSPs is in operation since 1982. During the study period the system was treating average flow of $3353 \text{ m}^3/\text{d}$ with population equivalent of 20,700. The system consists of two parallel primary ponds connected to secondary and tertiary ponds in series. Samples were collected at the interval of six hours and the flow rates were measured at the interval of three hours. Major

selected parameters were Biological Oxygen Demand, Chemical Oxygen Demand, Total Solids, Suspended Solids, Dissolved Oxygen, TKN, Ammonia and Nitrate.

Experimental investigation revealed that despite poor operation and maintenance, organic and solid removal efficiencies were not poor. The average BOD₅, COD and SS removal efficiencies were 84.9%, 82.7% and 89.7% respectively. The concentration of NH₃-N and organic nitrogen in effluent was increased by 9.9% and 52.4% respectively compared to influent concentration.

The operation cost of the pond system was found to be minimum compared to Oxidation Ditch and Constructed Wetland. Although the Kodku WSPs is about 22 years old, its removal efficiency and effluent qualities were comparable with Oxidation Ditch. Financial comparison revealed that WSPs is the simple, cheap and reliable option if land is available.

**Thesis Title: STUDY OF AMMONIA RELEASING
PROCESS IN DEEP WELLS OF
KATHMANDU VALLEY**

Submitted by: Ram Chandra Shrestha

Supervisor: Mr. Mahesh Bhattarai

ABSTRACT:

A study was carried out to assess the extent of ammonia pollution and identify the probable mechanisms associated in Kathmandu Valley. The Groundwater system in the Valley comprised of three zones. Groundwater samples were collected from 5 deep tube wells of central part and 4 wells of northern part of the valley. NH_4^+ , Fe II, HCO_3^- , COD, Electrical conductivity (EC) were measured in IOE laboratory, Pulchowk. Phosphate, NO_2^- , NO_3^- , Mn were measured in the CEMAT water laboratory, Kathmandu. Temperature, pH, oxidation reduction potential (ORP) were measured in the collection sites. Secondary bore log data were used for the geological investigation of 18 wells from central and northern parts of the valley.

Statistical analysis of relevant water quality parameters was made based on the laboratory data. Very high concentration of ammonia, iron and manganese, low nitrate values and negative

redox potential indicated that reducing chemical reactions prevail in the aquifer. Strong positive correlations of ammonia with HCO_3^- , COD, EC, PO_4^{3-} , Fe II, and Mn II was observed. Geological study showed that higher ammonia concentrations are associated with the higher well depth and thick clay and clay containing layers at the top or in between the aquifer. Central part of the valley has higher ammonia concentration which is supported by the suitable geological formation.

These results lead to the conclusion that the central aquifer is severely polluted with ammonia resulting from the microbial oxidation of sediment organic carbon which is a major constituent of lignite layer. The microorganisms convert ammoniacal nitrogen into ammonia in the reducing environment. Well water from northern part has less concentration of NH_4^+ because it has no suitable geological formation containing sufficient organic and nitrogenous materials essential for redox process. This study suggests that a concentration mapping of ammonia be developed in order to investigate further and mitigate the impacts associated.

**Thesis Title: ENVIRONMENTAL MANAGEMENT
SYSTEM IN HEALTH CARE FACILITY
AN APPROACH TOWARDS ISO 14001 (A
CASE STUDY OF KANTI CHILDREN'S
HOSPITAL)**

Submitted by: Sano Kaji Karkee

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Medical waste management in Nepal is poor and unsafe. In Kathmandu valley per day 1189 kg of medical waste is produced. 90% of health care facilities are dependent on municipal container and municipal sewer.

This thesis is focused on environmental issues of Kanti Children's hospital (KCH). During the study period strategy of working as a volunteer engineer in engineering section helped to collect the authentic information and get an insight into various environmental aspects of KCH.

It was observed that waste management is the major concern in KCH. Lack of regulation, monitoring and cheap transportation cost is the major promoting factors for prevalence of unsafe

waste management. National guideline prepared by NHRC is the only obligatory document on HCWM. Ministry level decision on dissemination and implementation of guidelines is made on 2059/3/5. and circulation of it is done by MoH by a letter of reference number 93, dated 2059/4/7. Kanti children's hospital was not following the guideline during the study period.

None of the prevailing law and regulation of Nepal regulates for management of medical waste. KMC is collecting all types of waste for NRs. 750 per ton. Disposal cost of medical waste in USA is \$650 per ton. Promulgation of workable and protective regulation is urgent to protect the environment and public health.

Incinerator installed in KCH was idle for a longer period of time, evidence of syringes with needle and infectious waste in the premises is common, and storage area located proximity to water supply system is breeding site for vector insects, birds and money earning field for scavenger. Water and energy consumption is high, wastewater is directly disposed to water body.

After identification and evaluation of environmental impacts, an effective and workable EMS is designed for KCH, which is compliant to ISO 14001.

First auditing result of KCH is encouraging. Finally, success of EMS depends on employee's participation, commitment of top management and persistence in the improvement process. KCH has strength and infrastructure; this potential if used in a structured manner accreditation of ISO 14001 is not impossible. Lets hope and wish that KCH be the first ISO certified hospital in Nepal.

**Thesis Title: POST CONSTRUCTION EFFECTIVENESS
MONITORING OF MITIGATION
MEASURES AS CONTAINED IN EMAP
FOR UP GRADING OF GORUSINGHE -
SANDHIKHARKA ROAD PROJECT**

Submitted by: Sharad Raj Shrestha

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Although roads are meant for the economic development, there are various types and degrees of environmental problems associated with their construction. These environmental problems are not only associated with the physical environment but also related to biological, social, cultural, and sometimes archaeological. Landslides, slope failures, soil erosion, loss of agricultural and forest land, and sedimentation into water bodies are some of the negative impacts of road construction that in some cases negates the objective of the development project.

Gorusinghe - Sandhikharka road forms a part of the upgrading (from earth to fair weather gravel roads) component of RMDP Project, HMG/N that offers safeguard to avoid or to mitigate negative impacts. Accordingly, Environmental Management Action Plan (EMAP) based on Initial Environmental Assessment

(IEE) was made mandatory as a part of the contract document for the enforcement of mitigation measures to minimize environmental impact during implementation of the project. As the Project is nearing to its completion phase, this study has been conducted to evaluate the degree of effective implementation of mitigation measures. Since the project is the first to incorporate the environmental aspect, we cannot expect perfect implementation but it is necessary to measure the effectiveness of the mitigation measures so that the experience could be applied to future activities of the same type.

Road construction involves series of environmental issues and spoil and construction waste disposal is above all of issues of the hill road construction where hill slope failures are the common occurrences. These have much more implication on the environment than any other issues and unfortunately this particular issue was found neglected by the performer. The Contractor responsible for implementation has sincerely expressed their inability to perform efficiently due to cost factor. Haphazard side casting was noted throughout the alignment and as a result, smothering of vegetation and topsoil on the valley side was immense causing scouring, erosion, slides and littering to high value and agricultural land at several locations. The emerging landslides were also identified by the Project Manager and realized that they occurred due to lack of environmental

management. The correct and efficient disposal of spoils into nominated sites would have little or no such environmental implications.

The contractual inclusion for the cost of mitigation measures in the project has been provisioned to be inclusive in the rates quoted by the contractor for road works in the Bill of Quantities. The contractor in an attempt to be competitive may not have increased their rates to a realistic level to adequately fund environmental mitigation and protection and thus have lacked in implementing mitigation effectively. This denotes that the cost for environmental mitigation should be visible and accountable to ensure that environmental management is not lost in material supply or labour rates that do not adequately reflect realistic environmental compliance costs. The study elaborates that no matter how practical and correct is the recommended mitigation measures, its proper arrangement in the project design for its implementation plays a vital role for the performers to perform comfortably to obtain an effective result.

Graduation Year 2005

**Thesis Title: EFFECT OF EFFECTIVE
MICROORGANISMS ON ORGANIC
KITCHEN WASTE COMPOSTING**

Submitted by: Gopal Prasad Neupane

**Supervisor: Mr. Padma Sunder Joshi, Mr. Sur Yug
Prasad Yadav**

ABSTRACT:

The composting bin with Effective Micro-organism (EM) are in use in urban area which is rising as an alternative technology for the reduction of kitchen waste at the source and the end product can be used as a manure can be used. It is an odorless process and very much suitable for kitchen waste.

In this context, it is worthwhile to determine the effect of varying doses of EM (10, 30, 50 ml. per Kg waste) in kitchen waste composting. The materials used for studying the EM composting process included organic fraction of kitchen waste and EM-2 solution. C/N ratio is adjusted to 20. This study was carried out in the condition as practiced in household level. The adjustment is only done to enhance process. The highest mean temperature

reached in the range of 15.5 to 15.67°C on day 14 and decreased gradually there after and then followed ambient temperature. The germination index reached 90.56 to 91.32 in different bins of EM treated and 76.88 in non-EM treated composting on day 92. The variation is not so significant among different in EM treated. The case of pH is almost same for all bins. The carbon dioxide evolution rate (CER) of composting with the application of EM was found smaller than without EM treatment. The maximum CER was measured as 10.84, 10.92 and 10.86 in EM treatment process on day 22 against 14.36g per kg per day in non EM treatment respectively. Initially CER increased and started decreasing after reaching maximum value on day 22.

The nutrient (NPK) is with in the range of general composting. EM application did not increase nutrient content but increased the quality of compost.

Although the applied doses are different the result is same. The variation in doses did not show any significant effects on the process. It is not necessary to use high doses for fast composting. EM treatment is found effective rather than non-EM treatment but result obtained is same of all different doses.

**Thesis Title: A CASE STUDY OF HEAVY METAL
REMOVAL EFFICIENCY OF
CONSTRUCTED WETLAND**

Submitted by: Nagendra Raj Sitoula

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

Wetlands are transitional areas between land and water. Wetlands, both natural and constructed, are those land areas where the water surface is near (above or below) the ground surface to produce saturated soil conditions and support plant life. Importance of wetlands is not recognized, but now a wetland is assumed as a natural kidney, purifier of anthropogenic as well as natural waste water. In my research, two pilot scale constructed wetlands were studied to evaluate the heavy metal removal efficiency at various concentration levels in influent. CW is designed on the principle of adsorption and plant uptake mechanism. Study was conducted on existing constructed wetlands built and operated by ENPHO and BASP. The former one is VFB and later one is HFB. Similarly CW of ENPHO is intermittent flow system and CW of BASP is continuous flow system. Laboratory study included the testing of heavy metals (Cr and Ni) at varying concentrations. The concentration level

varies from 2.54 and 2.49 mg/l to 150.4 and 160.5 mg/l for chromium and nickel respectively. The study revealed that HFB and VFB have remarkable heavy metal removal efficiency. The removal efficiency of CW was found above 80 percent in each bed. Study shows the removal efficiency of CW was found good even in the higher level of influent concentration. Therefore, constructed wetland can be very effectively used to remove heavy metal from waste water.

**Thesis Title: PERFORMANCE EVALUATION OF
 SUNDARIGHAT WATER SUPPLY
 SYSTEM**

Submitted by: Bal Chandra Shrestha

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT:

Sundarighat Water Supply System is in operation since 1971. The plant treats about 3 Mid water in the wet season and 2.71 Mid in average. The major components of the system consists of intake, collection chamber, treatment plants with coagulation and sedimentation tank, slow sand filter, pressure filter and chlorination unit, distribution lines to Balkhu, Kuleshor, Kalimati and Ravi Bhawan. Performance of this system was evaluated from June, 2005 to November, 2005 by observation, measurement and analysis of the major components of the system, water quality parameters such as turbidity, color, total iron, manganese, ammonia-nitrogen, hardness, alkalinity, and total coliform. The average treated water production is 2.71 Mid and supplied to the total area of 206.48 ha of ward 12, 13, 14 of Kathmandu and ward 2 of Lailtpur with the supplement of Kuleshor well groundwater to fulfill only 19% of present water demand. The existing system has no properly planned

distribution system and some of the treatment units are not in operation.

The maximum, minimum and average value of turbidity of treated water was found to be 17, 3 and 5.3 NTU respectively. The average concentration of total iron was 0.34mg/l in treated water. pH and alkalinity of raw water was in the range of 7.26 to 8.2 and 56 to 141mg/l respectively. Raw water contained 180+ No/100ml total coliform and no fecal coliform was detected. Residual chlorine and total coliform in CWT were between 0.1 to 0.25 mg/l and nil respectively. In overall evaluation, most of the parameters except turbidity during rainy season and total iron were found within the range of WHO guideline value. The groundwater from Kuleshor well was found rich of ammonia-nitrogen, iron and alkalinity with the concentration of 173mg/l, 3.9 mg/l and 382mg/l respectively and distributed without treatment. Total coliform were found in some distribution points due to the post contamination. The pipe networks are not capable for conveying water to fulfill the future demand in 2015. Maximum numbers of households do not have required quantity of water with irregular schedule of supply and low residual head.

Frequent desludging of collection chamber, sedimentation tank, increase in inlet weir length with baffle height of sedimentation

tank, proper and timely backwashing of filters, operation of slow sand filter with design loading rate, correct dosing of alum, chlorine, addition and replacement of pipe for efficient distribution of water are recommended for the improvement of the system.

**Thesis Title: PERFORMANCE EVALUATION OF
HORIZONTAL BED SUBSURFACE FLOW
CONSTRUCTED WETLAND WITH
DIFFERENT MEDIA**

Submitted by: Dharmendra Kumar Jha

Supervisor: Mr. Manoj Kumar Pandey

ABSTRACT:

In developing countries, like Nepal, the majority of the water pollution problems are created by direct disposal of untreated wastewater into the water bodies. As emphasis is usually given to develop infrastructure, most of the pollution problems remain unaddressed. Main Objective of this research was to evaluate the performance of Horizontal Bed Sub Surface Flow Constructed Wetland with two different media; Gravel from river bed and Marble Chips. Also one bed was kept blank with gravel media in order to compare the efficiency of media only i.e. without plants. The study was carried out in existing pilot scale constructed wetland reed beds viz. Marble bed, Gravel Bed and Blank Bed with gravel media located in the premise of Bagmati. Area Sewerage Project (BASP). Removal of various impurities like TSS, BOD, TKN, NH_4N , TP, and EC has been seem to be more in marble media than gravel media. The BOD in influent of

Marble Bed has been found to vary between 620 to 855 mg/l with an average value of 753 mg/l. The BOD in effluent has been found to vary between 110 to 400 mg/l with an average value of 280 mg/l. The marble bed has been observed to efficiently remove BOD, EC, TSS, TKN, NH_4N and TP upto 62.8, 22.3, 60.5, 37.53 and 40.5 percent respectively. The BOD in effluent of Gravel Bed has been found to vary between 310 to 650 mg/l with an average value of 442 mg/l. The Gravel bed has been observed to efficiently remove BOD, EC, TSS, TKN, NH_4N and TP upto 41.2, 14.3, 43, 20.7, 38.6, and 28.3 percent respectively. In reed bed plants help to remove the impurities by means of up taking Nitrogen, Phosphorus and Potash for their growth and also release oxygen through photosynthesis and some oxygen escapes through roots during respiration. The main reason for the difference in performance of Marble and Gravel Bed with plants is variation of growth of rhizomes inside the bed. There was more intrusion of roots inside the voids of marble media than in gravel media. As a result of which more nutrients were up taken by plants in marble bed than in gravel bed and also more oxygen was released from the roots and macrophytes of marble bed than gravel which in turn enhances the microbial activity. As there was presence of more fines in gravel bed due to which there were less growth of rhizomes in gravel bed than in marble bed. As from the analysis, the porosity of gravel media

was 36.6% only, whereas that of marble media was 43.2%. Also the hydraulic conductivity of the gravel media was 2.9×10^{-2} m/s whereas that of marble media was 3.22×10^{-2} m/s respectively. It means there was less blockage of wastewater flow in marble media than in gravel media. With increase in porosity hydraulic retention time increases, which means for the same flow useable volume for the microbial activity was more for marble bed than in gravel bed. Also from the graphs, it clearly seems that with decrease in discharge i.e. increasing hydraulic retention time the efficiency of the bed regarding pollutant removal was increasing in marble media than in gravel media. The Blank Bed with gravel media has been observed to efficiently remove BOD, COD, EC, TSS, TKN, NH_4N and TP upto 36.9, 59.9, 9.4, 38.6, 17.6, 34.6, and 19 percent respectively. There was very slight difference in removal efficiency of pollutants in gravel bed with plants and blank gravel bed without plants. There was less intrusion of roots inside the gravel bed with plants due to the presence of more fines in media. Due to which not enough oxygen was present in the bed for degradation of organic matter aerobically.

**Thesis Title: EFFECTS OF VENTILATION ON INDOOR
AIR QUALITY IN KATHMANDU VALLEY**

Submitted by: Dinesh Prasad Bhatt

**Supervisor: Dr. Bal Krishna Sapkota, Er. Chiranjibi
Gautam**

ABSTRACT:

Indoor Air Pollution is one of the major causes of death and diseases in the world's poorest countries. Air Pollution inside homes is associated with around 1.6 million deaths per year in developing countries. Results from past studies, comparing concentrations in various indoor locations show highest peak concentrations in kitchens. Indoor concentrations of various contaminants emitted from fuel combustion depend on indoor emission rate, air exchange rate, and room volume.

This thesis focused on the effect of ventilation on indoor air quality of kitchens. This is extended to find out status of indoor air quality of different kitchens in Kathmandu Valley.

Results show that particulate matter concentrations are higher in indoors than that in outdoors. The indoor/ outdoor pollutant ratio is found to lie in between 1.14 and 1.2 and with average of 1.17.

Natural and forced ventilation plays an important role to disperse pollutant from kitchen. In the model kitchen of 3m x 3.3m, the ventilation coefficient 0.03 reduces pollutant level below national ambient air quality standard (NAAQS) for LPG stoves while for kerosene stoves even ventilation coefficient 0.15 cannot reduce its maximum concentration below ambient air quality standard. Exhaust fan can reduce TSP concentrations below NAAQS for both type of fuel.

Survey results of 10 kitchens of size between 9 to 12 m² with 4 to 6 occupants in residential area Kupandole of Kathmandu valley using LPG show that the maximum TSP concentration lies in between 381.48 to 1229.71 $\mu\text{g}/\text{m}^3$ which is higher than the standard value 230 $\mu\text{g}/\text{m}^3$. Although there is provision of proper ventilation in the kitchen but in absence of awareness or other causes, people are not using these existing facilities in proper manner. Comparing present cost, LP gas seems costly than kerosene but for long run LPG options are better at the time of difficulty to move towards electric option.

To improve Indoor Air Quality in kitchens interventions to be carried out are: I) Application of building codes with consideration of indoor air quality and provision of exhaust fan.

II) Raising awareness about Indoor Air Pollution among public.

III) Government policy to influence public towards cleaner fuel.

**Thesis Title: HETEROTROPHIC DENITRIFICATION
IN WATER (USING RICEHUSK AS A
CARBON SOURCE)**

Submitted by: Gyanendra Kumar Jha

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr,
Ishwar Man Amatya**

ABSTRACT:

This study has mainly focused on the heterotrophic denitrification in water by using ricehusk as a carbon source. The nitrate nitrogen enriched water having insufficient BOD of < 4 mg/l was selected for the study. The attached growth systems in the reactors were operated under four different cycles at the hydraulic loading rates of 4, 10, 15 and $25 \text{ m}^3/\text{m}^2/\text{d}$. The influent nitrate nitrogen concentration for the first three cycles was maintained at an average of 65 mg/l where as the fourth cycles were operated with an average nitrate nitrogen concentration of 100 mg/l. In the reactor D.O., temperature, ph, and alkalinity were measured as 0.5 mg/l, 25 to 28°C , 7.1 to 7.8 of pH and 70 to 130 mg/l. Within the study, the value of COD has been found decreased from 88 to 3 mg/l. The turbidity and color both has been found decreased from 12 to 9 NTU and from 25 to 18 Hazen unit.

The highest nitrate nitrogen removal was achieved as 3 mg/l from an influent value of 70 mg/l at a hydraulic loading rate of 4 m³/m²/d. in comparison to 89 percent removal by the reduction to 100 to 9 mg/l were achieved at a hydraulic loading rate of 25 m³/m²/d.

The reactor having only the overburnt brick i.e. WCSR also reduced the concentration of nitrate nitrogen from 110 to 76 mg/l and this was thus much below than the reactor having both the overburnt brick and the carbon source ricehusk in which the nitrate nitrogen was reduced from 110 to 8 mg/l.

A regression analysis was performed to derive the relationship between nitrate removal efficiency and the hydraulic loading rate. The value of variance $R^2 = 0.9743$ was found with equation of nitrate removal percentage was found in the laboratory to be $96.125 * e^{0.0066 * HLR}$

**Thesis Title: TO ASSESS THE SOIL AND
GROUNDWATER POLLUTION DUE TO
DISCHARGE OF STEEL INDUSTRIES
EFFLUENT AT SIMARA, BARA**

Submitted by: Lokesh Chandra Singh

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

The Iron industries are the major producer of wastewater in Nepal. Iron industries in Nepal are producing iron products from imported ingots. In this process they are using variety of chemicals as per the demand of the process. Effluents are very acidic in nature and contains many heavy metals. This study was carried out to assess the impact of wastewater discharged from Galvanizing industry located at Simra, Bara. Iron and zinc were selected as a parameter to monitor the impact. Concentration of iron and zinc were measured in effluent, ground water samples and soil samples along the direction of natural drainage.

Fourteen water samples from existing tube wells in a span of 4 kilometer were collected and tested for pH, iron and zinc. Soil samples were also collected from same place and tested for above parameters. Maximum iron and zinc concentration in

ground water were 17.8 mg/l and 0.36 mg/l respectively. Distribution of their concentration did not show any specific trend with distances. However their concentrations in soils were found higher in the vicinity of point of discharge and decreasing with distance. Maximum concentration of iron was 12.20 mg/gm and that of zinc was 2.01 mg/gm. Concentrations were decreasing gradually with distance and after one kilometer they were found close to the values found in surrounding surface soils lying in reverse direction of natural drainage. pH of soil samples were also exhibited the same trend. pH in samples near to the point of discharge had lower values (5.55) i.e. soil was acidic near the point of discharge, whereas, prior to factory (i.e. opposite to surface run-off) area pH value of soil were on higher side of the scale, alkaline in nature (8.4). Soil samples from reference area (i.e., prior to the factory area) and 1Km east to the first line (in the direction of increasing contour) were also collected to fix a boundary that up to what distance the soil were contaminated. Four soil samples were also collected in between point of discharge and 11' at varying depths. Iron concentration was maximum 250 meter and decreases there after, whereas, zinc concentration was increases up to 500 meter and decreases thereafter. From the study it was found that soils up to one kilometer in the direction of surface run-off were getting affected by the industry discharge. However impact on ground water was

not so visible. This might be due to the fact that industries are relatively new to show the effect.

**Thesis Title: VERMICOMPOSTING OF FRESH FECES
UNDER SEMI - CONTINUOUS LOADING**

Submitted by: Shambhu Karkee

Supervisor: Mr. Mahesh Prasad Bhattarai

ABSTRACT:

This study attempted to compare the decomposition of fresh feces and its nutrient value of the end product using traditional composting and vermicomposting. Survival, growth and reproduction of *Eisenia fetida* under semi-continuous loading were observed.

Eight numbers of bins were used for both normal and vermicomposting in two cycles. Stocking density for the first and second cycles were 0.45kg worms/m² (11.323kg worms/m³) and 1kg worms/m² (25.987kg worms/m³) respectively. The initial parameters such as moisture content, pH, volatile solids, total organic carbon and total nitrogen of the feed material were determined. Feeding rate was 1kg-feed/kg worms/day and 0.75kg-feed/kg-worms/day for first and second cycle respectively. Collected feed material was mixed thoroughly before loading to each bin and loading was done in every alternate day for four weeks. In both cycles Vermicomposting

was carried out with one set of replication. Variation of room temperature during the study period was from 16°C to 28°C. For analysis, the representative samples were collected weekly.

The variation of pH on vermicompost was observed less than normal compost. The final pH of vermicompost was 6.86 and 6.81 for first and second cycles respectively. For the normal compost, the pH values were 7.72 and 7.79. The 56 days volatile solid content of normal compost was equivalent to that of vermicompost after 35 days. For stocking density of 1 kg worm/m² and feeding rate of 0.75kg - feed/ kg worm/day, the percent reduction of volatile solid content of fresh feces was around 86%. The cocoon production per worm at the end of eighth week was 3.16. The maximum individual biomass was 714mg and the average individual biomass was 653mg. Death of the worms was not noticed up to the end of the observation period. On both systems, the ratio of total organic carbon to total nitrogen and phosphorus decreased after fourth week. However, there was no significant difference on this ratio for vermicompost and normal compost. Concentration of Potassium on dry weight basis was found higher in vermicompost than the normal compost. Thus, vermicomposting of human feces is an attractive proposition with benefit of faster decomposition and achieving pathogen stabilized end product. However, for the design of

vermitoilets, a further research to determine optimum stocking density and optimum feeding rate is required.

**Thesis Title: AMMONIA REMOVAL BY
CHLORINATION IN WATER**

Submitted by: Sitaram Chaudhary

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
Ishwar Man Amatya**

ABSTRACT:

Different level and types of contamination degrade groundwater quality of Kathmandu valley. Most of local area has been experienced with excessively high level of nitrogenous compound. Nitrogenous compound in drinking water have related to groundwater contamination and inadequate sanitary conditions. Excess of ammonia nitrogen in drinking water is the symbol of primary organic pollution. It is considered as one of the most significant environmental causes of different disease.

Different types of contaminants degrade groundwater quality of Kathmandu valley. Among this ammonia -N is also one of the pollutant in groundwater. For removal of ammonia by breakpoint chlorination is one means for household.

In this study, several 250 ml flask were used for mixing by magnetic stirrer. Commercially available bleaching powder and commercially available kaolin powder were used for chlorine dose and determine the interference of turbidity in breakpoint chlorination respectively.

Contact time for the ammonia removal was found 25 minutes in synthetic ammonia -N water, groundwater and turbid water upto 30 NTU. Chlorine demand was noticed in increasing trend form 139.9, 169.0, 170.5 and 178.5 ppm for ammonia-N removal at 25-ppm ammonia nitrogen concentration due to effect of turbidity 5, 10, 20 and 30 NTU respectively.

Ammonia-N concentration upto 3 ppm was found 100% removal through breakpoint chlorination in presence of 5 NTU turbidity. The mass ratio of chlorine to ammonia -N found 7.58, 7.94, 8.25 and 8.5 at 5, 10, 20 and 30 NTU turbidity. The residual chlorine, after breakpoint chlorination is noticed 0.82 to 35.1, 0.71 to 11.0, 1.0 to 52.0 ppm and 2.5 to 42.0 ppm chlorine in 5, 10, 20 and 30 NTU turbidity at 1, 2, 3, 4, 5, 10, 15, 25 and 50 ppm ammonia-N synthetic water.

Graduation Year 2006

**Thesis Title: DISSOLVED AMMONIA ADSORPTION IN
WATER USING OVER BURNT BRICK**

Submitted by: Shukra Raj Paudel

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
Ishwar Man Amatya**

ABSTRACT:

This study has mainly tried to attempt the treatment of drinking water by using locally available over burnt brick as adsorption media, which is the waste product obtained from the brick klink. The synthetic ammonium chloride solution was used in this study. The adopted particle sizes for this study were 0.075 to 2.36mm.

The analysis of kinetics and contact time in agitated non flow system was conducted. The concentration of total ammonium chloride solution was used 5 ppm. The contact time was obtained from 3 to 9.5 hr as the adsorbent particle size increases. Initially the contact time increase rapidly with increasing rate declined and nearly become constant afterward.

The adsorption rate constant of over burnt brick for particle size of 0.075 to 2.36mm ranges from 0.0501 to 0.1079 at concentration of 5 ppm. The optimum value of adsorption rate constant is found as 0.1079 at particle size 0.850-0.600.

The adsorption data appears to fit the Freundlich's isotherm. The intercept of Freundlich's isotherm ranged from 0.003 to 0.00005 ppm for particle size of 0.15 to 2.36 mm and the intensity of adsorption ranged from 0.840 to 0.291 for particle size of 0.15 to 2.36mm.

The fixed bed adsorption operation indicated that the ammonia nitrogen is the function of service time, bed depth and flow. Linear regression model showing correlation of these parameters has been developed. This model can be used to design ammonia nitrogen adsorption treatment plant. Ammonia nitrogen removal significantly depended on the service time and bed depth. The ammonia nitrogen removal at different flow and depth of media ranged from 0.566 to 0.840ppm. The critical bed depth ranged from 0.967 m to 1.430 m at flow of 120-145 ml/min.

An economic analysis shows 50 % bed efficiency of locally available over burnt brick. The service time required is 4.5 hour for 1 m³/day water treatment.

**Thesis Title: **SOLID WASTE GENERATION RATES IN
SMALL MUNICIPALITIES OF NEPAL:
STUDY OF BANEPA, DHULIKHEL AND
PANAUTI MUNICIPALITY****

Submitted by: Nirmal Darshan Acharya

Supervisor: Mr. Padma Sunder Joshi

ABSTRACT:

This study is an attempt to study the waste generation pattern of small municipalities of Nepal, focusing on municipalities which lie in the population range between 10000 and 30000, which comes out to be 25 numbers (47.2%). For the study; three municipalities viz. Banepa, Dhulikhel and Panauti are taken and their household waste generation rates, Municipal waste generation rates, density and composition of waste are analyzed.

A 8 day household survey for analyzing the average household waste generation rates and thereby the per capita municipal waste generation rate were carried out in each municipality for two periods, dry and wet season. Similarly, composition of generated waste and density were measured and data collection about family size, Income level, composting activities, recycling and waste reduction and etc were done.

The per capita household waste generation rate of Banepa, Dhulikhel and Panauti municipality comes out to be 0.151, 0.150 and 0.107 kg/c/d respectively in wet season whereas it is 0.105, 0.107 and 0.073 kg/c/d respectively in dry season. Assuming the household waste is 75% of the total municipal waste, these figures comes out to be 0.201, 0.200 and 0.143 kg/c/d respectively in wet season whereas it is 0.140, 0.143 and 0.097 kg/c/d respectively in dry season. This shows that the average municipal solid waste generation rate of 0.34 kg/c/d (average household waste generation rate of 0.25 kg/c/d) is still on the higher side for small municipalities with population range between 10000 to 30000.

The frequency of generation shows that 60% to 80% of the sample households produce waste between 0.05 - 0.250 kg/c/d.

The differences of waste generation in wet and dry seasons comes out to be 30.46%, 28.67% and 31.77% respectively for Banepa, Dhulikhel and Panauti municipality. This difference may be mainly due to change in moisture content of the waste generated.

More than 65% of the waste generated in each municipality is organic in nature, therefore composting may be the best alternative way to reduce the waste and thereby efficiency of

waste management can be increased. Composting at household level also plays a vital role in reducing per capita waste generation.

The portion of plastics and paper waste comes out to be more than 9% and 7% respectively in these municipalities, which show that reuse and recycling activities are also potential aspect of solid waste management.

These results may be applicable for similar municipalities in the country having like geographic condition, location, culture. But it is recommended that this type of survey should be carried out for municipalities having different geographical location and culture etc. and it will be easier for analyzing the trend of change of waste generation and characteristics if such survey is conducted every 2/3 years.

**Thesis Title: INDOOR AIR QUALITY OF VERTICAL
 SHAFT BRICK KILN**

Submitted by: Ram Kumar Chaudhari

**Supervisor: Dr. Bal Krishna Sapkota, Er. Chiranjibi
 Gautam**

ABSTRACT:

Indoor air pollution in the Vertical Shaft Brick Kiln (VSBK) is higher than the ambient air standards set by Ministry of Environment and Population. Total Suspended Particle (TSP) level at the loading platform as well as at the various spots on the platform was found much more than outside the VSBK plant for majority of duration set by National Ambient Air Quality Standards (NAAQS).

During the study it was found that TSP was high during energy centering (damper closed condition) than the TSP during 'damper opened' condition in the same shift. Timely maintenance of components of VSBK such as cleaning of flue duct and covering of exposed glass wool was poor in the VSBK units.

Use of mask at the kiln was negligible and majority of the worker engaged at the kiln were unaware of ill effects of indoor

air pollution. General mask (a thin layer of cotton sandwiched between cotton cloth) which is available in Kathmandu's local market was not found effective in filtering TSP though it was found reducing TSP to certain extent.

Mask made from the combination of foam (5 mm thick), malmal (as known in local market) and net was found to be suitable for filtering TSP at large. Using this mask, the percentage reduction of TSP by the combination of these materials was found to be 85.43% and 82.43% respectively for 1' x 1' x 1' and 0.5' x 0.5' x 0.5' dimensions.

To improve indoor air quality in VSBK, interventions to be carried out are: awareness, use of mask, addition of flue duct at upper level, regular maintenance and proper stacking of green dried bricks at the platform (i.e. up to the height of parapet).

Graduation Year 2007

**Thesis Title: DETERMINATION OF EMISSION OF
 POLLUTANT DUE TO MIXING OF
 CASTOR OIL IN KEROSENE OIL**

Submitted by: Anand Mohan Thakur

**Supervisor: Prof. Dr. Bal Krishna Sapkota, Mr. Ram
 Kumar Sharma**

ABSTRACT

It is acknowledged fact that more than 90% of the world's population depends on fossil fuels as the source for producing energy. Energy is the basic materials required to meet the pace of the development effort of the nation. In the modern society the type and sources of the energy may vary but net requirement and consumption of energy will increase.

Nepal being a developing country, its need for fuel is immense at all time. Nepal is one sense is a growing economy too. This means the import bill of fuel will increase every year. At present context the international petroleum prices are more volatile. So petroleum price burden has to be distributed between the consumers and the government cautiously within appropriate

time. The accumulated billions of rupees loss of Nepal Oil Corporation, if seen seriously, has now become a national problem. Existing policies of fuel pricing are mainly influenced by welfare and equity considerations rather than on efficiency, economical or environmental grounds.

For an instance, we can take the case of kerosene- a fuel used by the lower and middle class strata of the society for cooking purposes. It has become very expensive compared to other sources of energy for cooking. If we consider the efficiency of kerosene stoves, even at the subsidized rate of Nrs 48.00 per liter cooking on kerosene is almost equivalent to cooking on electricity. So kerosene considered as a fuel source for lower strata of the society has become the most expensive source of energy. Most energy prices continue to ignore the costs imposed on the environment. Especially petroleum prices should consider the environmental costs as taxes on emissions of green house gases. Subsidy provided in kerosene is tremendously huge and is implicit but not budgeted. In case of renewable energy, because of the cost effectiveness and the decrease in the initial investment costs, there are some rational options in providing Bio-fuel to the rural household for cooking and lighting purposes. Thus rural poor can save fuel costs by not purchasing the subsidized kerosene at exorbitant prices.

This study show that the emission of TSP is higher in castor oil and fuel consumption is less by 17.66ml in ratio (91:09) and it is low cost fuel than net kerosene used when water was boiled in model kitchen, providing natural ventilation factor of 0.15.

**Thesis Title: VERMICOMPOSTING OF FRESH
 HUMAN FECEs UNDER NATURAL
 CONDITION AND CONTINUOUS
 LOADING SYSTEM**

Submitted by: Sichu Shrestha

**Supervisor: Mr. Mahesh Prasad Bhattarai, Mr. Iswar
 Man Amatya**

ABSTRACT

The study was conducted for the possibility of fresh feces treatment under natural condition and continuous feed system by vermicomposting. Effect of C/N ratio for conservation of nutrients using rice husk as carbon additives, mass balance of nitrogen and phosphorus were observed during the study period. Survival, biomass growth and reproduction of *Eisenia fetida* for the system were also observed.

Study was conducted in two cycles. The first cycle was comprised of two arrangements. Arrangement-1 was for monitoring continuous composting at FR 0.75, 0.5 kg feed/kg worm/d for each SD of 1, 1.2, 1.6 kg worm/ m² with C/N 30. The system was studied for seven weeks with three sets of control. Arrangement-2 was to study the effect of C/N on

nutrient conservation by varying C/N ratios at 8 (control), 15, 20, 25, 30, and 35 with FR 0.75 kg feed/kg worm/d and SD of 1.6 kg worm/ m². It was observed for ten weeks. In this cycle, sampling was done every week for newly formed cast only. Though all SD and FR combinations performed continuously in this cycle in terms of VS reduction and workability SD 1 kg worm/ m² and FR 0.5 kg feed/kg worm/d at C/N 30 was found better to continue for second cycle. Major difference was not noticed in nutrient conservation all C/N ratios therefore C/N 30 and C/N 8 were selected for second cycle.

The second cycle was conducted to study the same objectives in depth. Biomass growth was examined and mass balance was made for the nutrients. Due to decrease in ambient temperature, even best combination i.e., SD 1 kg worm/ m² and FR 0.5 kg feed/kg worm/d could not work continuously as expected. Hence, feeding was terminated at eighth week. The maximum VS reduction and TKN conservation was observed in vermicomposting with C/N 30, which were 71.17% and 91.12% respectively whereas in normal composting they were obtained as 53.24% and 76.78% respectively. However, C/N and C/P obtained at tenth week showed better nutrient conservation in vermicomposting at C/N 8 which were 5.60 and 129.13 respectively. Similarly, for normal composting and the ratios

obtained were 13.46 and 329.97 respectively. The maximum biomass growth was observed 86.16% and 93.54% at the end of tenth week for C/N 8 and C/N 30 respectively. But the productions of cocoons were obtained as 0.7 per worms.

**Thesis Title: PERFORMANCE EVALUATION OF
 NATURAL VENTILATION ON
 EXISTING BUILDING WITH RESPECT
 TO SUSPENDED PARTICULATE
 MATER IN INDOOR POLLUTION**

Submitted by: Bhaskar Kafle

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Prof.
 Dr. Bal Krishna Sapkota**

ABSTRACT

Survey conducted at the different location of the Kathmandu valley shows that maximum indoor concentration of TSP was found in Koteswor Chowk with a value equal to 386.12 $\mu\text{g}/\text{m}^3$ while the minimum value of indoor TSP concentration was recorded in the Green Land office of the New Baneshwor Chowk with a value equal to 14.97 $\mu\text{g}/\text{m}^3$. The gross average I/O at different location of the Kathmandu valley is 1.33. Most of the residential building have indoor by outdoor ratio is greater than 1 and it is seen that indoor pollution is directly depended to the outdoor pollution. Indoor pollution is not only due to the outdoor pollution but also from the indoor activities like cooking, heating, smoking etc.

In order to reduce the indoor pollution the role of natural ventilation is seen and found that natural ventilation has positive role in removing the indoor pollution. The minimum openable area to outdoor 0.093 or 9% of the total floor area was found from the experiment conducted at a model lab of Battisputali area.

In order to control the influence of the outdoor pollution entering in the indoor different types of curtains are used. Out of these, curtain IV having knot size 1764 per square centimeter was found good in comparison to the other types of curtain.

In conclusion, by opening minimum ventilation, indoor TSP concentration can be reduced to the National Ambient Air Quality Standard. At the same time, use of curtain in the ventilation will control the influence of outdoor pollution entering to the indoor.

**Thesis Title: DEVELOPMENT NUTRIENT BUDGET
OF THE CENTRAL ZOO POND**

Submitted by: Gaurav Shrestha

**Supervisor: Mr. Mahesh Prasad Bhattarai, Mr. Padma
Sunder Joshi**

ABSTRACT

This study was undertaken to assess the present status of the Central Zoo pond water quality so as to provide baseline data for future use and water quality management and to suggest some remedial measures for pollution control. The main objective of the study is to develop the nutrient budget of the pond that may provide more insight into causes of the pond eutrophication.

The maximum depth of the pond was 3.4 m and that of sediment was 1.1m. As the pond is shallow, water temperature did not differ significantly with depth and thermal stratification was not observed. Average DO concentration of the pond water was found to be 6.9 mg/l and pH was 8. The average moisture content of the sediment was 76 % of wet weight and the average VS was 14 % of dry weight. In-pond concentrations of NH_4^+ , NO_3^- and PO_4^{3-} were found to be 0.7 mg/l, 1.3 mg/l and 0.2 mg/l in average respectively. The external loading of NH_4^+ to the pond

was 113 kg/year, NO_3^- loading was 59 kg/year and PO_4^{3-} loading was 27 kg/year. The average flux of NH_4^+ from the bottom sediment was $8 \text{ mg/m}^3\text{day}$ in aerobic condition, that of NO_3^- was 3 mg/nr/day and for PO_4^{3-} , it was found to be 0.5 mg/nr/day . The average internal loading of NH_4^{+1} was 39 kg/year, that of NO_3^- was 14 kg/year and that of PO_4^{3-} was 3 kg/year. The mean NH_4^+ , NO_3^- and PO_4^{3-} concentrations accumulated in the sediment were 14 mg/l , 4 mg/l and 0.5 mg/l respectively and their corresponding accumulation rate to the sediment were 23 kg/year, 7 kg/year and 1 kg/year respectively. Chl_a content of the pond water was 54 mg/m^3 in average. Inorganic N:P ratios were found to be optimal for algal growth.

The study yielded that the pond water quality is being degraded due to discharge of heavy pollution loads and sediments. It has already passed its Mesotrophic state and is on the mid of the Eutrophic state- External loading contributes to 74 % of NH_4^+ loading, 81 % of NO_3^- loading and 90 % of PO_4^{3-} loading to the pond. Effective water quality management and remedial measures must be put into practice to control the pollution loads. Dredging and diversion of point sources seem to be pragmatic controlling options that can jointly reduce the total loading up to 39 % for NH_4^+ 26 % for NO_3^- and 12 % for PO_4^{3-} .

**Thesis Title: EVALUATION OF SUBSURFACE FLOW
CONSTRUCTED WETLAND**

Submitted by: Hemanta Prasad Bhatta

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
Manoj Kumar Pandey**

ABSTRACT

Constructed wetland (CW) technology is a low energy, low cost alternative for the removal of nutrients from municipal wastewater and agricultural runoff. Ecologically such a system is a balanced one since the nutrients are put back into the natural cycle without being lost. The research work was carried out in the pilot scale subsurface flow constructed wetland units established at the premises of sewage treatment plant at Guheswori, Kathmandu, Nepal and managed by Bagmati Area Sewerage Project (BASP). The overall objective of this research work is to examine the oxidation reduction potential (ORP) and dissolved oxygen (DO) variation in the CW, and the influence of influent composition (COD and TSS) on hydraulic conductivity of the bed.

Performance of CW was observed at five flow rates which are 0.464 m³/d, 1.56 m³/d, 2.26 m³/d, 2.37 m³/d and 3.05 m³/d.

Gradients of DO and ORP in the horizontal direction along the length of the bed have existed- It is particularly due to root release, atmospheric diffusion and microbial respiration. DO or ORP in the effluent of the reed bed shows a clear dependence on the oxygen supply and hydraulic behavior of the reed bed system. The effluent DO or ORP in SSF CW shows a linear relationship to the HLR. The effluent DO in SSF CW shows a linear relationship to the BOD₅ loading rate. Influent BOD₅ values ranged from 104 mg/l to 173 mg/l and influent ORP values ranged from -185 mv to -276 mv. Effluent BOD₅ values in HF and VF planted beds were 19.81 mg/l and 4 mg/l respectively at HLR of 3.87 cm/d and effluent ORP values in HF and VF planted beds were 66 mv and 195 mv respectively at the same HLR. The more negative ORP (En) values are associated to the higher BOD₅ values. So, a correspondence between organic load (expressed as BOD₅) and ORP has been proved. Hydraulic conductivity of bed shows linear relationship to HLR. Hydraulic conductivity of HFUB is less than that of HFUB at each HLR.

The theoretical HRT calculated using HLR of 14 cm/d and depth of saturated bed of 15 cm is 9.5 hrs for HF planted and unplanted beds. The mean HRT values are 10.12 hrs and 7.39 hrs for HF planted and unplanted beds respectively. Based on the experimental tracer response curves, the dispersion numbers

were found to be 0.13 and 0.1 in HF planted and unplanted beds respectively. It shows that both the beds are approaching towards plug flow condition.

**Thesis Title: COMPARISON OF VERTICAL AND
 HORIZONTAL FLOW PATH
 SUBSURFACE WETLANDS FOR
 WASTEWATER TREATMENT**

Submitted by: Shaphal Subedi

**Supervisor: Mr. Manoj Kumar Pandey, Mr. Mahesh
 Bhattarai**

ABSTRACT

With the development of urban areas, it has become necessary, from the public health and aesthetic considerations, to provide drainage or sewer systems to carry such wastes away from the area. After the failure of centralized conventional wastewater treatment system one after another needs for alternative system was felt. The objective of study is to evaluate and compare the individual performance of HF and VF Subsurface CWs for the treatment of municipal wastewater. The experimental setup consists of two units of HF bed and VF bed of size 6m*2m*0.6m and 6m*2m*0.8m (Length*Breadth*Height) respectively. In both HF and VF, one unit each was planted with *Phragmites Karka* (local reed) and next one was not planted. The system was fed with wastewater drawn from grit chamber of oxidation ditch system. The filter media of the bed consists of gravel of size D₁₀-

2.3mm and D_{60} -5 mm in both HF and VF CWs. The porosity was found to be 38%. The plants were placed in the HF bed and VF bed at the rate of 9 to 10 plants per m^2 . It was found increased to 50 plants per m^2 with in the one year in VF bed and 40 plants per m^2 with in the two-year in HF bed.

Removal of organic matter, nutrient and pathogens was found to be more in VF planted bed than the HF planted bed at all the selected HLR (0.038, 0.129, 0.188, 0.1975 and 0.254 cu.m/sq.m.d) and the removal efficiency of all parameters was most effective at HLR of 0.038 cu.m/sq.m.d. The average value of treatment efficiency on TSS, COD, TKN, NH_4 -N, TP and FC were 83.8%, 73.8%, 38.8%, 42.4%, 40.4% and 89.8% for HF planted bed and 95.4%, 92.8%, 52.5%, 62.4%, 68.7% and 97.2% for VF planted bed under HLR 0.0388 cu.m/sq.m-d. No significant difference was found in COD and TSS removal efficiency of planted and unplanted bed. The average plant contribution for TSS and COD removal are 4.34 % (HF bed), 3.74% (VF bed) and 5.4% (HF bed). 5.2% (VF bed) respectively. Significant difference was found in TKN, NH_4 -N and TP removal efficiency of planted and unplanted bed. The average plant contribution for removal of TKN, NH_4 -N and TP are 12.52% (HF bed), 20.9% (VF bed) and 13.3% (HF bed) and 22.4% (VF bed) and 17.9% (HF bed) and 47% (VF bed)

respectively. The average reaction rate constant for COD removal in the wetlands at temperature of 20 °C was found to be 0.49 and 0.849 per day for HF bed and VF bed respectively.

Thesis Title: THE PERFORMANCE EVALUATION OF CONTINUOUS -FEED PASSIVE COMPOSTING REACTOR (A CASE STUDY OF RATOPUL COMMUNITY COMPOSTING)

Submitted by: Smriti Tara Tuladhar

Supervisor: Mr. Padma Sunder Joshi and Mr. Ram Kumar Sharma

ABSTRACT

Kathmandu city is producing 335 tons of waste everyday. 69% of this waste generated is organic in nature. Unfortunately, this 69% of utilizable waste is being landfilled. The in-vessel composting had been carried out at Ratopul by ECI-Nepal, since 2002. There was no report on scientific data analysis of the composting and its process. In this context, it is worthwhile to study the performance of in-vessel community composting at Ratopul.

Three bins: 3000 liters A, 750 liters B and 750 liters C were used to evaluate the performance of continuous-feed in-vessel composting. The organic waste of the community was used as compost feedstock. Shredding and C/N (25:1) of the waste was set for composting bin-A. Shredding of organic waste was set for

bin-B and waste as discarded from the houses was set in bin-C. On an average 50kg, 13kg and 13kg compost feedstock was fed in bins- A, B and C respectively which were filled up on 107th day of the composting period. The feeding was done from the top and withdrawing of compost from the bottom openings was carried continuously for more than a month after 107th day. The withdrawn compost was cured for a month.

Various indicators of composting process were monitored during the study period. In bin-A maximum temperatures 48°C, 63°C, 57°C and 56°C were recorded during the first week of reaching four sampling ports A_1 , A_2 , A_3 and A_4 respectively. But in bin-B and C maximum temperature rose in was 48° C only. At the end of curing in all the bins, the moisture content was found variably reduced to 40%, 30% and 20% and volatile solid variably reduced in the range of 51% - 46%. The pH during curing was found variably in the range of 6.00-8.00. The NPK value was found in the range of 2-3 %, 0.02-0.04 % and 2.5-4.0 % on dry wt. respectively. The C/N had dropped to about 14. The GI of fenugreek seeds was found in the range of 70-99 %. The compost produced from bin A was found better than other bins. The economic analysis showed that the cost of land-filling is NRs.2.177 and that of in-vessel composting is NRs.1.268 based on every kilogram of waste.

Therefore, the in-vessel composting can be one of the better alternatives which however, need some improvements in the setting as well as composting processes.

**Thesis Title: SLUDGE DEWATERABILITY AND
STABILITY USING REEDS**

Submitted by: Sujan Maharjan

**Supervisor: Mr. Manoj Kumar Pandey, Mr. Iswar Man
Amatya**

ABSTRACT

Conventional SDB is being used to dewater sludge quite a long time ago in Nepal. But, a simple modification by planting vegetation like reed to this SDB called RDB have been used in other countries like Denmark since 30 years. In Nepal, RDB is a new concept. Conventional sanitary pipe networks are inconvenient for isolated dwellings. Now a day, septic tank is ubiquitously used in each and every such dwellings. This creates a problem of generated sludge disposing-off after exhaust. Conventional SDB have been used in major cities like Kathmandu but proved to be failure because septic sludge volume are far higher than these beds can hold. Hence, SDB with reeds is for study work.

The average MC of 87.84% in fresh sludge was reduced to average of 47.98% of MC in implanted bed and average of 37.9% of MC in planted bed after one week drying period. In

other words, planted bed have 19.41% more dewaterability at SLR of 15 kg/sq.m/yr. The VS/TS ratio of 0.46 in fresh sludge was reduced to average of 0.25 in implanted bed and average of 0.2 in planted bed after one week of stabilization. In other words, planted bed has 25.00% more stability than implanted bed at SLR of 15kg/sq.m/yr.

The average MC of 86.89% in fresh sludge was reduced to average of 37.98% of MC in planted bed with SLR. of 15kg/sq.m/yr and average of 44.39% of MC in planted bed with SLR of 30kg/sq.m/yr after one week drying period. In other words, planted bed with SLR of 15kg/sq.m/yr has 16.88% more dewaterability than planted bed with SLR of 30kg/sq.m/yr. The VS/TS ratio of 0.43 in fresh sludge was reduced to average of 0.21 in planted bed and average of 0.27 in planted bed after one week of stabilization. In other words, planted bed with SLR of 15kg/sq.m/yr has 28.57% more stability than planted bed with SLR of 30kg/sq.m/yr.

The size of planted and implanted beds is also determined for winter season at SLR of 100kg/sq.m/yr when ambient temperature ranged from 5°C to 19°C. A sample calculation showed per capita land area required for planted and implanted beds are 2.67m and 3.3m" respectively. Thus reed beds prove to

be more cost effective, more efficient and economically viable alternative for dewatering and stabilization of sludge.

Graduation Year 2008

**Thesis Title: PERFORMANCE EVALUATION ON
GAJALAXMI WATER TREATMENT
PLANT**

Submitted by: Bimala Prajapati

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

Gajalaxmi Water Treatment Plant is operating since 2007. The major treatment unit of this treatment plant consists of Aeration unit, Sedimentation tank, Slow Sand Filter and Chlorination unit. It has been designed to meet the water demand 5205 l/d for drinking purpose. The performance of this plant is evaluated from august to December 2007. Normally the plant is operated 8-9 hours per day but 12 hours/day at high water demand cases. The treatment capacity of the plant is 273.6 l/hr.

The average influent concentration of pH, Turbidity, Iron, and T-Coli is 6.5, 21.79 NTU, 7.08 mg/l, 28.625 units/100ml respectively with the average effluent concentration of 7.22, 0.98 NTU, 0.17mg/l, and 0 units/100ml respectively. All the effluent concentration of water is within the permissible range of WHO guidelines value.

**Thesis Title: DETERMINATION OF EFFECT AND
OPTIMUM ASPECT RATIO (L/W) OF
CONSTRUCTED WETLAND IN
HORIZONTAL FLOW BED AND
VERTICAL FLOW BED**

Submitted by: Dhruba Bhatta

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

One of the major environmental problems of Kathmandu valley is the pollution of the river systems. Since the waste water generated in the Kathmandu valley is discharged into Bagmati or one of its tributaries without treatment almost all the river system produce foul odors particularly during summer time. The pollution of the river can be minimized by reducing the wastewater generation by recycling and reuse and by proper treatment of the wastewater. Wastewater can be treated either using conventional mechanized treatment system or by natural treatment systems like constructed wetland. This study is related to natural treatment system using constructed wetland.

There is several constructed wetland system in Nepal. In recent years this system has become very popular in Nepal. However,

its correct design parameter has not been sufficiently studied. The effect of plant density, hydraulic loading rate, root depth of reed plant, area of bed, depth of bed and media on performance of waste water treatment by constructed wetlands with respect to aspect ratio has not been carried out in Nepal. In this study, media, performance data, plant density, hydraulic loading rate, root depth of plant bed depth size of bed, aspect ratio of existing operating constructed wetland unit were collected. The existing CW considered for the study was: Constructed wetland at Kathmandu University at Dhulikhel, Malpi International School at Banepa, Dhulikhel hospital at Dhulikhel, Sunga community wastewater treatment plant at Madhyapur Thimi guheshwari wastewater treatment plant, Susma koirala memorial hospital at Sankhu and -environmental Public Health organization at Anamnagar.

There is increase in TSS, COD, $\text{NH}_3\text{-N}$ and PO_4 removal efficiency in HFB by 0.38, 4.21, 20.43 and 20.2 percentages and decreased in BODS removal efficiency in HFB by 1.4 percentage respectively when media size decreased from 10 mm to 9mm. In vertical flow bed the BOD_5 , COD, TSS, $\text{NH}_3\text{-N}$ and PO_4 decreased by 22.5, 9.2, 11.3, 61.1 and 71.6 percentages respectively when media size decreased from 10mm to 9 mm. Decrease in media size had significant effect on $\text{NH}_3\text{-N}$ and PO_4

both in HFB and VFB. The optimum aspect ratio (L/W) with respect to media size to achieve 95% removal of pollutant is 8.17 in HFB and 0.175 in VFB. There is increase in BOD₅ by 4.4% when plant density decreased by 10 no. of plant per square meter in HFB. There is however, decrease in COD, TSS, NH₃-N and PO₄ by 10.1, 7.2, 18 and 17 percentages when plant density decreased 10 no. of plant per square meter in HFB. In vertical flow bed the BOD₅, NH₃-N and PO₄ increased by 16.24, 42 and 14.8 percentage respectively with decrease in plant density. The COD and TSS decreased by 37.5 and 5.2 percentage respectively with decrease in plant density. Decreases in plant density have significant effect on NH₃-N and PO₄ both in HFB and VFB. The optimum aspect-ratio (L/W) with respect to plant density to achieve 95% removal of pollutant is 4.54 in HFB and 2.1 in VFB. In horizontal flow bed the BOD₅, COD, TSS, NH₃-N and PO₄ increased by 0.57, 52.4, 65.7, 18.25 and 18.53 percentages respectively with decrease in HLR by 0.3 m/d. In Vertical flow bed the increase in HLR decreased BOD₅ and PO₄ by 86 and 11.8 percentage respectively. There is however, increase in COD, TSS and NH₃-N and PO₄ by 15.7, 25.1 and 8.36 percentage respectively when HLR increased by 0.4 m/d. The optimum aspect ratio (L/W) with respect to HLR to achieve 95% removal of pollutant is 4.38 in HFB and 1 in VFB.

**Thesis Title: APPLICATION OF HYDROCYCLONE
IN DRINKING WATER SUPPLY
SYSTEM**

Submitted by: Lokap Rajbhandari

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

This research was undertaken to study the Hydrocyclone type separator as a method to remove sediment from water for drinking purposes intending to replace conventionally used plain sedimentation and sedimentation with coagulation. Hydrocyclones produce centrifugal forces much more than the gravitational force, resulting in much more rapid separation than conventional methods. The separation efficiency of the hydrocyclone has been found to be much better than that of conventional settling devices. Simplicity, cost effectiveness, portability as well as low maintenance cost of hydrocyclone posses high potential for their application in the field of drinking water supply system. The comparison showed that residence time in hydrocyclones is of 2 to 3 seconds only compared to hours in sedimentation tank and in minutes in tube settlers. Further, hydrocyclone is simple in design, cheaper, highly compact and portable, easy to relocate compared to sedimentation tank and

tube settlers. In addition the maintenance cost is lower in hydrocyclones. Hence, hydrocyclones creates potential to replace more traditional physical separation processes in water supply systems.

A hydrocyclone having a diameter of 75 mm at the top was developed and tested. Factors which affect the separation achieved in a hydrocyclone are discussed. A double cone body having two different angles; 14° followed by 6° was designed. The hydrocyclone under investigation has a flow capacity of 0.51 litre/sec under the total feed head of 8.5 meters. The optimum value for the underflow to throughput (total flow) ratio came out to be 11.69 in terms of flow capacity and sediment removal capacity. This value of the underflow to throughput ratio gave a overflow capacity of 88 percent and particle removal efficiency of 98 percent.

The hydrocyclone was also tested for the varying feed pressure and feed concentration. Particle removal efficiency increased with the increase in feed pressure. Particle removal efficiency slightly decreases with the increase in sediment concentration, but there is not much improvement in sediment removal at lower sediment concentration. Turbidity has been reduced to a value of 8 NTU at the overflow effluent when the initial feed turbidity of

53 NTU at the inlet. The optimum sediment removal efficiency was observed when feed concentration was 19,000 mg/ltr. Grade efficiency curve showed the cut size as 35 microns.

Graduation Year 2009**Thesis Title: PERFORMANCE OF TUBE SETTLER****Submitted by: Anu Rajbanshi****Supervisor: Prof. Dr. Bhagwan Ratna Kansakar****ABSTRACT**

In the late 1960's tube settler was developed which has provided breakthrough for the improvement of sedimentation tank efficiency thus by reducing the detention time to less than 15 minutes. It required very small area compared to conventional sedimentation tank. The tube settler has been used in Siddhipur Water Treatment Plant (SWTP). The detail study on the performance of the tube settler installed in Siddhipur Water Treatment Plant has been done in this thesis report.

During study period, in first phase natural water having turbidity of 7 - 31 NTU from Godavari Khola was used while synthetic water having 31 - 170 NTU was used in second phase of the study. Evaluation of tube settler was conducted for four discharges of 2.4 l/s, 4.2 l/s, 7.3 l/s and 10.1 l/s. For influent turbidity 12.5 - 170 NTU effluent turbidity was 9 to 48 NTU for 2.1 l/s discharge. Similarly for influent turbidity 7 - 167 NTU, 12.5 - 164 NTU and 12.5 - 168 NTU, effluent turbidity were

found 5 - 53 NTU, 10 - 55 NTU and 10 - 69 NTU for discharges 4.2 l/s, 7.3 l/s and 10.1 l/s respectively. The average turbidity removed for discharges 2.1 l/s, 4.2 l/s, 7.31/s and 10.1 l/s were 37.93 NTU (50.12% of influent turbidity), 35.94 NTU (46.52% of influent turbidity), 34.08 NTU (45.41% of influent turbidity) and 33.09 NTU (44.38% of influent turbidity) respectively. The maximum turbidity measured in effluent was higher than WHO guideline value for drinking water. However the slow sand filter installed following the tube settler is expected to reduce turbidity to a level within the WHO guideline value for drinking water.

No significant effect was revealed from discharge 2.4 l/s to 10.1 l/s. The turbidity removal in the tube settler for discharges ranging from 2.4 l/s to 10.1 l/s is expressed as $T_r = 0.6927 T_0 - 8.7216$

For the discharge 2.4 l/s, 4.2 l/s, 7.3 l/s and 10.1 l/s, observed efficiency were found as 34.46%, 33.3%, 24.9% and 21.8% less than value obtained from YAO model and 40.39%, 39.4%, 31.7% and 28.0% less than Khatri model.

**Thesis Title: PERFORMANCE EVALUATION OF
 WASTEWATER TREATMENT AT
 POKHARA LANDFILL SITE**

Submitted by: Bhuvaneshwar Timilsina

Supervisor: Mr. Paadma Sunder Joshi

ABSTRACT

Disposal of domestic wastes directly near the periphery of the individual's home is common in urban Nepal. These solid wastes into roadside drains or public spaces are causing one of the major threats to the urban environment of Pokhara Sub-Metropolis. Bokhara Sub-metropolis is one of the urban centers of Nepal with population growth rate of 6.5% per annum (CBS, 2007). Solid waste landfill site of Pokhara sub-metropolis lies about 100m above from the Seti River. Leachate and other wastes from the landfill site are being disposed continuously to the river system. There is a treatment plant within the landfill site but the efficiency of the treatment plant is not explored yet. Hence, this study has been designed to explore the performance of leachate treatment plant of pokhara landfill site. Performance of leachate treatment plant is evaluated in terms of experimental parameters like pH, temperature, COD, BOD, TKN etc. Composite samples are collected. The sampling is conducted weekly. In every

sampling, a total of three samples are collected. COD, BOD_s and TKN are determined by K₂Cr₂O₇ Digestion method, titrimetric (Winkler's) and Kjeldahl method respectively. The sampling points are located at 4 different strategic points i.e. inlet and outlet of each treatment plant. The study showed that the leachate of pokhara landfill site was slightly basic with average pH value of 8.5 and concentration of BOD (220.19mg/l), COD (1330.0mg/l) and TKN (409.06mg/l) which were high to dispose off directly in to the Seti River. The HFCW has reduced the average concentration of BOD, COD and TKN by 70%, 72% and 71% respectively. Similarly, VFCW has reduced the average concentration of BOD, COD and TKN by 71%, 86% and 78% respectively. Thus the result ensures that the treatment plant of pokhara landfill site is working nicely. However regular monitoring and maintenance should be done at least twice a year.

**Thesis Title: PERFORMANCE EVALUATION OF
UNICEF FINANCE WATER
TREATMENT PLANT AT PULCHOWK
CAMPUS**

Submitted by: Gargee Pradhan

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

The newly built water treatment plant funded by UNICEF at Pulchowk Campus is in operation since 2008. The plant has capacity to treat about 30,000 liters/hour. The major component of treatment plant consists of deep tube well, degasification and aeration unit, gravel bed flocculator, dynamic sand filters, activated carbon filter. Performance of this treatment plant is evaluated from July 2008 to February 2009 by observation, measurement and analysis of the water quality parameter such as pH, Temperature, turbidity, dissolved oxygen and total iron with and without using chemical dosing.

The maximum, minimum and average value of turbidity of treated water with chemical dosing was found to be 67 NTU, 2.2 NTU, and 3.34 NTU respectively. Similarly the maximum, minimum and average value of turbidity of treated water without

chemical dosing was found to be 13 NTU, 4 NTU, and 8.5 NTU respectively. The average concentration of total iron of raw water was 4.7 mg/l and treated water with chemical was 0.1 mg/l and without chemical was 1.13 mg/l. The pH of the water of every treatment unit lies on WHO guideline value. It was found to 6.5 - 7.12. The maximum and minimum inlet DO concentration was found to be 0.5mg/l and 0.1 mg/l. The outlet maximum and minimum DO concentration measured was 5.8mg/l and 5.3mg/l respectively with temperature variation of 19°C -25°C.

In overall evaluation, the treated water with chemical dosing contain turbidity and iron to permissible level set by WHO and Nepal Standard for drinking water. So water must be treated before use. The DTW water contain 80 mg/l ammonia which is very high than the permissible level of 0.2 mg/l and to make water for drinking purpose ammonia treatment plant is recommended.

**Thesis Title: TREATMENT OF MUNICIPAL SOLID
WASTE BY COMBINING COMPOSTING
AND VERMI COMPOSTING USING
EISENTA FETIDA**

Submitted by: Gyan Ratna Maharjan

Supervisor: Mr. Iswar Man Amatya

ABSTRACT

The study focuses on finding whether the vermicomposting could be performed in an improved way by using the pre composted waste in spite of the fresh organics as the feed stock so that the advantages of both the composting and vermicomposting can be grabbed by combining these two processes.

The organic portion of the waste was first shredded into pieces of size less than 50 mm and blended with rice husk, dry leaves and saw dust in proportions so as to maintain the C/N ratio to 30. It was then allowed for composting. In the vermicomposting experiment, compost of different maturity was applied as a feedstock. The feeding was done in batch with an optimum feeding rate of 0.75 kg feed/kg worm/day at optimum stocking

density of 1,6kg/sqm. The entire study was done in two cycles of eight weeks.

From the experiment, it was concluded that the vermicomposting could be carried out successfully by feeding the partial compost. By using the combined system, the temperature requirement for pathogen destruction was easily met (reached above 55 °C for more than six consecutive days.) The conventional composting was found to be very effective in active microbial decomposition, particularly during the initial thermophilic stage. The application of worms during the maturation stage helped further to accelerate the maturation process. The volatile solid in the composting system and vermicomposting system was 32.94 % and 32.09 % respectively whereas it was 30.83 % and 27.6 % in the combined systems. The total organic carbon of the waste fell from 35.98 % to 18.3 % in the composting system and to 17.83 % in the vermicomposting system in a period of eight weeks. Considerable faster reduction (17.13 % and 15.33 %) was obtained in the case of the combined systems. Similar result was obtained in the case of the *CI* N ratio. Application of worms was effective in maintaining the pH to the neutral range. The composting system operated in alkaline range and the final pH of the compost was 7.86 and 7.75. The value is 7.01, 7.08 and 6.96 for the combined systems. The nutrient conservation was

effective in all the systems. The changes in the nutrient values during the different systems were very variable as a number of parameters are responsible for the cause. No mortality of the worms was observed but the growth of worms was less when compost was used as feedstock. The growth was 63.73 % in a month when fed with fresh waste. Using precomposted waste, it was only 43% and 26.51%.

This study thus revealed that the combined system had a lot of benefits. The worms play a significant role in improving the physical structure of the compost. It produces a more aesthetically desirable product, fulfills the pathogen destruction requirement, significantly reduces the volatile solid content, accelerates the maturation process and therefore is the best compared to the other systems.

**Thesis Title: FAECAL SLUDGE MANAGEMENT
THROUGH SLUDGE DRYING BEDS**

Submitted by: Prakash Pudasaini

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

Latrine and septic tank contents, the so-called faecal sludge pour directly into the river is one of the major urban environmental issues. So, the study was conducted for the possibility of faecal sludge drying through sludge drying beds. As Nepal is also promoting on site sanitation system either septic tanks rather than sewerage connected latrines. Since there is no treatment facilities for faecal sludge, sludge drying beds could be one of the good options for its management. Change in moisture content, volatile solids, total organic carbon, pH, nitrogen, phosphorous and potassium were analyzed during this study. The study was conducted for six months.

The study was carried out by installing 6 beds. Out of 6 beds, 3 beds are mixed with husk and 3 beds are mixed with ash separately and they are 33% in each bed. The maximum moisture content was found to be about 79% in bed of sludge mixed with rice husk in 10 days and reduced to 35% at the end of 115 days.

Total organic carbon varies from 37.22 to 10.56% up to 115 days. The pH variation of sludge was found to be 6.5 to 7.7 during sampling at different stages. The variation of total nitrogen is found to be 1.05% to 2.68%. The overall concentration of phosphorous is low as compared to other compost. Most of the value of potassium is higher than the range for matured compost (0.5-1.8%) i.e. from 1.56 to 3.54%.

In case of sludge mixed with ash moisture content reduction, volatile solid reduction and potassium content is better than sludge mixed with husk. Sludge mixed with husk contains more nitrogen and phosphorous which are two major plant nutrients out of three and also husk contain more organic carbon and organic matter (since organic matter is directly related with carbon content). Therefore, sludge can be mixed with both husk and ash based on availability of the material since there is no significant difference in physio-chemical parameter of faecal sludge. The parameters of carbon content (8-50%), pH (6-8.5) and Nitrogen (0.4-3.5%) lie within the range from the beginning. But the removal of odor, reduction of volatile solid, presence of white or grey color, and phosphorous take time to get its required properties therefore optimum time for matching of all these parameters to get matured compost is after 70 days of feeding of sludge in beds.

**Thesis Title: PERFORMANCE EVALUATION OF
BODE WATER TREATMENT PLANT
WITH ANALYSIS OF OPTIMUM-DOSE
OF PAC THROUGH JAR TEST**

Submitted by: Sarbagya Shrestha

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

Bode Water Treatment Plant (BWTP), constructed under Japanese Grant Assistance through JICA and commissioned in 2003, consists of flocculation, sedimentation, rapid sand filter and chlorination units. Performance evaluation was carried out in laboratory with reference to turbidity, total iron, free residual chlorine and total coli form reduction. During the study period (December 2008 to second week of March 2009), the plant was operated on an average flow of 10.42 MLD, where the design capacity is of 20.6 MLD.

The study revealed that the average turbidity removed in sedimentation unit, rapid sand filter nit and overall whole plant were 57.1, 7.3 and 107.1 NTU respectively. The turbidity of treated water was always found to be less than or equal to 5.0 NTU which is within the WHO guideline value. Total iron

removal in rapid sand filter and overall BWTP were 1.82 and 4.1 mg/1 respectively. Treated water always had color less than 0.5 TCU after average removal of color of 37.6 TCU. Likewise, the weekly average free residual chlorine varied from 0.8 to 1.1 mg/1 in the clear water reservoir.

During the study period, average total coli form was found 120+ in groundwater and 190+ in mixed raw water which was found to be nil in case of treated water. The parameters like color, turbidity, pH, total iron, free residual chlorine, total coli form, etc. are all found to be within WHO guideline values which indicates the satisfactory operation of the treatment plant.

The jar test for synthetic turbidity ranging from 25 NTU to 200 NTU with an interval Of 25 NTU entails that the optimum dose of 0.05 % PAC solution is directly proportional to the influent turbidity of the raw water. It varies from 7 ml of 0.05 %PAC solution i.e. 14 mg/1 of PAC dose for raw water turbidity of 25 NTU up to 25 ml of 0.05 % PAC solution i.e. 50 mg/1 of PAC dose for raw water turbidity of 200 NTU as the optimum doses.

**Thesis Title: REMOVAL OF AMONIA NITROGEN BY
AIR STRIPPING IN NITRIFICATION
REACTOR**

Submitted by: Sarita Dawadi

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

This study has tried to attempt the air stripping performance in the nitrification reactor. The impact of temperature on air stripping in the nitrification reactor was evaluated on two different columns, column without filter media and column packed with over bum, tack as a media. Two HDPE columns each of internal diameter 133 mm, and effective height 3.2 m was connected in series. In case of packed column, depth of packing was provided 4 m. Ammonia-N concentration was varied day to day during the study period. The P^H of water was increased to 9.5 during the study.

The ammonia-N removal was 0.07 gm/mVmin a, temperatine of 16 °C which was increased to 0.26 gmW/min at temperamre of 26 °C in the column without filter media In the column wM, filter media, 0.16 gm/m²/min of ammonia-N was removed a. 16 °C whereas 0.37 gmW/min of ammonia-N was removed at

temperature of 26 °C The result showed that removal efficiency of ammonia-N was directly dependent on air temperature. Among the column with and without filter media, column having filter media was found to be higher removal efficiency. The result further showed that tire detention time required in the column with filter media was shorter than that without filter media to remove the same ammonia-N concentration.

The amount of ammonia removed was decreased when flow rates were increased due to die lower detention period of water and lower air to water ratio in die column. The ammonia-N reduction profiles were almost straight lines in both columns which indicate die ammonia-N removal was linear. Hence overall rate of reaction appears to be zero order.

The effect of temperature on ammonia removal rate was evaluated using Arrhenius equation. The value of temperature coefficient was found to be 1.122 for column without filter media and 1.093 for column with filter media. The study showed that the ammonia- N removal is function of temperature and detention period.

Effect of pH during the air stripping perforce was also evaluated for the column without filter media. The study showed that the ammonia Nitrogen removal increases from 0.26 to 0.28 gm/m²/min as increment of pH from 9.5 to 10.8.

**Thesis Title: COMPARISION OF CERAMIC CANDLE
FILTERS WITH AND WITHOUT
COLLOIDAL SILVER COATING**

Submitted by: Shanti Lamichhane

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

Although colloidal silver (CS) coated disc and selected candle filters are used in water treatment for killing pathogens, colloidal silver coated ceramic candle filters are not commonly available in Nepal.

This study was performed under three types of ceramic candle filters to determine the effect of colloidal silver in bacteriological action and flow rate. This study has also been included the comparison of three types of ceramic candles for flow rate and removal of bacteria. The silver concentration was measured in the filtrate of CS coated filters. Flow rate and turbidity variation with time were also measured in the filtrate for groundwater.

The average flow rate values were measured as 4.36 l/hr, 0.49 l/hr, 0.68 l/hr respectively in MCC, Puro and Surya candles without colloidal Silver coating. The average flow rate values in

MCC, Puro and Surya candles with CS coating were reduced to 3.5 l/hr, 0.37 l/hr and 0.56 l/hr respectively. The concentrations of *E. coli* and total coliforms in the influent were observed as 960 cfu/100ml and 2937 cfu/100ml respectively in case of without CS coating while 985 cfu/100ml and 3004 cfu/100ml respectively in case of CS coating. *E. coli* removal efficiency of MCC was found 39-60% without CS coating and 69- 77% with CS while total coliforms removal efficiency is 45- 69% without CS coating and 65-79% without CS coating for given influent concentration. *E. coli* removal efficiency of Puro candle was found 100 % and total coliforms was 99.6 -100% with CS coating for the given influent concentration. *E. coli* removal efficiency is 99- 100% and total coliforms removal efficiency is 97- 100 % for Puro candle without CS coating for given influent concentration. *E. coli* and total coliforms removal efficiency of Surya candle is 99-100% with CS coating. *E. coli* removal efficiency is 86-96% and total coliforms removal efficiency is 89-95 % for Surya candle without CS coating for given influent concentration. Although the flow rate was decreased with CS coating, the bacteria removal capacity was increased in all three types of candles. Silver concentration of artificial sample and turbidity of groundwater observed in the filtrate in all three types of candles were found within acceptable range of World Health Organization (WHO) guideline.

**Thesis Title: DESIGN OPTIMIZATION OF
 CONSTRUCTED WETLAND USING
 ARTIFICIAL NEURAL NETWORK**

Submitted by: Sudeep Hada

Supervisor: Dr. Prajwal Lal Pradhan

ABSTRACT

This is a preliminary attempt towards a wider use of Artificial Neural Networks in the constructed wetland technology. It proposes a model to be used effectively in the estimation of the BOD₅ effluent concentration and value of reaction rate constant in the design of constructed wetlands. The influent BOD₅ concentration, flow discharge and temperature are used in the neural network as input parameters. Due to unavailability of sufficient data of CW system in Nepal for the modeling, data of laboratory scale CW system located at the Environmental Research Station of the Asian Institute of Technology (AIT) were used. The data volume comprised of 660 sets and was divided into two subsets i) 650 data sets as a training sub set for adjusting the connection weights, and ii) 10 data sets as a testing sub set for checking the model ability. The input parameters are the area of the influent BOD₅ concentration, temperature and flow discharge. Consequently effluent concentration and value of

reaction rate constants are considered as output parameters. After several and extended training-testing efforts a Modular Artificial Neural Network was determined to be the optimal one. The optimal neural network architecture has single hidden layer with five nodes at 0.005 learning rate, 13500 iteration cycles. This optimal architecture is found by hit and trial method based on the minimum average error between the actual output and neural network output. Also, the coefficient of determination and trend line are determined for the consistency and reliability for the optimality.

**Thesis Title: COMBINED COMPOSTING AND
VERMICOMPOSTING OF ELEPHANT
DUNG**

Submitted by: Arun Prasad Parajuli

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

This study on the "Combined Composting and Vermicomposting of Elephant Dung" focuses on the treatment of elephant dung to minimize the environmental problem and utilize the nutrient in agricultural lands efficiently.

The raw dung was collected from the Central Zoo, Jawalakhel, Nepal and the composting was done in a heap on the open ground after removal of inorganic substances by hand sorting and manually breaking of lumps. Composted dung only after two weeks was feed in the circular earthen flower pots of average diameter of 0.15 m and surface area of 0.017 m each with small holes at the bottom. The adult healthy *Eisenia fetida* with a stocking density of 1.6 kg-worm/m with feeding rates of 0.75, 1, 1.5 and 2 kg-feed/kg worms/day in the batch basis were used in the separate sets for vermicomposting in moisture content of 70 to 80% (monitored daily by eye judgment and adjusted by

sprinkling water) at normal room condition in two cycles of 10 weeks in the researcher's residence at Koteshwor, Kathmandu.

From the experiment, it was revealed that the vermicomposting on fresh dung was 100% fatal for *Eisenia fetida* within 24 hours but survival, growth and reproduction could be achieved in the composted material after 2 weeks. The combined system was efficient in the USEPA's temperature requirement for pathogen destruction. The composting was found to be effective in active microbial decomposition, particularly during the initial thermophilic stage. The pH values in all the systems (except at the first week in composting systems) were operated in the alkaline range.

Comparing the results, the combined composting and vermicomposting system with feeding rate of 0.75 kg-feed/kg worms/day was more effective in maintaining pH nearer to neutral value of 7.04, reducing volatile solids to 42.52%, carbon content to 23.62%, C/N ratio to 15.29 and conserving nutrient (nitrogen to 1.55%, phosphorus to 0.99% and potassium to 1.42%) at the end of 10th week to produce high quality vermicompost. However, the combined composting and vermicomposting system with feeding rate 2 kg-feed/kg worms/day was more effective in biomass growth (81% of initial

mass of worm) and cocoon production (22.92 numbers per g initial mass of worm) for vermiculture.

**Thesis Title: DETERMINATION OF EFFLUENT
TURBIDITY OF MAHANKAL CHAUR
WATER TREATMENT PLANT USING
ARTIFICIAL NEURAL NETWORK**

Submitted by: Junu Prajapati

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
Iswar Man Amatya**

ABSTRACT

Water is a basic need and as a result, water supply entities have the responsibility to supply clean and safe water at the rate required by the consumer. Due to complex process involved in the water treatment process, it is often difficult to find out the relationship between input and output parameters by conventional methods of modeling.

This study is a small attempt to develop ANN model for the prediction of effluent turbidity characteristics of Mahankal Chaur Water Treatment Plant (MCWTP), Kathmandu. In this study, multilayer perceptron with back propagation algorithm was used. Due to limited data available, 110 dataset are used for the training of model. The optimal architecture is found by trial and error method based on minimum average error between actual

output and neural network output of 10 data sets used as testing data. The optimal neural network architecture is found at single hidden layer with four nodes at learning rate 0.1, 480000 iteration cycles with minimum average error of 5.95%. To check the reliability of ANN prediction, predicted results from ANN are compared with observed values. It is found that result from ANN model show the consistency with the measured data and coefficient of determination was found to be 0.954. The results show that an ANN model can make good predictions even with fewer inputs.

**Thesis Title: PERFORMANCE EVALUATION OF
PRIMARY TREATMENT UNIT AND ITS
IMPACT ON OTHER OPERATION AT
GUHYESHWORI WASTE WATER
TREATMENT PLANT**

Submitted by: Suman Roka

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
Iswar Man Amatya**

ABSTRACT

Bagmati river is the largest river in the capital city of Kahmandu valley which comprises fifty seven rivers and rivulets as its tributaries. The river originates from Bagdwar, Shivnpure and crosses the valley at Chovar. The river has its own importance in various aspects as cultural and religious heritage, holy places and has aesthetic value. Despite being such a heritage, the river is used as a major drainage of Kathmandu valley. In order to curb further environmental degradation of the Bagmati river and adjoining area as well as to restore the condition of Bagmati river, the Government of Nepal formed a high powered committee for monitoring and implementation of Bagmati Area Sewerage Construction/rehabilitation Project (BASP) on 6th Mangsir, 2052 B.S. (1995 A.D.). The project has developed the

treatment plant at Guhyeshwori and known as Guhyeshwori Wastewater Treatment Plant (GWWTP).

In today's scenario, GWWTP was not functioning well. The major problem observed during the study period was of floating materials which was due to the failure in existing 2 cm opening size screen. So for this study, performance evaluation of primary treatment units was conducted from 3 February, 2009 to 9 November, 2009 and parameters like TSS, FS, VSS, floating materials, COD, temperature and pH were observed by installing different opening size screens.

This study revealed that average removal of TSS, floating materials and COD parameters by treatment plant was average 51%, 75% and 63% respectively with existing 2 cm opening space screen. But after installation of 1 cm opening space screen, it was observed average 89%, 100% and 88% respectively. Again with 0.5 cm opening space screen, it was found average 90%, 100% and 96% respectively.

From the observation, it was deduced that floating material can be converted to TSS. This was confirmed by mass balance analysis and TSS versus floating materials data analysis in the grit chamber. When new screens started performing well and

begin to filter the floating materials, at the same time grit chamber and succeeding units started to perform desirably better. So, with the help of new screens having lesser opening size, the problem in *plant in* terms of TSS, floating materials, COD removal was mitigated.

**Thesis Title: REMOVAL OF AMMONIA NITROGEN
BY AIR STRIPPING IN NITRIFICATION
REACTOR**

Submitted by: Sarita Dawadi

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
Iswar Man Amatya**

ABSTRACT

This study has tried to attempt the air stripping performance in the nitrification reactor. The impact of temperature on air stripping in the nitrification reactor was evaluated on two different columns, column without filter media and column packed with over burnt brick as media. Two HDPK columns each of internal diameter 133 mm, and effective height 3.2 m was connected in series. In case of packed column, depth of packing was provided 4 m. Ammonia-N concentration was varied day to day during the study period. The pH of water was increased to 9.5 during the study.

The ammonia-N removal was 0.07 gm/m³/min at temperature of 16 °C which was increased to 0.26 gm/m³/min at temperature of 26 °C in the column without filter media In the column with filter media, 0.16 gm/m³/min of ammonia-N was removed at 16

°C whereas 0.37 gm/m²/min of ammonia-N was removed at temperature of 26 °C. The result showed that removal efficiency of ammonia-N was directly dependent on air temperature. Among the column with and without filter media, column having filter media was found to be higher removal efficiency. The result further showed that the detention time required in the column with filter media was shorter than that without filter media to remove the same ammonia-N concentration.

The amount of ammonia removed was decreased when flow rates were increased due to the lower detention period of water and lower air to water ratio in the column. The ammonia-N reduction profiles were almost straight lines in both columns which indicate the ammonia-N removal was linear. Hence overall rate of reaction appears to be zero order.

The effect of temperature on ammonia removal rate was evaluated using Arrhenius equation. The value of temperature coefficient was found to be 1.122 for column without filter media and 1.093 for column with filter media. The study showed that the ammonia-N removal is function of temperature and detention period.

Effect of pH *during* the air stripping performance was also evaluated for the column without filter media. The study showed

that the ammonia nitrogen removal increases *from 0.26 to 0.28* gm/m²/min *as* increment of pH from 9.5 to 10.8.

Thesis Title: SOLVATTEN AS A DISINFECTION SYSTEM

Submitted by: Bijaya Karmacharya

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr. Iswar Man Amatya

ABSTRACT

Solvatten is very simple, low cost technology for drinking water disinfection at household level. The total capacity of the Solvatten unit is 6 litres.

Through the transparent side water is exposed to the heat and UV radiation of the sun, the opposite side of the container is a heat absorbing black colour. The synergetic effect of solar radiation and temperature occurs when the water temperature rises above 50° C.

In rainy season, the average solar intensity in Kathmandu was 529.75 W/m² and in spring season, it was 1641.56 W/m² in Kathmandu. The coliform removal efficiency in rainy season after exposure to Solvatten was 87.50% and in spring season, it was 100%. In spring and summer season, Solvatten treatment is preferred. The average solar intensity in Hetauda was 837.12

W/m and in most of tests, the water temperature reached up to 60° C. At 60° C temperature, water is completely free from coliform. The coliform removal efficiency was 100%. Water with highly turbid <134 NTU can also be treated, if the temperature in Solvatten reaches 60 C. The average initial water temperature was 30° C.

The average solar intensity in Phaplu was 1351.95 W/m . Due to initial water temperature of 10.5° C to 15.5° C, even in high solar intensity the water temperature in most of the cases could not increased to 50° C. Only in 6 samples, the temperature increased above 45° C and coliform removal percentage at the corresponding test day was 100%. This result shows in Solvatten, removal of faecal coliform is mainly due to increase in temperature. The water temperature above 45° C and exposing the water to solar intensity above 1200 W/ m in average removes all the coliform in Phaplu. The test results shows Solvatten as an effective disinfection method and water can be treated with exposure of 5 hours in average with solar intensity greater than 800 W/m².

The test result shows Solvatten as a effective disinfection method.

**Thesis Title: INCLINED PARALLEL PLATE
SETTLER AS HIGH RATE CLARIFIER**

Submitted by: Bharat Maharjan

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
Iswar Man Amatya**

ABSTRACT

Parallel plate settlers are placed parallel to the length of the sedimentation basin with the inclination of 60° in order to improve the efficiency of settlement in conventional sedimentation basin. Firstly a set of six parallel plates is applied on the experimentally developed sedimentation basin and secondly another set of six parallel plate settlers is used to divide basin horizontally into two parts in order to lower the rate of surface charge. Thus the performance is analyzed and compared in terms of turbidity and total suspended solids for the sedimentation with and without plate settlers. For this study, the synthetic turbidity ranged 20 to 375 NTU are fed to sedimentation basin at five different flow rates of 15.60, 23.00, 26.00, 30.00 and 39.00 ltr/min.

The suspension stability test of the local pottery clay showed that 45% of the initial turbidity can be removed for the maximum

detention time of 35 min. But the result showed that the turbidity removal is up to 53.09% of the initial turbidity and the TSS removal is up to 73.12% of the initial TSS by the two sets of plate settlers; up to 51.75% turbidity and up to 62.10% TSS by one set of plate settlers and 36.91% turbidity and 50.90% TSS by sedimentation without plate settlers.

During peak flows, they showed much better performance than conventional settlers. Below 26 ltr/min (66% of maximum discharge), one set of plate settlers and > 26 ltr/min, the two sets of plate settlers showed effectiveness in turbidity removal but the two sets of plate settlers work better than one set of plate settlers for all discharges in case of TSS removal. The same turbidity and TSS removal can be obtained placing one set of plate settlers with reducing detention time half and placing two sets of plate settlers with reducing detention time one third of the detention time of sedimentation without plate settlers.

The surface area of the sedimentation basin (A_1) and plate settlers (A_2) required for the discharge(Q) to remove the required amount of the turbidity (Tr) from influent water having turbidity (X) can be obtained from the relations $Y=Tr*Q/A$ and $Y= \psi*X^a$ such that $A=A_j$ when $\psi = 0.01054$ and $a=1.1935$ for sedimentation without plate settler, $\psi = 0.0312$ and $a=1.5029$ for

one set of plate settlers and $\psi = 0.022$ and $a = 1.5763$ for two sets of plate settlers. Again $A = A_1 + A_2$ when $\psi = 0.0226$ and $a = 1.5029$ for one set of plate settlers and $A = A_1 + 2A_2$ when $\psi = 0.0117$ and $a = 1.5603$ for two sets of plate settlers.

**Thesis Title: IRON REMOVAL BY AERATION WITH
 GEO-TEXTILE**

Submitted by: Bidur Jha

**Supervisor: Prof. Dr. Bhagwan Ratna Kansakar, Mr.
 Iswar Man Amatya**

ABSTRACT

Bhaktapur Hospital Water Treatment Plant (BHWTP) consists of aeration, sedimentation, pressure filter, carbon filter and disinfection units. Study of aeration unit was carried out with reference to turbidity, total iron, dissolved oxygen, temperature and pH for tray aerator and aerator with geo-textile. The study period was from September 17, 2008 to June 23, 2009. The study with conventional tray aerator revealed that the average iron removal was 1.07 ppm (28.26%), 1.26 ppm (34.21%), 1.42 ppm (38.34%), 1.64 ppm (44.89%) and 1.74 ppm (48.81%) at discharges of 0.30 lps, 0.25 lps, 0.20 lps, 0.15 lps and 0.10 lps respectively. The overall iron removal was 1.43 ppm (38.90%) from average influent iron of 3.68 ppm.

With geo-textile, the average iron removal was found to be 1.60 ppm (44.64%), 1.80 ppm (49.17%), 1.97 ppm (53.79%), 2.27 ppm (61.57%) and 2.54 ppm (69.34%) at discharges of 0.30 lps,

0.25 lps, 0.20 lps, 0.15 lps and 0.10 lps respectively. The overall iron removal was 2.03 ppm (55.70%) from average influent iron of 3.66 ppm. Average turbidity removal in geo-textile was 13.22 NTU, 16.10 NTU, 17.62 NTU, 19.01 NTU and 20.12 NTU at discharges of 0.30 lps, 0.25 lps, 0.20 lps, 0.15 lps and 0.10 lps respectively. The overall turbidity removal was 17.22 NTU with average influent turbidity of 26.23 NTU. Thus, turbidity removal was found as one of the major functions of geo-textile in addition to the improved iron oxidation efficiency.

With geo-textile and addition of oxidant and coagulant, average iron removal was 2.21 ppm (72.98%), 2.36 ppm (78.00%), 2.41 ppm (80.51%), 2.51 ppm (83.33%) and 2.64 ppm (88.84%) at discharges of 0.30 lps, 0.25 lps, 0.20 lps, 0.15 lps and 0.10 lps respectively. The overall iron removal was 2.43 ppm (80.73%) from average influent iron of 3.01 ppm.

Though iron removal increased from 38.90 % with tray aeration to 55.70% with the use of geo-textile, the effluent iron concentrations are well above the WHO guidelines and Nepal Drinking Water Standards of 0.30 ppm. The aeration with geo-textile and addition of oxidant and coagulant increased the average iron removal upto 80.73%. Hence aeration with geo-textile with addition of coagulants is the most effective option.

Graduation Year 2010

**Thesis Title: OPTIMAL DESIGN OF SEWER
 NETWORK**

Submitted by: Tharendra Poudel

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

This paper is an attempt to find out the optimal cost of a sewer network by arriving the suitable combinations of pipe sizes and depth of excavation and backfilling.

The method applied for the study is non linear Dynamic Programming Optimization technique. The algorithms used in this paper have been incorporated into software and the PC version is written in Visual Basic version 6.0.

The study showed that the non linear dynamic programming method can be effectively used as simple and reliable tool for the design of sewer network in developing countries like Nepal where there is constraint in resources and limited budget in wastewater conveyance system.

Compared to the conventional design, the study also showed that the present model based design is less time consuming, systematic and interactive search procedure with a very high probability of reaching the optimum design. The application of the developed- model and software in the design of sewer networks of Tribhuvan Nagar municipality, Dang showed its suitability to achieve the optimal design.

**Thesis Title: IMPACTS OF CLIMATE CHANGE ON
DISCHARGE OF MELAMCHI RIVER
USING SNOWMELT RUNOFF MODEL**

Submitted by: Kaji Ram Karki

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

Climate change has been one of the global issues today in the world and its impact are seen everywhere. Due to the effect of global warming, there is continuous increase in surface temperature of the earth. The increase in temperature is relatively high at the Himalayan region thereby affecting the accumulation and ablation process of snow and ice. The snow and ice are very important source of fresh water and are one of the most sensitive indicators of climate change. The assessment of climate change impacts on the hydrological resources of a country is an important assessment to be carried out, before planning any long-term water resources utilization program. Melamchi River is proposed as water source to Kathmandu valley. This research has attempted to study the climate change on snow melt runoff of Melamchi basin with analysis of hydrological data such as rainfall, temperature and runoff.

Satellite remote sensing is an effective tool for monitoring snow covered area. The remote sensing snow cover data of Moderate Resolution Imaging Spectroradiometer (MODIS) satellite from 2000 to 2008 have been used to analyze some climate change indicators. The snow products used in this study are the maximum snow extent, which come in 8-day temporal and 500 m spatial resolutions. Some important trends of snow fall are also observed. In particular, the decreasing trend in January and increasing trend in late winter and early spring may be interpreted as a signal of a possible seasonal shift. However, it requires analysis with more years of data to verify with certainty.

Geographical Information System (GIS) and ERDAS Imagine software are used for in this study for processing. Melamchi watershed was selected to study the potential effects on snowmelt runoff using a Snowmelt Runoff model (SRM) based on degree day factor algorithm. The runoff in a snowmelt season was simulated using measured temperature, precipitation and remotely sensed snow covered data. The changes in air temperature, precipitation, and snowfall and snowmelt runoff were analysed. The possible changes of snowmelt runoffs in Melamchi catchment in response to warming scenarios T+1, T+2 and T+3 were also simulated. The result indicated that a forward shifting of snow melting season and an increase in water flows in

earlier melting season. The considerable contribution of snowmelt to runoff during winter season and significant impact of climate change on snowmelt runoff were observed.

**Thesis Title: POULTRY FAECES MANAGEMENT BY
BIOCONVERSION TECHNOLOGY
WITH MODIFIED GGC 2047 MODEL**

Submitted by: Shree Krishna Neupane

**Supervisor: Mr. Ram Kumar Sharma, Mr. Shiv
Shanker Karki**

ABSTRACT

This research study entitled "Poultry Faeces Management by Bioconversion technological with Modified GGC 2047 model" focuses on various parameters relating to physico-chemical characteristics of the substrate, fertilizing value of digested poultry waste and potential to create profitability from biogas energy thus generated and balancing the environmental aspects using poultry waste digestion in Nepal.

Gobar Gas and Agricultural Equipment Development Company Pvt. Ltd. (GGC). established in 1977, has designed a biogas plant called GGC 2047 model. As problems arise in that model, it was modified by increment in inlet pipe size, curved floor on digester, inclined outlet and circular manhole and named modified GGC 2047 model. This modified model was set up at Bardibas in Mohattari District. This research has identified the

optimum feeding rate to produce biogas from poultry waste and its nutrient value.

From the experiment, temperature obtained in fermentation chamber was about 4°C above from ambient, volatile solid destruction was around 45% while carbon to nitrogen ratio reduction was around 30%. It was revealed that the biogas generation from chicken droppings was efficient and nutrient value also found more in digested slurry than of raw chicken droppings.

Comparing the results, biogas production from chicken faeces has obtained more by feeding around 8.5 kg per day. It is concluded that capacity of 4 m³ modified GGC 2047 model digester could be run by around 2.5 quintal chicken faeces per month to burn stove around 2.5 hours per day. Hence, without poultry those families who can manage this quantity of waste and requirement of stove burning around 2.5 hours they can think about bio-digester farm.

Gas production theoretically in cycle I, cycle II and cycle III is 18.85 m³, 20.193 m³ and 14.633 m³ respectively, practically in cycle I, cycle II and cycle III is 3.925 m³, 3.7215 m³ and 3.2585 m³ respectively.

Graduation Year 2011

**Thesis Title: REMOVAL OF CHROMIUM IONS
FROM THE POLLUTED WATER BY
USING ADSORBENT MEDIA
CHARCOAL**

Submitted by: Arbind Kumar Mahaseth

Supervisor: Mr. Ram Kumar Sharma

ABSTRACT

Cr (VI) is considered to be potentially carcinogenic to humans. Removal of Cr (VI) ions from aqueous solution under different conditions was investigated using non activated charcoal (NAC) as adsorbents. Batch mode experiments were conducted to study the effects of adsorbent dose, contact time, pH, temperature and initial concentration of Cr (VI). Results showed that the adsorption of Cr (VI) depended significantly on pH and temperature. Equilibrium studies showed that Cr (VI) had a high affinity for NAC at pH 2.45. For NAC, maximum adsorption was found at 24°C. Freundlich and Langmuir adsorption isotherms were also applied and they showed good fits to the Langmuir's experimental data only. The results suggest that NAC could be used as effective adsorbents for the removal of Cr (VI) ions.

The present study attempts at resolving towards treatment of industrial waste water. The synthetic samples were used in the study. The removal of chromium ions from the polluted water by adsorption was attempted. Locally available adsorbent, like sal wood charcoal was used to absorb the chromium ions, which was the product obtained by burning waste root of sallo tree for general purposes. Adopted adsorbent particle sizes were 0.15 to 4.75 mm in granular and < 0.075 mm in powdered charcoal.

The rates of adsorption of total chromium for different sized adsorbent were compared. Concentration of total chromium was used 5mg/l for powdered adsorbents as well as granular adsorbents. More than 90% of chromium (VI) removal appeared at solution pH (2 to 2.5), temperature (23°C to 25°C), adsorbent dose (5gm/100ml to 7gm/100ml), initial concentration (5mg/l to 10mg/l) and particle size (1.18mm to 4.75mm). The adsorption rate constant for granular adsorbent from particle size 0.150mm to 4.75mm was found 0.87 to 1.12 respectively. It shows that increase in adsorption rate constant is significant in increasing particle size and found constant value of 1.12 for particle size 1.18mm to 4.75mm.

**Thesis Title: WATER DEMAND MODELING SMALL
 TOWN IN TERAI REGION (A CASE
 STUDY OF SURUNGA**

Submitted by: Bed Prakash Chhetri

Supervisor: Prof. Dr. Bhagwan Ratna Kansakar

ABSTRACT

The population in the newly developed urban centres has been increasing rapidly mainly due to rural migration. As a result, growing small towns are facing inadequate water supply. Small Town Water Supply and Sanitation Projects are being launched to address the water demand of such towns. The Surunga water supply scheme addresses water demand of newly developed small town of Surunga VDC located in the Eastern Terai of Nepal.

Different socio cultural behaviour of the society in the city, the weather condition, ethnic communities in the city, family structure, economic status of people, sanitary facilities have direct or indirect impacts on overall water consumption.

Domestic water demand models have been developed by using the regression module. In regression model formulation, different

variables like ethnic groups, economic status, and household size have been used as explanatory variables.

The study showed the peak hour consumption at 7:00-9:00 AM and minimum consumption at 9:00 PM to 5:00 AM. The hourly peak factor is calculated as 3.2.

The daily consumption varied from 36.5 to 50.87 litres per capita per day. The daily peak factor of 1.25 is calculated.

The per capita water demand of Bramhin, Chhetri and Others ie domestic demand are found to be 113.1 lpcd, 85.84 lpcd and 56.63 lpcd respectively. The water demands for livestock and institutional are found to be 10.3 lpcd and 8.4 lpcd respectively.