ENVIRONMENTAL ENGINEERING (EnE)

**ENE 200201   AQUINO, Charlymagne R. (MS Envi. Eng'g)
Groundwater Quality Monitoring with Emphasis on Data Analysis at the Payatas-Novaliches Reservoir Area. 2002**

Concern over the possible contamination of the Novaliches Reservoir due to leachates from the Payatas Open Dumpsite have escalated ever since the tragedy that occurred at Payatas in July 2000. Several agencies have conducted studies on the groundwater at the Payatas-Novalices Reservoir area using techniques such as georesistivity survey and groundwater modeling. This study aims to investigate the effects of the Payatas Open Dumpsite on the Novaliches Reservoir using statistical analysis of groundwater quality data collected in the study area.

Initial investigation of the laboratory results of the groundwater sampling for 18 sampling points showed that most physio-chemical and metal parameters analyzed pass DAO 34 standards for Class A waters. These include the parameters, pH, conductivity, TDS, TSS, C1, BOD_5, COD, Ammonia-N, TKN, As, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K and Zn. The parameters DO, total coliform and fecal coliform were, however, found out to be above the standards in almost all the 18 sampling points in the study area.

Contour plots were constructed showing the groundwater quality profile in the study area for 13 water quality parameters. The results showed that the groundwater near the dumpsite is slightly acidic. The levels of conductivity, TDS, C1, Ca and Mg were also found out to be high near the dumpsite relative to the concentrations near the reservoir.

A comparison of the concentration of several water quality parameters using the *t-test* and the U-test was done for wells located near the dumpsite and wells located near the reservoir. The results of

these tests show that the decrease in pH from the reservoir to the dumpsite is statistically significant. The t-test conducted for the parameters conductivity, TDS, C1, Ca and Mg confirm the presence of dissolved salts contamination of the groundwater near the dumpsite.

The U-test conducted for the parameters Cr, Cu and Zn confirm the presence of contamination of these three metals at the wells near the reservoir. Both the t-test and the U-test, however, do not give any indication of the presence of contamination of the groundwater near the reservoir due to leachates from the dumpsite.

The collected groundwater monitoring data was also used in constructing prediction intervals allowing an early prediction of groundwater contamination near the reservoir based on future groundwater quality measurements. The calculated upper prediction limits for four of the five regulated heavy metals are, As= 0.0022 mg/L, Cd = 0.0018 mg/L, Cr = 0.0052 mg/L and Pb = 0.0681 mg/L. The confidence level of the upper prediction limit is 95% confident (92.3% for Cr and Pb) that the next two future measurements of As and Cr will fall below their respective upper prediction limits. Any measurement above this limit is an indication of the presence of contamination in the groundwater near the reservoir.

ENE 200302   BANDOJO, Rosalie L. (MS Envi. Eng'g.)

Vulnerability Assessment of Lingayen Gulf Coastal Areas Due to Sea Level Rise Using Geographic Information System. 2003

Sea level rise is a growing environmental concern especially along coastal areas. It is a fact that areas having difficulties coping with the present relative sea level rise will be the same areas that will be most vulnerable to future sea level rise. The use of Geographic Information System (GIS) facilities the identification and quantification of vulnerable areas.

Sector II of Lingayen coastal communities in Pangasinan province was chosen as the study area. The flatness of the area and the presence of major rivers make it an ideal choice for vulnerability assessment. The area is also exposed to other hazards which will be enhanced should there be a significant increase in sea level in the near future.

Using the Geographic Information System (GIS) technology vulnerable areas were identified using the tools for analysis. The raw data from field survey was processed using the GIS tool for contour generation, which delineates the two boundary conditions of 0.5 – and 1.0 meter. The overlaying analysis was then used to identify and quantify areas that will likely be inundated. Tabulated reports were automatically generated by the system as a non-spatial result of the overlay analysis.

The implications of sea level rise were discussed in view of its impacts on the following areas: 1) effects on population, and 2) physical effects. Census data were incorporated to determine the population that will be displaced in year 2100. Topographic data was used to determine the vulnerability of some areas to geologic and hydrologic hazards that will be enhanced should there be a significant increase in sea level.

The maps generated have shown that 7,666 hectares of land along the coast lie below the 0.5-meter contour. About 9,668 hectares of land will be inundated if sea level rises to 1.0 meter. Of the seven municipalities included in the study area, Binmaley Dagupan and Lingayen are the most vulnerable areas to sea level rise.

ENE 200003   BEJA, Rachel M. (MS Envi. Eng'g)
An Analysis of Microbiological Parameters of Septage as Related to Septic Tank Management and Design: Cagayan de Oro City, 1998-1999. 2000

In an attempt to characterize the septage of Cagayan de Oro City, the parameters like coliforms and ascaris eggs were determined from septic tank sludge and effluents. The results were related to septic tank design and management practices such as vault capacity, number of tank users and desludging frequency (sludge retention time). Samples were taken from 25 septic tanks, five from each of the five barangays considered

The findings revealed that the mean number of vault users in CDO is 6.4 ± 2.10 persons, sludge retention averaged at 11.32 ± 6.90 years while the mean tank capacity is 3.74 ± 2.15 cubic meters. All septic vaults studied were double chambered having a digestive and the leaching compartment. Based on design, the tanks in this study should be cleaned-out/desludged approximately every five years given an average

number of vault users and capacity of 6.4 and 3.74 m^3, respectively (Oravetz, 1991 and Canter & Know, 1986). The sludge has a coliform mean count of 6.5x 10^5 ± 1.9 x 10^5 per ml of sample and an average of 1.3 x 10^4 ± 6,172 ascaris eggs per one (1) liter of sample. The rate of survivability of pathogens (coliforms) in the leaching chamber of tanks was generally high at positive 62.21% ± 90.92. The coliforms in the leaching compartment multiplied by almost twice the number in the digestion chamber. The coliform, ascaris egg counts and rate of survivability of coliforms between tanks of different number of vault users, sludge retention and capacities did not vary significantly. In general, the sampled tanks have design and management practices below the theoretical standards necessary to insure optimum treatment efficiency.

ENE 200304 CARILLO, Jan-Michael Y. (MS Envi. Eng'g)
Air Dispersion Modeling of SO$_x$ and NO$_x$ Emissions from a Petroleum Refinery Plant. 2003

Dispersion modeling of SO$_x$ and NO$_x$ emissions from a petroleum refinery plant was performed using United States Environmental Protection Agency (USEPA) recommended Air Dispersion Modeling software. Monthly emissions data, terrain information and weather data were obtained and used to create a one year study of the dispersion of NO$_x$ and SO$_x$ in the vicinity of the Refinery. Ambient air concentration contour maps for SO$_x$ and NO$_x$ were created to illustrate the dispersion of these pollutants on a monthly basis.

Chronological NO$_x$ and SO$_x$ emissions were obtained indirectly from calculations based on first principle modeling and data from furnace and boiler online Oxygen analyzers and refinery fuel flow meters. Weather data were gathered from the refinery's local weather station and other weather data requirements such as mixing height and stability were calculated based on mathematical correlations. Terrain data from the refinery's plot plan, aerial photographs, elevation contour maps and field survey were also incorporated into the model.

The dispersion modeling had shown that seasonal monsoon winds impacted on the dispersion of the SO$_x$ and NO$_x$ inland and into some of

the populated areas. The modeling determined the locations where the highest concentrations of SO_x and NO_x occurred and it showed that values go beyond the Ambient Air Quality Guideline Values for SO_x as prescribed by the Philippine Clean Air Act at 50 m above sea level. The model reported maximum 24-hr averaging period of SO_x values ranging from 800 to 1360 micrograms per normal cubic meter, and maximum 24-hr averaging period of NO_x values ranging from 2.0 to 3.6 microgram per normal cubic meter.

ENE 199905   COSTALES, Fernandina F. (MS Envi. Eng'g)
A Proposed Evaluation of a Membrane Separation Process Using Reverse Osmosis System Analysis (ROSA) Software. 1999.

Seawater desalination offers an alternative solution to water scarcity problems. In fact, a lot of seawater desalination plants are already in existence in countries abroad. This study is conducted to determine the viability of constructing and operating a local seawater desalination plant.

The early stages of the research were described as the selection of suitable site and appropriate desalination technique. There were three provinces considered under site selection, i.e. Batangas, Bataan and Cebu, and among these three, Cebu emerged to be the most suitable site. Mactan Island was chosen as the specific location since the area has an increasing water demand and is presently experiencing salinization and depletion of groundwater resources. Under the process selection, reverse osmosis appeared to be the most appropriate technique for seawater desalination. Its selection was accounted mainly on its economics and its applicability to various types of feedwater.

The selection process was followed by the evaluation of market, technical and financial viability of the project. The market study dealt with water supply and demand, and the identification of plant capacity. The wide variance between the projected water demand and supply at Metro Cebu justified the need for new water projects in the area. The plant capacity was identified to be ten thousand cubic meters per day ($10,000m^3$/day). The technical study, on the other hand, focused mainly

on the design of auxiliary equipment and of the reverse osmosis train thru Reverse Osmosis System Analysis (ROSA) software. ROSA was developed by Dow Filmtec for analysis of membrane and system performance parameters. Lastly, the financial study assessed the profitability of the project by identifying its net present value (ROR), payback period and rate of return. Two financing schemes were evaluated, i.e. 10 years and 25 years load period. A selling price of P63.00 per cubic meter was obtained in both schemes to produce an ROR of more than 20 percent and a positive NPV. The sale of desalinated water together as well as the quality of the product water was found to be competitive in industrial and commercial areas. As against bottled mineral water, the desalinated water was found to be a lot cheaper.

ENE 199906   DE SALES, Louernie F. (MS Envi. Eng'g)
                Land Reclamation by Faecal Sludge Application. 1999.

This study evaluates the feasibility of applying septage to soil for land reclamation. Lahar is used in this study since it is deficient in nutrient and lacks organic fraction. In addition, lahar has physico-chemical and mechanical properties way below the average arable soil. This study also aims to determine the characteristics of septage generated in Metro Manila which can make it suitable for use in soil reclamation.

The study determines the effect of applying sludge for the improvement of soil quality and compares the growth of pioneer plants (talahib – *Imperata cylindrical*) and short term crop (pechay – *Brassica oleracea*) on the septage amended soil.

The experiment was divided into six sections. The first sections used thirty nine (39) 1m x 1m x 0.6 plots lined with plastic on the sides to prevent contamination from the surrounding soil. Section VI used twenty one (21) 6 inches (diameter) by 10 inches (height) polyethylene pots. Each section has specific variations such as amount of sludge, type of soil, method of application, exposure (sheltered, unsheltered) and irrigation (with or without watering).

Septage samples used in the study were obtained from different parts in Metro Manila and were analyzed before applying to lahar/soil plots. Lahar samples were taken from Mexico, Pampanga and Bamban, Tarlac, representing early and late deposited lahar, respectively. Arable soil samples were obtained from University of the Philippines Arboretum.

The soil and lahar samples were subjected to physico-chemical and microbiological analyses. Post treatment analysis was performed to evaluate the efficiency of the process.

The conclusions drawn from the evaluation of the feasibility of septage for land reclamation are as follows:

a) Metro Manila septage is a potential source of nutrients that may be used for the reclamation of nutrient-deficient soils particularly lahar. The septage does not contain large amount of heavy metals that can possibly cause soil and groundwater contamination. When applied in excessive amounts, septage containing ammonia which will be oxidized to nitrate-N in soil and can lead to groundwater contamination. This can be prevented by planting grasses/plants, since these can assimilate the nitrate-N formed in the ground.

b) Irrigation and the amount of sludge applied are significant factors on the growth of talahib grass. Of all the application rates (10, 30, 40 and 80 $1/m^2$) which were tested, the ideal amount of septage was found to be 80 $1/m^2$. The calculated maximum sludge application volume was 130 Metric tons/hectare.

c) Septage begins to manifest its effect on the growth-height of the talahib after four (4) weeks of sludge application. Pechay starts to respond to septage application at about ten (10) days after treatment.

d) There were significant improvements in the physical and chemical properties of lahar after septage application. Significant increase in the water holding capacity, organic matter of lahar and cation exchange capacity (CEC) were observed. Nutrient requirements of plants such as nitrogen, phosphorous, potassium, sodium and calcium levels of lahar were also increased. These parameters were found at satisfactory amounts for plant growth except for the concentration of potassium which is still low for most plants even after sludge application.

e) For the survival of faecal coliform and nematode eggs, there was a 96.6% or 5-7 decimal power reduction in faecal coliform (from a range of 80×10^5-13×10^7 to a range of $30 \times 10^2 - 80 \times 10^5$) count in three months of faecal sludge stabilization. A 50% reduction (from 6,044 to 2,872 eggs/kg) in nematode egg count was achieved after three months. The amount of sludge, irrigation and the type of lahar were found to be significant on the nematode eggs survival.

ENE199707   DIOKNO, Maria Rosa E. (MS Envi. Eng'g)
Development of a Mathematical Model of the Diffusion and Reaction of Soot and NO_x in a Soot-Coated Catalyst Particle. 1997.

A model of diffusion and reactions of oxygen and NO_x in a soot-coated copper modified ZSM-5 particle was developed. A single particle of Cu-ZSM-5 was preloaded with soot and exposed to different operating conditions. Runs were made using different NO and O_2 concentrations, operating temperatures and capture rates. The individual reactions occurring in the soot layer and catalyst core were also monitored. In order to accomplish this a numerical scheme based on the method of lines technique and Chebyshev collocation and a differential algebraic equations solver to integrate in time was used. From the runs made, it was found that at particular operating conditions, there exists a range of reactant concentrations and that can used. It was also found that `changes in temperature greatly affects the soot removal rate. The model's behavior closely resembles the results of the rotating fluidized bed experiments that inspired this study.

ENE 200208   DULAY, Josephine Aries L. (MS Envi. Eng'g)
Process Simulation and Performance Optimization for the Oxidation Ditch Sewage Treatment Plant in Baguio City Through the Application of IAWQ Activated Sludge Model. 2002

The organic and nitrogen impurities removal of the oxidation ditch of Baguio City Sewage Treatment Plant was investigated through the application of the Activated Sludge Model No. 1 in the Activated Sludge Simulation Program.

Detailed wastewater characterization is necessary to produce accurate estimates of process performance. The ASM authors recommended the methods used in the characterization of wastewater. The inert particulate organic matter X_I, inert soluble organic matter, S_I, readily biodegradable substrate, S_S, slowly biodegradable substrate, X_S, and heterotrophic biomass, X_H, were determined experimentally with values 12.01 to 13.05% X_I, 10.20% S_I, 24.24% S_S, 43.06 to 44.10% X_S, and 9.45% X_H. The wastewater component fractions of Baguio City were within the range estimated by the International Association of Water Quality (IAWQ) used in ASM 1 with values 15% X_I, 10% S_I, 25% S_S, and 45% X_S.

A few of the stoichiometric and kinetic coefficients were experimentally determined. These were the heterotrophic yield, Y_H, maximum specific growth rate of heterotrophs, $\mu\char`^_H$, and heterotrophic decay coefficient, b_H with values of 0.6387, 8.94 and 0.447 respectively. Likewise, the ASM authors recommended the methods used in the parameter determination.

ASM 1 was calibrated in order to optimize the performance of the full-scale plant. To fit the model to the observed results, only a few model parameters need to be changed. Aside from experimentally determined Y_H and $\mu\char`^_H$, the maximum specific growth rate of autotrophs, $\mu\char`^_A$ with a value 0.9, and the saturation constant for soluble substrate, K_S with a value of 100, determined through simulation were changed. The values found were within the estimated range suggested by the ASM authors. It was shown that the results of simulation agree with the observed results of the full-scale plant system. Furthermore, validation of the model confirmed the evaluated stoichiometric and kinetic parameters indicating that the model mimicked the actual performance of the plant.

The model has the ability to simulate a variety of possible scenarios observed in the full-scale performance of the wastewater treatment plant. The condition for optimum operation of the wastewater treatment plant for a high rate nitrogen removal was found. The effect of decreasing the dissolved oxygen concentration from 3.25 to 2 mg/L in the anoxic zone improved the rates of nitrification and denitrification in the ditch. Other scenarios showed the effect of changing the return sludge rate and the effect of shock loading when the return sludge valve was shut off intermittently but maintained the treatment efficiency of the ditch.

ENE 200209   DUMLAO, Maria Isabel R. (MS Envi. Eng'g)
Carbon and Nitrogen Removal from Sanitary Landfill Leachate in an Aerobic Moving Bed Biofilm/Anoxic Suspended Growth Reactor. 2002

This study focused on two main objectives: (1) to determine the biodegradability of the leachate from a sanitary landfill, and (2) to determine the efficiency of an Aerobic Moving Bed Biofilm Reactor (AMBB/ASGR) in treating high-strength leachate and compare it with a conventional Aerobic/Anoxic Suspended Growth Reactor (A/ASGR). The potential advantages of this hybrid system over conventional A/ASGR are lower energy requirements, reduced sludge production and higher biomass concentration. The leachate came from San Mateo sanitary landfill.

Duplicate simultaneous runs were performed for the biodegradability test. Following the Modified Semi-Continuous Activated Sludge Test, the flasks were operated for 41 days with an influent of 1,270 ± 262.71 mg/L average total COD level. The leachate from the landfill was found to be only partially biodegradable. Total COD reduction of 24.80% to 40.06% was achieved after 41 days of operation.

To determine the performance of the two reactors in removing tCOD and total NH_4^+-N, two reactors, each with a working volume of 8.705 L, were used. Both reactors have five chambers: aerobic in the middle, anoxic and settling zones on both sides. One reactor, the Aerobic Moving Bed Biofilm /Anoxic Suspended Growth Reactor (AMBB/ASGR), has its aerobic chamber filled with Kaldness^{TM} carrier materials, while the other, the Aerobic/Anoxic Suspended Growth Reactor (A/ASGR) has none of these carrier elements.

The raw leachate was firstly diluted to an average total COD value of approximately 1,000 mg/L before it was fed to the reactors. The reactors were both operated at an HRT of 24 hours during the first 82 days of the run while 36 hours in the next 71 days of operation at 25-28°C.   The influent and effluent tCOD, NO_2^- -N, NH_4^+-N and NO_3^- -N

concentrations were determined to assess the performance of the reactors. Temperature, pH and dissolved oxygen in each chamber were likewise monitored during the investigation period. Total COD, NO_2^- -N, NH_4^+ -N and NO_3^- -N concentrations were obtained at the end of each run to get the concentration profiles across each reactor.

Increasing the HRT from 24 hours to 36 hours increased the percent tCOD removals from 23.39 ± 10.01% to 35.27 ± 11.47% in the two reactors. A higher NH_4^+ -N reduction of 122.5 ± 41.25 mg/L is achieved in AMBB/ASGR only at lower NH_4^+ -N loading rates (0.06-0.19 g/L-d). Average NH_4^+ -N reduction at NH_4^+-N loading rate range of 0.22 – 0.48 g/L-d was 150.06 ± 92.04 mg/L in the two reactors. The concentrations of NO_2^- -N in both reactors were relatively greater than 100 mg/L as long as the calculated free NH_3 concentrations in the effluent were higher than 1 mg/L and at concentrations greater than 0.001 – 2 mg/L of free HNO_2.

ENE 200110   ENCARNACION, Ronnie H. (MS Env. Eng'g)
Reduction of Microbial Contamination in Septic Tank Sludge by the Process of Composting: Effects of Type of Bulking Agent and Volume Ratios of Septage to Bulking Agent. 2001

This study was conducted to evaluate the feasibility of reducing microbial contaminants (i.e. fecal coliform, salmonella, and helminth eggs) in the dewatered septic tank sludge or "septage". The dewatered septage and bulking agents were co-composted following the simple and cost-efficient windrow composting process. The dewatered septage exhibited characteristics such as high moisture content, low volatile solids, and low carbon content – parameters that are significant to composting. In addition, the septage possesses adequate nitrogen level (1.73% drb), low metal content, and reduced levels of fecal coliform (E.coli) that can be attributed to the anaerobic digestion it underwent inside the septic tank. In order to enhance the septage composting capability rice straws, sawdust, and woodchips were used as bulking agents (BA's). These bulking agents have become sufficient source of carbon (TOC>42%), high

solids content and give structure to the windrow pile. The blending of the dewatered septage and BA's has produced a compost-blended feedstock that has the capability of composting. However, the plastic nature of septage (moisture content – 78%) resulted to difficulty in handling the compost feedstock. Mixing ratios of 1:1, 1:2, and 1:3 on the volume basis were formulated to address the earlier concern in handling and establish a more practical approach in monitoring for microbiological destruction.

Initial co-composting of the raw materials has achieved thermophilic temperatures for both sawdust-septage mixtures and woodchips-septage mixtures. A maximum of 42 °C was attained in the first week of composting but due to limiting factors like small windrow pile volume, atmospheric condition, and numerous voids on the set of mixtures with woodchips as BA's, temperature decreased. pH likewise declined in the initial phase of composting as organic acids were produced. Fluctuations in the operating parameters such as pH, temperature, and organic matter content (TVS) were noted. Temperature values in all mixing proportions have fluctuated to ambient levels and the pH values approached 7.0 towards the end of the composting period (after 60 – 70 days). Sawdust and rice straws amended compost mixtures accomplished 95% reduction in fecal coliform. All compost products have passed the USEPA guideline for pathogen reduction (Salmonella, E. coli, Helminth eggs) prior to land application. Assessment of the composting process has identified all the woodchips-septage, mixture have achieved the highest reduction in combustible organic matter content (TVS-25%), fastest composting period (61 days), and a temperature of 41°C.

ENE 199911   GHIMIRE, Ashok B. (MS Envi. Eng'g.)
Start-up of Full-Scale Two-Stage Upflow Anaerobic Sludge Blanket (UASB) Reactors Treating Distillery Slops. 1999

This study is an evaluation of the start-up performance of full-scale two-stage upflow anaerobic sludge blanket (UASB) reactors, treating distillery slops of an alcohol distillery in the Philippines. Each stage consisted of three reactors. These reactors were inoculated with non-granular seed sludge acquired from an existing methane upflow reactors (MURs), treating slops of the same distillery. The reactor pH was stable

and within the range, i.e., 6.8-7.5. The temperature of the reactors was within the desired operating range of 35-38°C (mesophilic). There were no observed reactor upsets which could be attributed to sudden increase in volatile fatty acids (VFA) levels in the reactor contents, indicating that the system had sufficient buffering capacity. The methane content of the biogas was 57-62%. The produced biogas was used to generate power for the plant operations.

An upflow velocity increment of 0.4m for every day resulted in sludge washout, especially in the second-stage reactors. Nevertheless, after the re-addition of more seed sludge and nuclei to the reactors, and adjusting the upflow velocity increase to 0.5m for every 2-4 days, the sludge production and its retention in the reactors significantly improved with time.   Sludge concentration varied over the depth. It was higher in the lower sections of the reactors. The smaller and poorly-settling sludge were slowly washed out of the reactors while a heavier and better-settling sludge developed in the lower depths of the reactors. As a result, more sludge with better settleability accumulated in the reactors.

The COD_t removal efficiency of the reactors was widely varying. This could be attributed mainly to shock loadings caused by inconsistent COD concentration and volumetric flow rate of the influent, and insufficient quantity of sludge. The first-stage reactors performed fat better compared to the second-stage reactors in this regard. The second-stage reactors were severely affected by highly varying concentration of the first-stage effluents. However, in the light of significant improvement in the sludge production and its accumulation in the reactors, it could be projected that the first-stage reactors would reach the steady-state condition in about 220 days and the second-stage reactors in about 280 days as well. To conclude, the overall start-up performance of both first- and second-stage UASB reactors was satisfactory.

ENE 200312   GO, Jason V. (MS Env. Eng'g)
The Chemical Oxidation of Trichloroethylene (TCE) and Tetrachloroethylene (PCE) in Contaminated Aqueous and Soil Systems Using Modified Fenton's Chemistry. 2003

Chlorinated solvents indiscriminately disposed to the subsurface impacts not only the soil but may potentially contaminate the groundwater

thus impacting the human health as well. Residual contaminants are left in the pores of the soil matrix as the solvent migrate in the subsurface, which in turn may serve as long term source of groundwater contamination. Treatment and removal of these contaminants may be facilitated by chemical oxidation using Fenton's chemistry. Hydroxyl radicals formed by the action of hydrogen peroxide and the ferrous ion catalyst chemically degrade these organic compounds to relatively benign by-products such as carbon dioxide, water and metallic salts.

In the study, the viability and efficacy of using Fenton-like chemistry in the chemical oxidation of chlorinated solvents, specifically trichloethylene (TCE) and tetrachloroethylene (PCE) in contaminated aqueous and soil systems was evaluated. The study was divided in two experimental phases which included aqueous studies and soil vial experiments.

Bench-scale treatability studies done on the TCE and PCE-contaminated aqueous and soil samples maintained at near neutral pH conditions showed significant contaminant removal. Aqueous samples treated with 0.521 M hydrogen peroxide and 1:1 (M/M) chelated catalyst concentration ratio resulted to a 95.83 ±5.28% COD removal. Soil vial experiments conducted on contaminated soil samples using GC headspace analysis resulted to 93.62 ± 0.34% TCE and 94.40± 0.35% PCE removal upon treatment. The reagent mass loading rate to the soil samples was 20000 mg hydrogen peroxide, 0.0271 mg iron and 0.00789 mg citric acid per kg of soil. The experimental results, hence, show conclusively that chemical treatment based on Fenton-like chemistry is technically viable in removing organics in both aqueous and soil systems maintained at near neutral pH.

ENE 200313   JOSE, Joselito N. (MS Envi. Eng'g)
Development of a Dilution Protocol for a Treatability Test Using the Sequencing Batch Reactor (SBR) on Specific Industrial Effluents. 2003

The main objective of the study is to develop a dilution protocol for treatability of industrial wastewater using aerobic biological process thru a

laboratory scale Sequencing Batch Reactor (SBR). The industrial effluents to undergo treatability are from pulp and paper waste, brewery waste, airlines and food catering waste, and waste from textile wash down water. The SBR will be operated using a similar cycle time of approx. 8.25 hours, 6 hours aeration, 1.5 hours settling, 0.25 hour filling, and hour idle time. There are two kinds of sludge to be used in the experiments, one from the existing wastewater treatment plant of Baguio City and the other one from a commercial blend of bacterial culture – RBC 106. An initial dilution protocol for the specific industrial effluents based on 10% increments was used initially. The results of the experiments show that this initial dilution protocol is workable protocol as far as COD degradation is concerned although this leads to process upset in the initial runs of the SB Reactor. Upset condition of the SBR was overcome by the system after third and seventh cycle runs of the experiment, which is when there is substantial mass of the sludge present in the SBR, which are acclimated to the wastewater. The behavior and performance of the SBR were verified by monitoring the removal of conventional pollutant parameters particularly COD and TSS. The results gathered in the experiments were used to optimized the initial dilution increment/interval protocols adopted in the experiments to assure optimum removals of the chosen contaminant and to shorten the treatability time involved. Optimization resulted in the formulation of new dilution criteria that will assure positive degradation of COD and easy attainment of steady state condition. The initial dilution protocol has been fine tuned to overcome the upset of the system on the earlier runs and a target COD removal range derived from the experiments is adopted. Fine tuning for the first and earlier runs should be done by using a 5% increment/interval until the observed COD removal of 5 to 30% is achieved, then 50% dilution is adopted whenever the COD removal of >30 to 60% is observed. At this stage, the sludge is well acclimated and increase in dilution should be done using 70% dilution when the COD removal of >60 to 80% is achieved, and finally 100% of pure wastewater has to be fed to the SBR system whenever the observed COD is >80%. Trials are stopped when COD removal rates approach steady state. This dilution criteria is applicable to the SBR experiments whenever the seed sludge has grown substantially and with minimum MLSS concentration of approx. 400 mg/L.

The refined SBR dilution protocol with expected range of COD removal could be used as a guide in operating, commissioning, and starting-up a full scale SBR Treatment Plant. The experimental results demonstrated the applicability, advantages, and feasibility of using SBR in treating five high strength industrial wastewaters following the systematic SBR dilution protocol. For a fixed react time of six hours and one and a half hours settling time, adopted in the study, biodegradable COD removal efficiencies >80% were achieved at influent COD of 300 mg/L to 1400 mg/L. The SBR setup was found to be very effective in removing the influent TSS. DO readings during the SBR Process Cycle for all the experimental phases were also monitored ranged from 2 to 8 mg/L.

ENE 199714   LIM, Jose Marie U. (MS Env. Eng'g)
          Thermophilic Denitrification of High-Nitrate Industrial
          Wastewater. 1997

Thermophilic high-nitrate denitrification was investigated using a specific industrial wastewater with 14,000 mg/l of NO_3-N. The wastewater has a soluble COD of 110,000 mg/l, 75 to 85% of which was found to be ethylene glycol. The wastewater contains no ammonia or nitrite, making nitrate as the N-source for bacterial cell synthesis. A CSTR set-up was used for batch and continuous thermophilic denitrification. Biomass yield on the electron donor (ethylene glycol) and electron acceptor (nitrate) was found to be 80 to 85% lower when compared to results of mesophilic denitrification.

A pure strain of *Bacillus stearothermophilus,* a known thermophilic denitrifier was found to accelerate denitrification removal rates. The wastewater was supplemented with magnesium sulfate, sodium biphosphate, and Vishniac solution (combination of metals and other micro-nutrients).

The optimum temperature is 62 °C. Complete denitrification can be expected between 56 °C up 62 °C without significant nitrite accumulation. As temperature increases beyond this optimum temperature, the % nitrate removal rate decreases up to a low value of 10% at 75 °C.

The apparent inhibitory effect of ethylene glycol was observed at 20% WW possibly, due to the consequent decreases activity of water needed for cell synthesis. Complete denitrification was observed up to 20% WW concentration.

At a dilution rate 1 d^{-1}, complete denitrification is still achievable with nitrite accumulation of not more than 5%. Thermophilic biological kinetic parameters are: ki at 34 g/l; k_s at 36 g/l and μ_{max} at 2.2 d^{-1}.

ENE 199715   MENDOZA, Victorino C. (MS Envi. Eng'g.)
Noise Baseline Data for Ninoy Aquino Parks and Wildlife Nature Center: A Protected Area. 1997

Ninoy Aquino Parks and Wildlife Nature Center (NAPWNC) is one of the Protected Areas (PA) considered as an initial component under the existing Republic Act 7586 known as the National Integrated Protected Areas System (NIPAS) Act of 1992. Currently, NAPWNC is considered an area of national significance which is characterized by a harmonious interaction of man and nature while providing opportunities for public enjoyment through recreation and tourism.

In order to continue enhancing the quality of service to the visiting public, one of the intentions of this study is to help the administration of NAPWNC in the management of the said park through proper sectoring and zoning for a better and functional use as far as environmental noise and related control measures are concerned. Under the existing Department of Environment and Natural Resources (DENR) Environmental Quality Standard for Noise in General Areas, NAPWNC-PA is not yet specifically classified.

The setting to fast and instantaneous methods of the sound level meter was used in monitoring design schedule of sound intensity level within the NAPWNC area. The existing operational procedure for noise measurement of the DENR stated under the Official Gazette, Article 1 of Section 79, a-c [NPCC (12)] has been applied in gathering data to attain the quality of monitoring objectives. This method is expected to give reliable results for setting up noise baseline data.

The data gathered from the ambient sound level condition at the different established stations within NAPWNC can be used as baseline data in deriving a single and comprehensive regulation for the entire protected area throughout the Philippines in the same typical protected area (PA) set up. This baseline data can also be an important material in the preparation of Environmental Impact Assessment (EIA) for any proposed project within NAPWNC compound and its adjacent areas. Further to setting up the noise baseline data (NBD), this study details out procedures in data gathering as well as establishing noise trends and intensity levels within a certain study area. This will be an invaluable tool to others who area intending to pursue further studies in this field of endeavor.

ENE 199916   NABATILAN, Marilou M. (MS Envi. Eng'g)
Effect of pH and Ammonium on Lipid Degradation in the Anaerobic Digestion of Fish Processing Wastewater. 1999

The effects of pH and ammonium on lipid degradation in the anaerobic digestion of fish processing wastewater were determined in batch experiments. These experiments were conducted at pH levels pH4, pH5, pH6, pH7, and pH8. LCFA analysis performed at pH4 and pH8 showed that both lipid hydrolysis and lipid acidification were inhibited at low pH, e.g., at pH4. Furthermore, it was shown that at pH8, lipid acidification is limited by lipid hydrolysis. Thus, it shows that lipid hydrolysis is rate limiting at pH8. No significant differences were observed on lipid degradation among pH treatment levels pH6, pH7, and pH8. Studies on total COD conversions, however, suggested that COD hydrolysis, COD acidification, and COD methanogenesis were optimal at pH7.

The treatment levels of ammonium (as NH^{4+}-N = 0.0, 0.3, 0.6, 0.9, and 1.5 g/l) did not significantly affect lipid degradation, specifically, lipid acidification. Analysis of total COD conversions (hydrolyzed, acidified,

and methanogenized) however, showed significant differences between ammonium levels 0-0.9 g/L and 1.5 g/L. Since the fish wastewater also contains proteins, this difference is considered an effect of protein degradation. Protein degradation (specifically, protein acidification) is more susceptible to high ammonium concentration than lipid degradation.

ENE 200017   PANDAN, Mary Ann T. (MS Envi. Eng'g)
Identification of Vulnerable Areas in Bago City Using the Drastic Approach and Simulation of Lead Transport in the Underlying Aquifer Using ASMWIN. 2000

The DRASTIC system which is an assessment method based on the hydrogeological setting was used to determine the relative vulnerability to groundwater contamination in Bago City. Seven parameters, namely (1) D – depth to groundwater (2) R – recharge rate (3) A – aquifer media (4) S – soil media (5) T – topography (slope) (6) I– impact of the vadose zone and (7) C – conductivity (hydraulic) of the aquifer were used to assess the potential for contamination in the study area. Highly vulnerable areas were identified in the coastal areas while the least vulnerable areas were in the mountainous regions.

Using the DRASTIC index, possible sources of contamination were evaluated. The one which presents the greatest risk was established and this is the open dumpsite. For this type of source, the threat of leachate infiltration was considered and its annual volume was calculated at 273020 m3. The heavy metals in the leachate were of major concern specifically, lead (Pb) and based on monitoring data from a similar disposal site, its concentration was assumed to be 0.397 mg/L.

Modeling of the transport of the lead component in the leachate was done using the Aquifer Simulation Model for Windows (ASMWIN). Hydrologic models of the two aquifer systems within the study area were done and the results were used to model the movement of the lead and its contaminant plume. Results indicate that in the confined aquifer, the influence of lead will only be felt in the vicinity of the source and the resulting concentrations will have a minimal environmental impact on the area. In the unconfined aquifer, it was determined that the contamination will not have any significant effect.

ENE 200118   QUEBRAL, Ricardo D., Jr. (MS Envi. Eng'g)
Reconstruction of Past Heavy Metal Concentration in the Sediment Using the Seagrass *Enhalus Acoroides* (L.F.) Royle as a Biological Indicator. 2001

Bioindicators of heavy metals often describe the recent changes in concentration levels in the marine environment rather than the past metal concentration profile. A correlation study was conducted to test the possibility of reconstructing the historical profile of heavy metal concentration in the sediment by analyzing metals absorbed by the seagrass *Enhalus acoroides.* Copper, calcium, lead, and zinc which accumulated in annual sections of the rhizomes and dead leaf fibers of the seagrass were correlated with the concentration levels in the sediment for the corresponding years.

The copper levels in the sediments and in the two seagrass parts were found to be significantly correlated across the seven-year period with R^2 values of 66% for sediment vs. rhizome and 32% for sediment vs. dead leaf fiber. Significant but very low correlation was found for zinc (R^2 sediment-rhizome: 8%; R^2 sediment-dead leaf fiber: 11%). No significant correlation was found between seagrass and sediment for lead. It was concluded that *Enhalus acoroides* is a potential bioindicator in the reconstruction of past copper concentration in the sediment. However, further studies must be conducted to improve the correlation of copper between seagrass and sediment by considering other environmental factors that may have an effect on metal uptake of the seagrass.

ENE 200219   RACOMA, Lizandro C. (MS Envi. Eng'g)
Phytoextraction of Lead and Chromium in a Land Treating Unit of an Oil Refinery Using *Vetiveria zizanioides* (L.) Nash. 2002

This study aims to determine the possibility of using *Vetiveria zizanioides* (L.) Nash in the phytoremediation of soil contaminated with lead and chromium and the effect of ethylenediaminetetraacetic acid (EDTA) in the phytoextraction of these metals. EDTA at a concentration

of 1 g/kg soil was applied to the root of *Vetiveria zizanioides* (L.) Nash two weeks after transplanting. The weight of the root and shoot of the plant as well as the concentrations of chromium and lead in them were measured every month for a period of six months.

In the six month period, there was a net increase in the concentration of chromium and lead in both the root and shoot of the plant. At the 6th month, the mean concentration of Cr in the root and shoot were 21.67 mg/kg ± 2.27mg/kg and 6.35 mg/kg ± 1.89 mg/kg, respectively, while those of Pb were 9.38 mg/kg ± 1.16 mg/kg and 4.92 mg/kg ± 0.39 mg/kg, respectively. Total accumulation of chromium and lead in *Vetiveria zizanioides* (L.) Nash increased in time. The concentration and total accumulation of chromium and lead in the root and shoot of *Vetiveria zizanioides* (L.) Nash were not significantly different between o g EDTA/kg soil and 1 g EDTA/kg soil. The chromium and lead concentrations and their total accumulations in the root and shoot of Vetiveria zizanioides (L.) Nash were both significantly higher in the root than in the shoot.

The total accumulation Cr in the root plus shoot was 21.99 mg ± 2.38 mg while 10.61 mg ± 0.24 mg for Pb cluster of vetiver. The accumulated metal in the plant was still increasing at the 6th month and has not yet reached maximum levels. This study has shown that even without EDTA applied on soil, *Vetiveria zizanioides* (L.) Nash can be used for phytoremediation of soil contaminated with Pb and Cr.

ENE 199820   RIVERA, Cherry B. (MS Envi. Eng'g.)

> **Study of Carbofuran Partitioning Under Upland and Lowland Rice Farming Systems in Nueva Ecija and Bulacan. 1998**

Agricultural pesticides are effective tools for increasing crop yields and quality. This is because pests and diseases have always been major obstacles to crop production. However, continued use of pesticides have become a potential non-point source of contamination of the environment.

A study was conducted for the purpose of evaluating the fate and behavior of a commonly used pesticide, carbofuran, in rice farmlands through the use of a computer simulation model called PESTFADE, which stands for Pesticide Fate and Dynamics in the Environment. Data set on chemical, soil and climate were collected from rice farming systems in the provinces of Nueva Ecija and Sta. Maria, Bulacan to represent lowland and upland farming conditions, respectively.

Based on the results, it was found that the upland area in Sta Maria, Bulacan, is slightly susceptible to runoff/erosion as reflected in the mild soil loss during high rainfall events. The terracing practice being employed under this plantation indicates that despite the vulnerability of the sloping terrain to runoff and erosion, the transport of pesticides and sediments is slightly controlled. As for the leaching potential of the chemical, it was found that the pesticide did not leach up to the groundwater level even until the end of the growing season.

In contrast, in the lowland area in Nueva Ecija, the pesticide reached the groundwater only at 6 days after application with a concentration of 2.24 ppb, which exceeds the tolerable limits for carbofuran of 2 ppb as set by the World Health Organization (WHO). This has been attributed to the higher mass flow or leaching under saturated conditions. Therefore, under the lowland rice farming system, a management practice which can retard the flow of water and solutes is recommended to control groundwater contamination.

ENE 199921   SIERRA, Antonio L. Jr. (MS. Envi. Eng'g.)

Color Removal in Wastewater Using Attapulgite Clay. 1999

In order for water to be consumed in any desired amount without concern for adverse effects on health, it must be free from organisms that are capable of causing disease and from minerals and organic substances that could produce negative physiological effects. It must also be aesthetically acceptable i.e. it should be free from apparent turbidity, color, odor and any objectionable taste.

This study determines the ability of attapulgite clay on removing color in wastewater. Attapulgite clay, a locally available clay mineral, was used in different processes such as filtration, adsorption and coagulation. The results from the experiments were compared to that of other color removal processes such as activated carbon adsorption, alum coagulation and polymer coagulation.

ENE 199822   TANCHULING, Maria Antonia N. (MS Envi. Eng'g)
Proposed Environmental Performance Rating System
for Manufacturing Plants. 1998

The Department of Environment and Natural Resources launched the Industrial Ecowatch project in 1996. It is a public information program where factories are given color-coded ratings based on the efforts of the companies to manage its release of pollutants to the environment. Gold, green, blue, red and black correspond to the following ratings respectively: excellent, above average, average, below average and poor. Ratings will be made known to the public through the media.

This study was conducted to evaluate the limitations of the Ecowatch Rating System and to propose an alternative. The major shortcomings of the Ecowatch Rating System are the ambiguous indicators for the criteria on completeness and accuracy of data from the self-monitoring reports.

The main features of the proposed rating system are the application of statistical techniques to test for randomness and representativeness of data and the use of the wastewater standards for conventional parameters as 90th percentile values. To refine the original Ecowatch Rating System, additional system features include the following: indicators for poor maintenance of waste treatment plant (WTP), factory selection criteria and procedure, identification of parameters to monitor, and a procedural flow on how to conduct the ratings.

The proposed rating system was applied to thirty-one manufacturing plants and compared with the results from the original Ecowatch Rating System. The number of blue companies increased from

two to four due to the use of standards as 90th percentile values. The number of companies categorized as "under assessment" decreased from eighteen to eleven, signifying that there is less room for uncertainties in the proposed rating system.

The proposed Ecowatch Rating Criteria can replace the current Ecowatch Criteria to improve the bases for judgment. It can also improve the regulatory function since it contains safeguards against fraudulence in SMRs and incentives for the proper and continuous operation of WTPs.

ENE 199423   TIO, Barbara Dar J. (MS Envi. Eng'g)
Polymeric Encapsulation of Heavy Metal Bearing Sludge. 1994

The study attempted to employ polymeric encapsulation as a viable alternative for the handling and disposal of heavy metal bearing sludge produced from the wastewater treatment of a semiconductor firm. Two encapsulation agents were employed in the investigation; a thermoplastic and a thermoset. Virgin polypropylene resin and unsaturated polyester resin were used for thermoplastic and thermoset encapsulation, respectively.

Sludge concentration using thermoplastic material as binder was varied from 10 to 40 per cent by weight to determine the optimum sludge-polypropylene ratio. A 30 per cent concentration was found to be an ideal value during blending/compounding. The thermoplastically encapsulated experimental, slabs were subjected to tensile, impact morphological, and leaching tests. Results of these tests showed that tensile strength of the material is decreased as the sludge content is increased while that of impact test almost remain unchanged. Morphological analyses revealed that binding of sludge particles was merely physical entrapment through encapsulation. Leaching test confirmed that thermoplastic encapsulation immobilized the heavy metal contents of the sludge. For the thermoset encapsulation, the amount of sludge used was 50 to 80 percent. The sludge-resin mix containing more than 60 per cent sludge lumps and unpourable. On the other hand, mixture with 60 per cent sludge gave satisfactory results based on its consistency, moldability, and smooth

appearance of the encapsulated artwares. The artwares were stored at varying conditions for one month and was found to have no remarkable change except for the slight decrease in weight of the sample which can be attributed to the evaporization of water formed during condensation polymerization. Leaching test on the thermoset encapsulated sludge was also conducted. The results showed that thermoset encapsulation likewise immobilized the heavy metal content of the sludge to a lesser extent compared to thermoplastic encapsulation.

ENE 200124   TORRES, Wilma S. (MS Envi. Eng'g)
Simulation of Activated Sludge Treatment Using ASIM 1 version 3.0 with Extant Kinetic Biodegradation Parameters. 2001

Experimental determination of extant biodegradation kinetic parameters maximum growth rate û (hr^{-1}) the and half-saturation constant K_S (mg/L) was conducted through respirometry using activated sludge as biomass and wastewater as substrate taken from an existing activated sludge plant. The wastewater is generated from the process washings of consumer products formulated from sulfonated/sulfated surfactants and contains only a minimal amount of phosphates (0.07%) and no nitrogen-based compounds.

Values determined for the maximum growth rate û ranged from 0.360 ± 0.018 hr^{-1} to 1.188 ± 0.036 hr^{-1}, with 95% confidence intervals. Values determined for the half-saturation constant K_S ranged from 6.8 ± 0.4 to 8.2 ± 0.4 mg/L with 95% confidence intervals.

These parameter estimates were used along with process information to generate simulations into the ASIM ver 3.0 software. Actual influent COD values from facility records were also inputted. Chi-square (x^2) tests were run at a confidence level of α = 0.05. The simulation runs were successful in predicting effluent COD values if influent conditions were within 75% of the typical influent COD.   However,

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simulations generated using influent COD values more than 75% of typical influent COD were observed to have significant discrepancies between the predicted and actual COD values. Further studies are recommended on how ASIM can model the impact of shock load variations on effluent COD. The assumption of Monod kinetics may need to be re-evaluated for high COD concentrations, which inhibit biodegradation. Finally, sampling techniques may need to be redefined to provide a better basis for simulation comparisons.

ENE 199325 TUBONGBANUA, Marlo C. (MS Env. Eng'g)
An Evaluation of the Efficacy of Compost Fungus Activator on Aerobic Composting of Wet Market Solid Wastes. 1993

A study on the evaluation of the efficacy of *Trichoderma harzianum Rifai,* known as compost fungus activator (CFA), in aerobic composting of wet market solid wastes (WMSW) was conducted. Characterization of WMSW showed that 85 to 94% of the waste is highly biodegradable which favors composting as a mode of valuable material recovery in the form of compost and as a method of minimizing the bulk of the wastes for disposal.

The bench study revealed that, on the average, composting with CFA inoculation lasted for about 14 days with pile temperature that remained in the range of 40ºC to 48ºC for the first 6 days while the unseeded runs lasted for 16 days with pile temperature identical to the experimental runs. The results also showed that CFA can reduce the biodegradation time of WMSW but the difference in ripening period and the weight losses of the substrate used between the experimental and control runs are not significant at 5% level.

Compost derived from WMSW has low nitrogen, phosphorus and potassium values that can only be classified as soil conditioner and still contains adequate counts of microorganisms that health risks associated with its handling is at stake.

ENE 200026   VALMONTE, Edna DG. (MS Envi. Eng'g)
Degradation of Linear Alkylbenzene Sulfonates (LAS) During River Water Infiltration: Laboratory Column Studies. 2000

The degradation or removal of commercial linear alkylbenzene sulfonates (LAS) associated with directly discharged domestic wastewater during river infiltration has been investigated. Laboratory column experiments under aerobic (wastewater influent was aerated) and anaerobic (wastewater influent was not aerated) conditions were conducted on saturated river aquifer sediments. The LAS concentrations of the effluent samples across the column depth were analyzed using the methylene blue active substances (MBAS) method.

LAS was rapidly metabolized by the acclimatized microorganisms in the columns. It also supported microbial growth acting as a sole carbon and energy source. The LAS and COD removal rates for the aerated system of the experiment were maximum within the first 10-cm flow distance. LAS and COD were further removed as the flow distance increased with relatively slower rates.

As a general observation, oxygen plays an important role in the biological degradation of LAS and COD. In the aerated systems, as the oxygen is consumed within the first 10-cm of the column, both LAS and COD were easily degraded. As the flow distance increases from 10-cm to 40-cm, the oxygen concentration available to support microbial activity of aerobic bacteria decreases resulting to lower rates of LAS and COD removal.

In the non-aerated condition, the effects of the removal of oxygen in the effluent was manifested in the decreased LAS and COD removal rates particularly in the first 10-cm of the column. Compared to the aerated condition, the removal rates were significantly lower in the non-aerated condition.

When the glucose was removed as a carbon source from the wastewater, the microbial community used LAS as their carbon source as manifested by the reduction of the LAS concentration ratio (LAS/LAS_0).

Removal of nitrate in the system has increased both LAS/LAS_0 and COD/COD_0 values. This might be explained by the cessation on the denitrification.

The pH level increased rapidly during the first 10-cm flow distance. It stabilized at a range of 6.2 to 6.8 as the flow distance increases. This increase in pH value was the result of alkalinity generated during the conversion of nitrate to nitrogen in a denitrifying system.

When actual river water was fed in the column, the microbial community was able to mineralize the LAS up to a LAS/LAS_0 value of 0.3.

The kinetic constant of an assumed pseudo first-order reaction model decreases with the flow distance as observed in the aerated system. The rate constant was however variable in the other phases of the experiment.

ENE 200027   VERIN, Gerry T. (MS Envi. Eng'g)
Effect of High Concentrations of Nitrate (1-3g/L) and Glucose (3-12 g/L) on Thermophilic Denitrification. 2000

This study investigated the effects of high-substrate (3,432 to 11,440 mg/l COD) and high-nitrate concentrations (1,000 to 3,000 mg/l NO_3-N) on thermophilic denitrification by *Bacillus stearothermophilus* at 62°C. Series of batch experiments were conducted in a 1.5 liter glass Applikon reactor. Synthetic wastewater, containing nitrate and glucose was prepared for the experiment and was supplemented with the necessary macro-and micro-nutrients.

Wastewater containing fixed 1,000 mg/l NO_3-N was denitrified with increasing percentage of excess COD (20 to 300% excess as glucose). The rate of denitrification decreased as the percentage excess glucose increased.

In another series of batch experiments, both NO_3-N and glucose-COD concentrations were increased while maintaining the COD/N concentration ratio constant at 20% in excess. At higher NO_3-N and

glucose-COD concentrations, the rate of denitrification, was lower. Compared at the same initial glucose-COD concentration, the rate of denitrification was lower at higher initial NO_3-N (2000 mg/L compared to that at 1000 mg/L).

In another series of batch experiments, the initial NO_3-N concentration was varied while the initial glucose-COD was kept constant but not sufficient for the runs at higher NO_3-N levels (2000 & 3000 ppm). The time at which maximum denitrification was achieved increased at increasing initial NO_3-N concentrations, this was due to the possible aging of the biomass.

ENE 200028   VILLADOS, Danilo P. (MS Envi. Eng'g)
Impacts of Volcanic Ejecta on Surface Water (Mt. Pinatubo Case). 2000

This study was designed to determine the possible effects of volcanic materials on surface water of the Pampanga River following the deposition of sediments particularly during the rainy season. After the June 1991 eruptions of Mt. Pinatubo, tons of volcanic debris had been deposited over a broad area. On the onset of rainy season, these volcanic materials or pyroclastic fall deposits are mobilized, blocking up all available spaces towards low-lying area. Lahar, a mixture of water and volcanic debris from Mt. Pinatubo contains sediments and minerals, which may contaminate rivers along the periphery of Mt. Pinatubo and low-lying rivers including the Pampanga River. The Pampanga River is one of the most important rivers in Central Luzon supplying about 14,716 million cubic meters of water for agricultural, industrial and domestic/municipal use. At present the surface water of Pampanga River is being used largely for irrigation of various crops.

The conclusions drawn from the evaluation of the surface water characteristics of the Pampanga River are as follows:

1. The surface water of the Lower Pampanga River (LPR) remains a potential source of surface water for various requirements, despite the continuous flows of lahar from Bamban River Basin. Specifically, the soluble salts and total dissolved solids are at low levels. Sodium content is very low, thus, sodium hazard will not be a problem if ever the water is utilized for irrigation purposes. The

river water maintains its high levels of calcium and alkalinity while sulfate and chloride levels have increased from values obtained in 1976-1977. Their levels however, were still within the acceptable limits. Other water quality parameters were unaffected by the flow of volcanic materials.

2. The results of monitoring in July 1997 indicated that the ratios of total dissolved solids (TDS), electrical conductivities (EC) and sulfate at Arayat Sampling Station at LPR and San Isidro Sampling Station at Upper Pampanga River (UPR) were 1.3, 1.2 and 2.0, respectively.

3. The results of forecasting indicated that EC and chloride values at Arayat Sampling Station at LPR may reach the 1995-1997 levels observed at San Isidro Sampling Station at UPR after the rainy season of year 2000 and the levels of TDS and sulfate beyond 2001. The rates at which TDS and sulfate are decreasing per year are 3.0% and 4.5%, respectively.

4. Variations in water quality maybe attributed to the intensity of rainfall, volume of sediments being deposited at the source, and water discharge at Arayat Sampling Station at LPR.

5. The surface waters of both the Lower and Upper Pampanga River, in general, remain a good source of water for irrigation of various crops.