

ENVIRONMENTAL ENGINEERING (ENE)

- ENE 8101 Peralta, Genandrialine L. (MS Env. Eng'g.)
Developing a solid waste management plan for the
Philippines Diliman community.
1981.

The communal storage facilities within the community are unsuitable for proper storage of refuse in the strictest sense, but they could still be utilized with corresponding modifications for about 3-5 years more after which they should eventually be phased out. Storage at the household level is not uniform; most of the containers are without cover and are not well maintained.

One-way collection, as in the use of portable disposable containers which provide direct emptying into a vehicle, offers higher productivity and lower health risks to workers. Repair is confused with maintenance, which implies that preventive vehicle maintenance is not practiced. The collection system at U.P. community has an overuse of labor, utilizing five men per crew. There is an apparent need for new and more collection vehicles that will service the total U.P. community.

Open land dumping and burning as methods of solid waste disposal are definitely improper for an academic community such as the study area. The U.P. refuse, depending solely on its own potentials, may not be appropriate as a composting substrate mainly because its C/N value is very much less than what is normally required. For U.P. campus, as in other small communities, it is outright obvious to dismiss incineration as a solution to the problem of waste disposal, because of the constraints in terms of capital and operating costs, which are beyond its present means. Based on the accomplished studies and analysis, sanitary landfill has been found capable of solving the

solid waste disposal problems of U.P. on a medium range approach. However, this can be projected only after detailed studies, extensive surveys, and complete evaluations of potential landfill sites have been made, long range land use zoning plans and other more pressing parameters determined. In terms of both cost and environmental protection, sanitary landfill emerges as the most suitable method of solid waste disposal. Besides, there is available land close to the source of wastes.

Success of any resource recovery activity depends on the availability of markets for the salvaged products, economic viability of the process, and where pre-separation at home is required of practiced, public acceptance and cooperation. In the salvaging of paper and bottles, segregation at the source (especially paper) could most likely prevent their depreciation as when taken from mixed refuse. The resource recovery practiced within the study area cannot be marked a success due to several drawbacks, among which are poor entrepreneurship and lack of stable market.

ENE 8202 de Castro, Teresa R. (MS Env. Eng'g.)
A study of copper and zinc content of green mussels collected in coastal waters near industrial and rural areas.
1982.

The levels of copper and zinc concentrations in the green mussel, Perna viridis from an urban area (Bacoar, Cavite) and a rural area (Himamaylan, Negros Occidental) were determined by atomic absorption spectrophotometry. The results have shown that zinc levels in Perna viridis were higher in the urban area than in the rural areas. The results for copper concentration in P. viridis for both study areas were comparable. Zinc and copper concentration in P. viridis reached a peak in the month of July. Values for copper and zinc during the summer months of April-June were lower than those of the rainy months of July-August. Zinc concentrations were much higher than that of copper and this can be explained by metals in Perna viridis.

Results of the study indicate that zinc is the more appropriate metal to analyze in assessing heavy metal pollution if the test organism to be sampled is Perna viridis.

ENE 8203 Gaspillo, Pag-asa D. (MS Env. Eng'g.)
A fundamental study of the shearing stress of biological film in a trickling filter process.
1982.

A well established model for microbial growth in trickling filters has been used to study the effective hydraulic loading range and its corresponding shearing-stress that would develop and maintain an active biological film community for super-high rate operations.

Two separate models were used, one in laboratory scale and the other is pilot-scale trickling filter. Experimental investigations for pilot scale were limited to hydraulic loading rates test at no bio-mass hold-up due to very limited time and that very low winter temperature in Tokyo, Japan (below 10½C) where the research was conducted, prohibited any microbial growth on filter media. However, values obtained from laboratory scale experimentation at different flow velocities of waste water were interpreted for characterization of the bio-mass system for pilot scale experimentation. These values were based on constant BOD loading conditions within the range of 40 to 60 ppm.

An empirical formulation which relates shearing stress to hydraulic loading rates was developed, given in the form:

$$T = 0.01463 Q^{0.5024}$$

and detention time to hydraulic loading:

$$t_d = 644.6144 Q^{-0.47889}$$

Hydraulic loading rates within the range of 90 - 215 (m^3/m^2 - day) were found effective in the investigations conducted, and that a critical lower range of 28 (m^3/m^2 -day) and below were suggested.

ENE 8204 **Manalastas, Susan M. (MS Env. Eng'g.)**
Treatment of black liquor by the anaerobic upflow
filter.
1982.

This study resulted from an experimental investigation made to verify the effectiveness of anaerobic treatment of black liquor. The anaerobic filter of the upflow type was used as the treatment process.

The anaerobic filter had been found to be effective with the black liquor in terms of gas recovery, but low in treatment efficiency. Results showed that using a hydraulic loading of 700 ml per day, BOD reduction was 9.1 percent and gas production rate was 750 ml per day; for 1,000 ml per day hydraulic loading, BOD reduction was 9.5 percent and the rate of gas production was 1,174 ml per day. A 1,000 ml per day loading gave a 19.3 percent BOD reduction and a gas production rate of 938 ml per day. Lastly, at 2000 ml per day hydraulic loading, BOD reduction was 8.7 percent and production rate of gas was 164 ml per day.

In spite of the low BOD treatment removal exhibited by the anaerobic filter process, its non-dependence on oxygen, the small amount of sludge produced and its conversion of organic matter into basically carbon dioxide and methane make the anaerobic filter process a worthwhile low-cost alternative to be considered in wastewater treatment.

ENE 8305 **Espiritu, Angel B. (MS Env. Eng'g.)**
Computer modeling of oxygen in Marikina River.
1983.

A mathematical characterization of the physical, and biochemical processes responsible for the existing water quality profile of the Marikina River was developed by utilizing a modified concept of the Streeter-Phelps oxygen-sag equation model. Aside from the two mechanisms (deoxygenation and reaeration) already considered in the original formulation, several other processes, respiration, and photosynthesis, were incorporated into the model.

The model predicts the annual mean BOD and DO profiles

of the Marikina River. Verification results over a 5-year modeling framework indicate close agreement with field data. Computed median relative errors compare reasonably with findings in literature.

Finally, the sensitivity of the model to the varying values of system parameters was tested. It was found that the DO concentration in the stream is: relatively sensitive to the oxygen concentration in the waste discharges and to the values of the rate coefficients L_p and S_R ; sensitive to a lower degree to the magnitude of the waste loads and to the values of the rate constants k_1 and k_2 ; and almost insensitive to the value of rate constant k_3 .

In relatively clean water, the DO fluctuates near the saturation value as source (oxygen added by the surface reaeration and photosynthesis) and sinks (oxygen removed by aquatic microorganisms, respiration of plants and benthic demands) are approximately equal. However, in streams receiving high concentrations of oxidizable waste, this natural balance is upset, and the DO drops appreciably. The process by which a flowing stream exchanges oxygen with the atmosphere; the effects of microbial decay; and the mechanisms of sedimentation, absorption, resuspension, runoff, respiration, and photosynthesis have been studied extensively and mathematical models to simulate these natural processes have been developed.

ENE 8306 Portal, Marisol G. (MS Env. Eng'g.)
Developing a simulation model for refuse collection
for Iloilo City.
1983.

The study aims to develop a computer simulation for refuse collection system in urban areas using Iloilo City as the study area. Prime consideration for the simulation are economics and routing schemes. Two interactive models were designed to derive the optimal solution. The models can be subjected to different combinations of operating variables and can comparatively be used to determine the cost and quality of operation for each of these combinations. The operating variables examined were crew size, frequency of collection, and truck capacity.

A time and motion study was conducted to determine the

characteristics and operations of the collection system of Iloilo City. This includes the rate of collection of crews, rate of travel of collection trucks, slack time and unloading time, and the probability distribution of the observed values of these characteristics. The refuse production per street and its daily fluctuations/variations and the characteristics of the street networks of Iloilo City were taken into account.

The present collection operation in the city was studied and compared to the optimum routes derived. It was observed that the optimum route derived if operated will render a higher efficiency, serve a bigger population and cost lower than the present collection system. The scheme derived will involve seven 3-manned-14 cubic meter dumptrucks (not including driver) serving Iloilo City Proper and Molo district daily and the districts of Jaro, La Paz and Lapuz thrice a week.

The models were simulated negating the effects of rainy season, fatigue of crews, number of stops per street, width of streets and traffic loading. The effects although appreciable were not included since these will involve working on parameters which are beyond the control of the observer; e.g. fatigue and weather.

ENE 8407 Tuazon, Felizardo N. (MS Env. Eng'g.)
Philippine model study : the interrelations of
population, pollution, natural resources, capital
investment and agriculture.
1984.

Human activities represented by capital investment, agricultural production, natural resource usage, pollution generation, interrelated to each other and to man's number, is modelled using Forrester's world structure based on his method of feedback dynamics. Forrester's results portrays of an uncontrollable decline of human activities and number within a century for the world condition.

Since Forrester's model may be utilized for a national entity, the Philippine condition is simulated using it. The result is similar to that for the world condition, in fact the "collapse is more intense this time.

Scrutiny to Forrester's model lead to modification of

the system structure which is the addition of control loops to pollution and capital investment. These loops represent the ability of human decision and the economy to abate pollution, and the cost adjustment for increased utilization of energy. Simulating the Philippine condition with this modification does not necessarily lead to a collapse.

The model finally created is "intuitive" in that it conforms with current developmental policies. Increase in capital investment generation and natural resource pool, and population control lead to enhanced human condition. Several other policy implementations, for instance lowered pollutant emissions, decreased capital investment generation, etc., may be carried out using the model.

This work however is necessarily at a high level of abstraction due to the fact that many of the assumptions adapted and utilized are yet subject to verification, for which further study is suggested.

ENE 8508 **Macaranas, Esperanza M. (MS Env. Eng'g.)**
Joint municipal and agricultural refuse management for
Baguio City and La Trinidad.
1985.

The small volume of solid wastes and suitable site in La Trinidad, and the large volume of refuse in Baguio City without suitable site for sanitary landfill make it economically and technically justifiable to have a joint solid wastes management of the two areas. The agricultural wastes of La Trinidad which are at present untreated are to be collected and disposed of together with the municipal wastes of Baguio City. Chemical analysis showed that the agricultural wastes and putrescibles of both areas have similar characteristic; the C/N ratio of which is below the optimum requirement for composting. Hence, sanitary landfill method of disposal for all the refuse is suggested in this study.

The estimated annual cost of this joint management has been included in the study.

Several suggestions as a cooperative venture between the private sector and the local government have likewise been offered.

ENE 8509 Marcelo, Veronica J. (MS Env. Eng'g.)
 An estimation of the X/Q value for the first
 Philippine Nuclear Power Plant (PNPP-1).
 1985.

Atmospheric transport and dispersion of gaseous effluents in routine releases from the first Philippine Nuclear Power Plant (PNPP-1) were determined using the XOQDOQ computer code. This code is a computer program which calculates average relative effluent concentrations (X/Q's) and average relative deposition values (D/Q's) at locations specified by the user, and at standard radial distances and segments for downwind sectors for routine plant releases.

The input data utilized for the estimation of atmospheric transport and dispersion are based on the information gathered from the Final Safety Analysis Report (FSAR) and the Environmental Report (ER) for the first Philippine Nuclear Power Plant.

The objective of the study is to provide conservative estimates of average relative effluent concentration (X/Q) at distance out to 80 km from the PNPP-1. In order to provide estimates of annual average atmospheric dilution factors, the Constant Mean Wind Direction Model outlined in Section C (excluding Cla and Clb) of Regulatory Guide 1.111, "Methods for Estimating Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors" was applied to the four years Napot Point Meteorological data base incorporating the PNPP-1 design parameters. The dilution factors were calculated using a ground level release for 16 cardinal directions at distances extending from exclusion area boundary to 80 km from PNPP-1. Radioactive decay and relative deposition were also considered in making the X/Q estimates. The joint frequency distribution speed and direction categories by stability class was used as the Meteorological data input for calculating the annual average X/Q values.

The computer output gives the calculations of annual average X/Q at distances ranging from 0.4 km (0.25 miles) to 80.5 km (50 miles) - over the 16 direction sectors. For corresponding distances and sectors annual average relative deposition per unit area (D/Q) values (meters⁻²) are listed. Calculation of X/Q values and D/Q values of the different receptor types within 10 km from the site are also given. Modelling assumptions used for these calculations are :

- a) Ground level release for a vent height of 57 meters.
- b) Negligible exit velocity.
- c) Wind measurements taken at 10 meters.
- d) Height of the vents's building of 57 meters and cross-sectional area of 2140 square meters.

ENE 8810 Villaluz, Maya Gabriela Q. (MS Env. Eng'g.)
Environmental impact assessment of small scale gold
mining operations in Davao Del Norte.
1988.

The Philippines is experiencing a new boom in the mining industry. This is brought about by the small scale mining activities sweeping all over the country.

This study explores the significant impacts on the environment of small scale mining operations. The escape of hazardous wastes in the air and water environment, increased seismicity, land subsidence, erosion, siltation, improper land use are all possible adverse effects resulting from the exploration, development, exploitation and processing of gold ore deposits. Each of these phases has differing impacts on the environment. The small scale mining activities in Diwalwal have been used as a case study. Findings revealed the extent of the changes as a case various sectors of the environment.

Mitigation and monitoring measures have been recommended to prevent the current level of environmental degradation. To achieve this, the proper institutional arrangements must be made which include legalizing the operations of the scale miners, educating the miners on the proper methods of mining and processing of the gold ores, filling up of mined-out workings, stabilizing slopes to control erosion and water pollution by vege-mechanical means and revegetation, and adopting engineering controls at working areas to control the escape of mercury vapor.

ENE 9111 **Araza, Dionisio M. Jr., (MS Env. Eng'g.)**
Development of a water quality index for the Laguna De
Bay (Central Bay Area).
1991.

The "modified DELPHI" method was used in the development of a Water Quality Index (WQI) for the Laguna Lake. The following steps are involved under this methodology: selection of parameters, determination of parameter weightings, establishment of parameter rating curves, establishment of a WQI classification based on WQI, and mathematical formulation and calculation of the WQI.

Six (6) significant parameter are used in the WQI. These parameters and their respective weightings are : dissolved oxygen (0.23), pH (0.19), turbidity (0.15), nitrate (0.15), total dissolved solids (0.14), and total coliform (0.14).

The rating curves of the 6 parameters were established using the average rating of the water experts. These curves were modified and refined by formulating equations that best described the analytical curves. The water quality of any measured concentration of the respective parameters is determined either by extrapolating on the individual rating curves or using the derived equations. A water quality rating from 0 to 100 was used, where a good water quality is indicated by higher rating.

A Water Quality classification based on the numerical values and ranges of WQI was also established. The WQI is translated into qualitative description with the use of this Classification. The WQI formulation recommended for use is the Arithmetic Weighted Mean (AW).

The WQI was applied to the 4 major bay observation stations of the Lake: the Central Bay, the West Bay, the East Bay, and the South Bay, using actual 1986-1987 water quality data from the LLDA.. The WQI obtained are from 72.0 (min.) to 73.0 (max.) for the annual average, and 62.1 (min.) to 83.9 (max.) for the monthly average water quality data of the 4 bays. The results of both applications showed that the 4 bays has a "very good" to "excellent" water quality during these observed periods. The formulation can be used for current and future analysis to derive single and comprehensive description of the Lake's water quality.

ENE 9112 **Ballesteros, Florencio C. Jr., (MS Env. Eng'g.)**
An evaluation of the efficacy of cementitious solidification as treatment technology for heavy metal wastes.
1991.

Sludge laden with heavy metals such as Arsenic, Silver, Cadmium, Chromium, Lead, and Mercury once disposed indiscriminately underground is potentially contaminating to groundwater resources. Treatment of such wastes is therefore required prior to disposal.

The solidification process using cement is a low-cost technology option for the treatment of hazardous wastes. To evaluate its suitability as a treatment technique, this inquiry was carried out through the following steps:

a. Waste characterization to determine the total heavy metal burden and as basis for the development of the correct sludge to cement formulation/mixes.

b. Evaluation of the performance of the product in the disposal site through simulation studies.

c. Microscopical studies of the cement structure to verify the binding mechanism.

The simulation studies proved that the treated waste once disposed underground will not contaminate the environment particularly the unsaturated zone of the aquifer. It was shown in the microscopical studies that these heavy metal were entrapped in the silica matrix of the hardened cement thus reducing the heavy metal's mobility.

ENE 9213 **Matuguina, William R. Jr., (MS Env. Eng'g.)**
An environment audit for the National Power Corporation's Naga plant complex.
1992.

This research work is an attempt to apply the concepts of environment auditing to the National Power Corporation's Naga plant complex in Cebu. The study presented a review of the present plant environment. Data from the corporation's environmental department and other related studies were major inputs in the review. Review results indicated the need or conduct of an assessment.

The audit procedure was patterned from that adapted by the International Chamber of Commerce (ICC) with some modifications to suit its nature of operations. The audit was conducted by the researcher with the assistance from various plants involved. Audit activities lasted for 2 weeks. Initial findings were informally transmitted to concerned personnel.

Control measures were considered in the area of noise, particulates and SO_x, liquid effluents, hazardous materials (like spent laboratory chemicals, waste oils and sludges, and spent PCB contaminated transformer oils):

(1) Noise levels from 3 operator stations can be reduced to occupational levels by using concrete and glass enclosures and with proper ventilations;

(2) Improved maintenance, greening to buffer particulate emissions;

(3) gaseous SO_x emissions: fuel substitution and increased stack height for CDPPI-I;

(4) liquid effluents from the water treatment plant are to be reused;

(5) the oil-water separator efficiency can be improved by increasing its capacity and use of adsorbents.

(6) hazardous substances: the waste oils-sludges are either burned as fuel for CTPPI-I or disposed of by land treatment; the waste transformer oils are to be disposed of by scientific landfilling (burned as fuel if PCB levels are insignificant), and the laboratory wastes are disposed of by fixation.

ENE 9214 Pascual, Amir Y. (MS Env. Eng'g.)
Determination of groundwater pollution potential in Metro Manila using DRASTIC approach.
1992.

The DRASTIC system coupled with a geologic software was used in this study to determine the location of potential areas in Metro Manila where groundwater is susceptible to pollution.

The DRASTIC system was developed in the United States in 1987 by Linda Aller, et.al., as a generalized vulnerability assessment method which determines regional variations in groundwater pollution potential by evaluating

a set of parameters within designated hydrogeological settings. These parameters are: (1) depth-to-water; (2) net recharge; (3) aquifer media; (4) soil media; (5) topography; (6) vadoze zone media; and (7) hydraulic conductivity. These parameters are incorporated in a relative ranking scheme which uses a combination of weights and ratings to produce a numerical value called the Drastic Index. Metro Manila is represented by 100 DRASTIC cells for groundwater pollution potential assessment. In this study, a Drastic index that ranges from 70 to 109 indicates low potential to groundwater pollution of the cell or area; an index value of 110 to 129, moderately potential; to groundwater pollution of the cell or area; and an index value of 130 and above, highly vulnerable to groundwater pollution of the cell or area.

The findings in this study show that the shallow groundwater table in Metro Manila is located in the vicinities of Parang, Marikina and in Fairview Park, Quezon City, with an average depth of 0.5 meter and 1 meter, respectively. The vulnerable areas to groundwater pollution are located in Fairview Park near La Mesa reservoir and in the National Government Center down to the Capitol Homes subdivision, all in Quezon City with a vulnerability index of 141 and 136, respectively.