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PHYSICAL OCEANOGRAPHIC INVESTIGATION PROCEDURE FOR A SEA  
OUTFALL PROJECT

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INTRODUCTION

Coastal areas of the oceans have long been used for the disposal of domestic and industrial effluents. With growing interest in environmental problems came the realization that there is a limit to assimilate all pollutants. Much need to be done to our ocean and other resources in a way which negates their destruction but permits maximum utilization. Even though the coastal water body is the most utilized medium for waste disposal, the behaviour of all pollutants is not adequately understood, as the waste assimilating or disposal characteristics depend upon numerous physical factors.

The obvious function of a wastewater disposal installation is to convey the waste, treat it to a suitable degree before final disposal so that its effect on the receiving waters will be minimum, even at the point of initial mixing. The point of final disposal must be selected on the basis of overall suitability for rapid and thorough initial mixing of the waste with the receiving waters. For these reasons, physical oceanographic investigations are inevitable at each location of interest for proper planning and design of

an outfall (Quentin, et al., 1986). Indeed, besides physical Oceanographic parameters the overall planning also requires, chemical, biological, geological and engineering parameters. These aspects are not dealt with in this presentation. The present study confines to the physical oceanographical parameters for the selection of coastal outfalls. For details on ocean outfalls see Reed (1975).

#### SIGNIFICANCE OF PHYSICAL PARAMETERS

The most important physical influence on the distribution of pollutants is exerted by motions of fluid. The motions in the sea ranges from molecular dimension to large scale oceanic current systems. Eddy diffusion resulting from irregular multidirectional turbulence is responsible for mixing and dilution of pollutants. Transport of pollutant plume takes place due to current advection. Thus the diffusion and dispersion, are determined by the movements of different origin along with the rate of eddy diffusion. Currents resulting from density anomaly are well defined in direction, whereas the tidal currents periodically change velocity and direction. Data on coastal currents is therefore a necessary input which can also indicate the possibility of effluents reaching the shore.

Wind is probably the most important and effective source of energy to the marine system. Wind produces wind waves and drift. On nearing the coast, the waves get modified and break in shallow water. Information on waves is important for

planning, designing, construction and maintainance of a sea outfall.

In combination with the salinity, the thermal layering increases the stability of density stratification which in turn controls the vertical diffusion. Rainfall, river discharge etc., are the additional factors in affecting the density distribution of the nearshore waters.

Most of the coastal outfalls are taken into the receiving waters through a beach, which is a variable zone with cycles of accretion and erosion due to natural and artificial effects. A detailed survey on beach level variation is thus required.

#### COLLECTION AND ANALYSIS OF DATA

Navigational hydrographic charts give descriptive features of the coastal waters at selected areas. But these details will not be sufficient for specific needs. Currents can be recorded continuously with the self recording current meters which has the option for conductivity and pressure sensors.

Although the recorders got the advantage of operating for several months, retrieval at more frequent intervals, will prevent from some of the most frequent troubles like battery failure or fouling.

In the absence of self recording current meters, the direct reading current meters can be substituted for the purpose. The measured current data are represented in the form of rose diagrams. Graphs of speed and direction against time are drawn with tidal curve and wind vectors superimposed.

Frequency tables are made for current velocity and resultant current velocity can be estimated by preparing progressive vector diagrams. Time series data can also be subjected to spectral analysis to study the influence of various factors. It is thus possible to determine measured variable time relationships, relative current velocity and direction diagrams harmonic or spectral analysis of tide-induced velocity components, a velocity component in a given direction etc.

Temperature and conductivity instrument is used in areas where there is a density stratification. Temperature and conductivity measurement sets are now available with several temperature sensors and several conductivity sensors spaced at regular intervals. The receiving instrument, which is similar to recording current meters, records the signals at regular time intervals.

Drogues and floats can provide the best and the most economical data for charting the currents transporting the effluent away from the point of discharge under different tide and wind conditions. It enables clear distinction between the currents at various specific depths of drogue immersion. The drogues can be adjusted to represent the flow at the required depth. Positions of the floats are observed by using a suitable position fixing system.

Colour tracers, usually the dye rhodamine-B, has usually been used for measuring surface-current. But the method is not advisable in areas where growth of the patch in time due to

horizontal dispersion makes it difficult to get accurate results, where current velocity is low.

Representative tidal data are required to determine the lag and lead, together with height ratio with respect to the nearest recording station for comparison purposes. Mechanical, electro mechanical and electronic tide gauges are now available. Harmonic analysis is done with short and long term records.

Wave measurements are expensive. Self recording pressure wave gauge is either suspended at a subsurface level or mounted at the sea bottom. Wave rider buoy is moored at required location. It transmits the signals which are recorded at shore station. With the knowledge of nearshore bathymetry and wave characteristics, the wave shoaling and depth refraction can be estimated.

Turbidity is estimated using a Secchi disc. Seawater samples are collected and filtered to estimate the silt content. Transmissometers are also used for in situ measurement of turbidity. Turbidimeters can be employed in fairly turbid waters. In shallow waters, bottom seabed sediments are collected with Van Veen grabs. Using standard sieves, the grain-size distribution is studied.

Changes in beach levels are measured during low tides of the spring tidal day. From the annual profiles, the maximum change in beach elevation is estimated. Littoral sediment transport are estimated using the breaking wave characteristics.

#### DIFFUSION CHARACTERISTICS

Diffusion is often characterized by diffusion coefficients, the values of which differ considerably in three dimensions (x, y & z). The computations of diffusion parameters from time series record is subjected to more theoretical analysis and needs sophisticated computer. For shallow waters, valid empirical relationships are available to estimate the diffusion coefficients (Taylor, 1954, Elder, 1959, Talbot & Talbot, 1974; Talbot, 1978).

The general procedure is the fluorescent dye aqueous is released in the receiving water body. With the concentration of the dye at the centre of the patch decreases and along the periphery initially it increases and then decreases. The measure of the diffusion coefficient can be estimated from spread of the dye patch with time. Such experiments are more delicate than expected as natural currents are apt to vary appreciably in both direction and speed during the experiments, thus distorting the patch and hence the principal direction, which implies that several measurements should be carried out under different weather conditions.

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