LOCATION OF MARINE OUTFALL AND DESIGN OF DIFFUSER FOR A SHORE BASED INDUSTRY OFF SOUTHEAST COAST OF INDIA

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ABSTRACT

Disposal of industrial effluent in the sea necessitates exhaustive study on the marine environment and the hydrodynamic behavior of the plume discharge with the ocean. Site specific baseline information on currents, waves, tide, density stratification and seabed bathymetry have to be collected. This paper describes the approach and methodology adopted for designing a effluent disposal system for a chemical industry at southeast Tamilnadu coast. Effluent discharged at 200 m^3/hr for 9.5 hour per day undergoes initial dilution to the order of 50 at a water depth of 5.3 m. The buoyant plume after reaching sea surface undergoes further dilution of 6 due to dispersion, yielding a total dilution of 300 in 3 hours, before the effluent can reach the shore.

INTRODUCTION

Economic reformation and industrial liberalization by the Indian Government have captivated varied national and multi-national companies to invest on major industries like power plants, petroleum refineries, fertilizers and petrochemicals and metal industries. Convenience in transporting raw materials, availability of sea water for desalination/cooling towers, and disposal of trade effluent force the industries to locate close to the sea. Most of the industrial effluents intend to be discharged into the sea comprise either chemical waste, brine or warm water. It is pre-requisite to pretreat all such effluents confirm to the standards laid down by State and Central Pollution Control Boards. The location for disposal and the diffuser design have to be carefully adjudged to bear minimum impact on the biological and chemical characteristics of the marine eco-system. The studies should integrate the multi-disciplinary investigations on biological, chemical, physical and engineering aspects of the effluent and marine environment (Reed, 1975).

DESCRIPTION OF OUTFALL AREA

The study region is situated along the southwest coast of India as indicated in Fig.1. The coastline consists of 15 - 25 km wide coastal plains composed of recent alluvium. Low sand dunes are seen up to nearly 2 km inside from the coast. River Tambraparani joins Gulf of Mannar about 10 km south of the study region. Low sandy beaches are present near the proposed landfall point. Beach rocks occur in and around the region. The nearshore for about 8 km from the shore is fringed with reef patches. In general the seabed till 20 m water depth is composed of reef patches and sand with negligible percentage of silt and clay.

OCEANOGRAPHIC INVESTIGATIONS

Current speed and direction were measured at 3 locations in June and September 1995, by deploying self recording current meters manufactured by Aanderaa Instruments, Norway (Fig. 1). Dispersion studies were carried out using fluorescent tracers to estimate the dispersion coefficients of the nearshore water. Variation in beach levels was measured. Nearshore bathymetry was carried out along the proposed pipeline route for 4 km distance into the sea using the echosounder and GPS.

RESULTS

Winds: The wind data for this region compiled based on the 30 years observations (1931 to 1960) from the Climatic Tables shows that the average wind speed in this region is 10 to 15 km/hr. Wind direction during April to September is between south - southwest, and during the rest of the year, it is between north - northeast. The wind speed is expected to momentarily exceed 60 km/hr during cyclonic days. Though cyclones rarely cross this region, they mostly occur during October and November, i.e. during the northeast monsoon period.

Waves: The wave climate of the region is dominated by south-west monsoon (June to September) north-east monsoon (October to January) and fair weather periods (February to May). Based on the ship reported wave data (Anonymous, 1990), the significant wave heights during southwest monsoon are higher between 1.75 - 3.25 m. They predominantly vary between 0.75 - 2.25 m during northeast monsoon and 0.75 - 1.75 m for the rest of the year.

Currents: The current measurement locations 1, 2 and 3 lie at a distance of 1, 2 and 4 km respectively. The typical variation of current speed and direction measured over one spring to neap tidal cycle is shown in Fig. 2. Currents in this region are in general weak with speed mostly below 0.05 m/s. Low range of tides, presence of offshore reefs and harbour breakwaters, considerably obstruct the flow in this region. The direction of flow vary with location. In June, flow was northerly at locations 1 and 2, and southwesterly at location 3. In September, the flow at all 3 locations was towards south. While the currents at location 1 tend to reach the shallow reef, the currents at location 3 posses the tendency to flow into the sea. The currents at location 3 indicate that this region would form ideal in transporting the effluent offshore with minimum possibility to reach the shoreline.

Seabed Bathymetry: The variation of seabed profile from the back shore to 4 km distance into the sea is shown in Fig.3. More the depth of discharge, the higher will be the initial dilution. The placement of diffuser block needs an even stretch of the sea floor. The nearshore is shallow with 4 m contour occurring at 1000 m distance and thereafter very flat with 5.5 m contour occurring at 4000 m distance. There is a slight rise in seabed level at a distance between 2400 - 3000 m, and between 3400 - 3800 m.

Dilution and Dispersion: Based on the dilution of the dye experiment, it is estimated that the dispersion coefficients in the direction parallel to shore (K_x) was 0.3 m^2/s, where as in the perpendicular (K_y), it was 0.03 m^2/s. The dilution, dispersion and diffuser design were worked out based on above details using the NIO computer model SEAMIX.

LOCATION FOR EFFLUENT DISPOSAL

The quantity of effluent discharge is 1900 m^3/day during initial stages and expected to increase 4840 m^3/day at a later stage. The design discharge of 202.5 m^3/hour has been considered for calculation with 9.4 hours pumping in a day for the discharge of 1900 m^3/day, and 24 hours pumping for the discharge of 4840 m^3/day. The internal diameter of the effluent pipeline is selected as 0.26 m. Current pattern suggests that at location 3 currents are directed into the sea without reaching any obstruction. The rising effluent jet plume from the ports can travel more distance and can undergo more turbulent mixing. The bathymetry of the bottom feature shows that location at 3700 m distance from the lowest tide line is found to be better to place diffuser section. The depth in this region will be about 5.3 m which can give rise to a better initial dilution. The NIO computer model shows that for the region under consideration, the effluent plume raised to the sea surface is stipulated to undergo further secondary dilution to the order of 6. This would yield a total dilution of 300 in 3 hours, i.e. before either reaching the shore or harbour breakwater or the submerged reefs.

Based on the various above criteria, it is found that the location at 3700 m distance into the sea from the lowest low tide line would be suitable for the proposed quantity of effluent discharge. The proposed location is indicated in Fig. 1.

DIFFUSER SYSTEM

From the base line data collected and considering the location of the outfall, the preliminary diffuser port design is worked out based on the model SEAMIX and the details are presented below.

Number of Ports	= 16
Port diameter	= 60 mm
Spacing between the ports	= 1.7 m
Port opening type	= Circular
Orientation of ports	= horizontal & facing sideways
Diffuser configuration	= I - shape diffuser
Initial Dilution	= 50

The diffuser system is designed as a single block with circular top which can allow the trawling nets to slip over.

ACKNOWLEDGMENTS

Authors thank Director, National Institute of Oceanography, Goa for encouragement.

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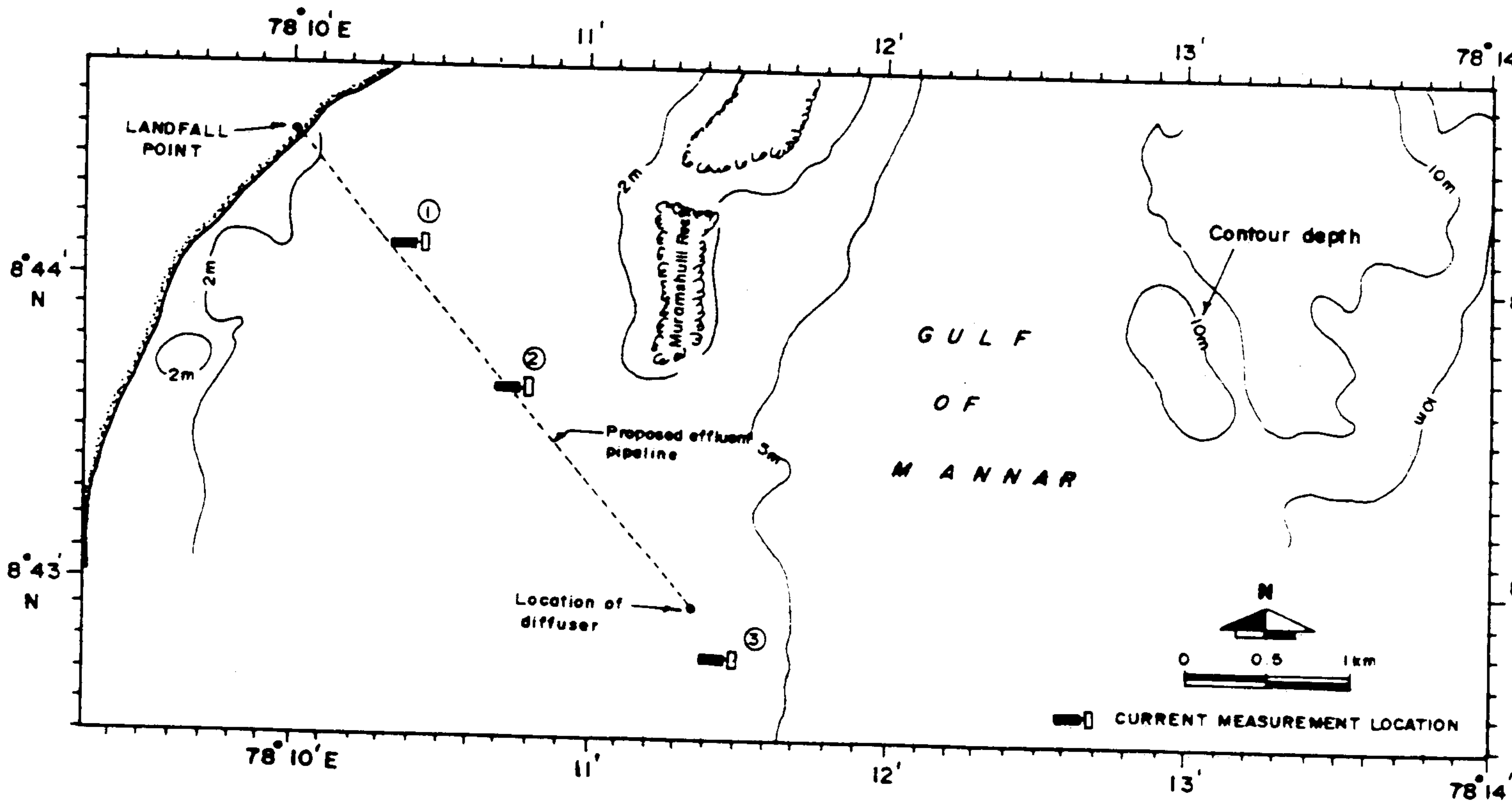

FIG. 1 STUDY AREA AND LOCATION OF CURRENT MEASUREMENTS

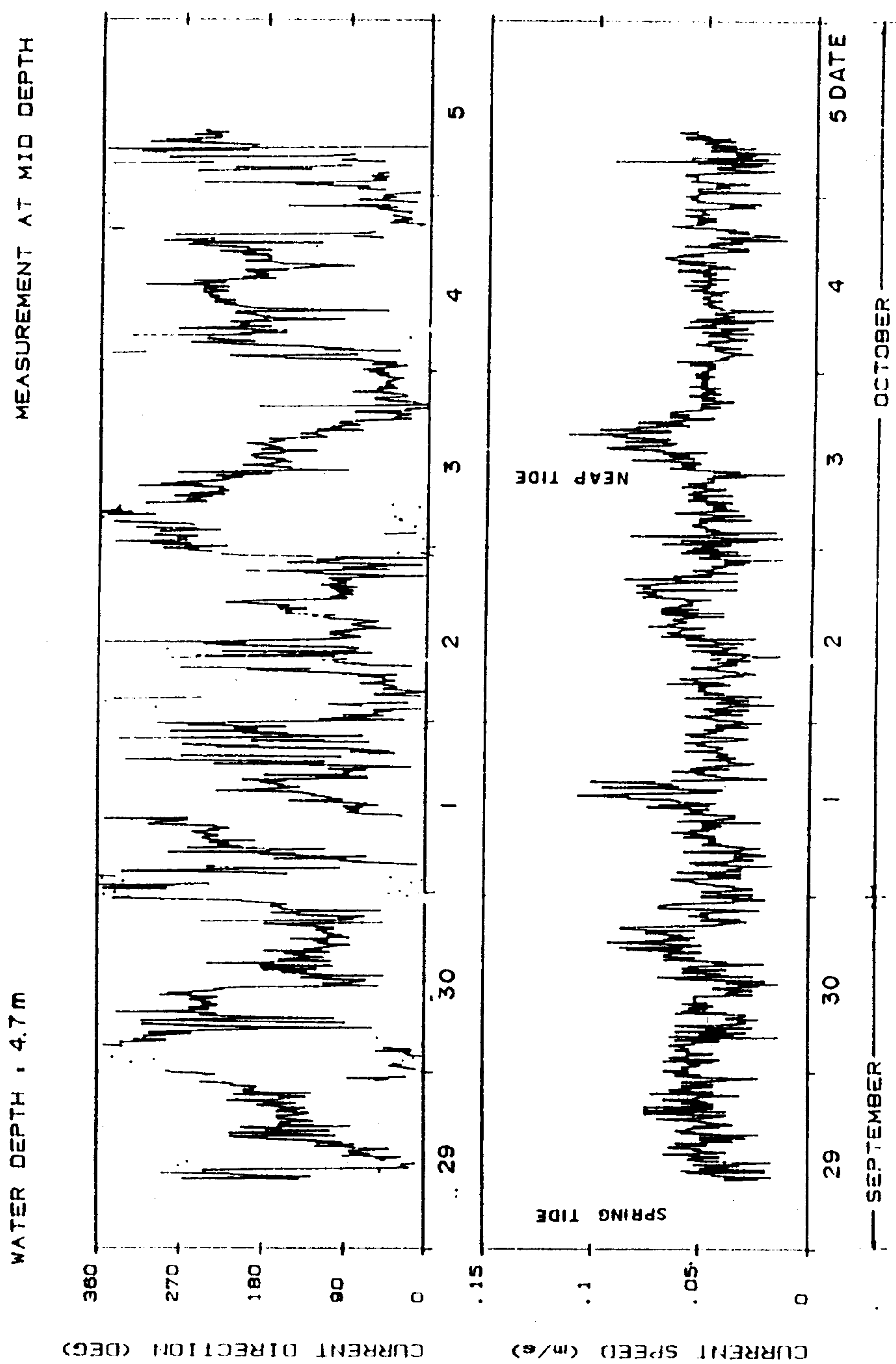

FIG. 2. VARIATION OF CURRENT SPEED AND DIRECTION AT LOCATION - 2

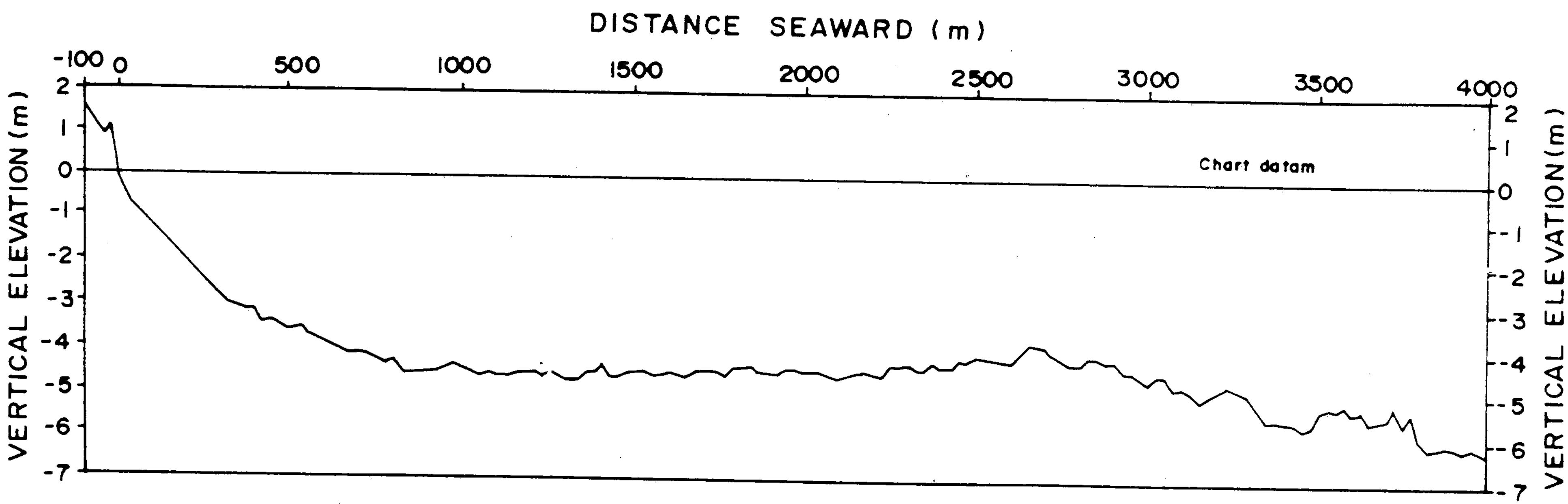

FIG. 3 BATHYMETRY ALONG THE PIPELINE ROUTE