Development of a Decision Support System for

Long Sea Outfall

Designing and Operations

Final Report

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Declaration

I certify that this thesis does not incorporate any material previously submitted for any degree or diploma in any university and to the best of my knowledge and belief it does not contain any material previously published or written or orally communicated by another person except where due reference made in the text.

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To the best of my knowledge above particulars are correct.

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Abstract

Long sea out-fall is an acceptable method of domestic wastewater disposal, provided that the design is done properly, and it is constructed robustly and according to the design. The dispersion of the sewage after discharging to the sea has come under increased scrutiny in recent years, due to the sea and seashore pollution.

In a properly designed and constructed long sea out-fall, the waste is discharged at a point in sea, away from any environmentally sensitive areas such as coral reefs, and far enough from the beach so that the quality of water reaching the beach conforms to the stipulated standards.

In this research development of SOS (Sea Outfall System) was done and a successful implication of GA (Genetic Algorithm) in sea outfall optimization and ANN (Artificial Neural Network) in concentration prediction after discharging to sea is introduced.

The SOS is specially developed to design and identify pollutant behavior of sewage discharged using Multi-port Diffusers. The system is designed to handle several scenarios such as stratified and unstratified sea conditions and stagnant and flowing plumes. The system can predict concentrations of parameters in the far field as well as the near field, and also can be used as a decision support system for designing. It is also capable of analyzing the near field of single port sea outfalls, and can be developed for the far field analyzing and design decisions of multiport diffuser discharges.

SOS Expert (Decision-maker) provides decisions on required designing configurations, so that the user can find optimum configurations. SOS HELP provides necessary information about long sea outfalls as well as information about the SOS.

In addition to SOS, Artificial Neural Network (ANN) too is used in concentration prediction after outfall discharging. Artificial Neural Networks are capable of modeling experience based non-algorithmic knowledge. Different technologies and data gathering methodologies used in ANN training and it is possible to develop site-specific neural networks for predictions.

The system is developed according to Object Oriented Techniques. Major programming is done using Visual C++ Version 6.0 and MATLAB 5.3 was used in GA optimizations. WinNN Version 0.93 used in ANN designing, training and testing. The system provides an easy way to identify concentrations due to dispersion and decaying. With the help of SOS Expert designers can optimize outfall configurations. The cost and time needed in sea outfall designing and operations can be reduced with the SOS, SOS Expert, GA optimization technique and ANN predictions.

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Notation and Sign Convention

SOS	Sea Outfall System	*dz*	Vertical Density Gradient
ρ	Ambient Water Density	g	Gravitational Force
$\Delta\rho_D$	Discharge Density Difference	GA	Genetic Algorithm
b_1	Plume Width	h_1	Thickness of the Plume
k	Decay Constant	L	Diffuser Length
C_D	Discharge Concentration	Q_D	Discharge Flow-rate
DNA	Deoxyrhibo Nucleic Acid	U	Ambient Current Velocity
q	Probability of selecting the best individual	r	Rank of the individual, where 1 is the best.
P	Population size	C_{dt}	Unit diffuser cost
C_{pt}	Unit pretreatment cost	T_l	Required pretreatment level
a_i	Lower bound of GA variable *i*	b_i	Upper bound of GA variable *i*
D_2	Dispersion factor	Q_{min}	Minimum flow rate
V_{min}	Minimum sewage velocity in the pipe	L	Diffuser length
D_p	Distance between ports	N_p	Number of Ports
P_a	Pipe area	PT_a	Port area
PE	Processing element	H	Discharge depth
H_{eqm}	Equilibrium plume height	N	Buoyancy frequency
g'_D	Discharge buoyancy	I_{avg}	Average initial dilution
F	Froude number		