General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

Produced by the NASA Center for Aerospace Information (CASI)
LANGSAT OBSERVATIONS OF OCEAN DUMP
PLUME MOVEMENT AND DISPERSION

V. Klemas, G. Davis, R. Henry
College of Marine Studies
University of Delaware

July 26, 1976
Report on Significant Results
NASA LANDSAT CONTRACT NAS5-20983
UN 20570

Prepared for
GODDARD SPACE FLIGHT CENTER
Greenbelt, MD 20771
Eighteen LANDSAT images were analyzed to study the dispersion and movement of ocean dump plumes thirty-eight miles southeast of Cape Henlopen, Delaware, at the disposal site for waste discharged from a plant producing titanium dioxide. The discharge is a greenish-brown liquid containing up to 10% acidity (expressed as HCl) and 4% iron as iron chloride salts. The barge which transports this waste is capable of releasing one million gallons of the liquid upon radio-command from a tow ing tug. It makes several trips to the disposal site per month.

The following preliminary results were obtained:

a. The frequency of the dumping made it possible for the LANDSAT satellite to image the waste plume in various stages of degradation, ranging from minutes to days after dump initiation. The long visual persistence has been explained by the formation of a suspended ferric floc. Spectrometric measurements indicate that upon combining with seawater the acid waste develops a strong reflectance peak in the 0.55 to 0.60 micron region, resulting in a stronger contrast in the MSS Band 4 than the other bands.

b. The predominant direction of movement of the waste plumes imaged by the LANDSAT satellite was to the southeast. This appears to be due to the fact that northeasterly winds produce stronger currents than those driven by southeasterly winds and by the thermohaline circulation.

c. The average drift velocity for surface drogues and the waste plumes as observed by LANDSAT was about 0.5 knots. Drogues released at different depths frequently travelled along different paths, and at different speeds, indicating the presence of strong current shear. During stratified conditions the near-bottom drogues showed very little movement.
d. The water at the test site were highly stratified and stable in the summer and nearly homogeneous in the winter. A distinct thermocline was observed from June through August, at depths ranging from 43 to 103 feet. During most dumps the acid plume was unable to penetrate the thermocline and reach the bottom.

The current circulation data is being used to assess the movement and dispersion of the acid waste plumes together with wind and weather data. In general, it appears that rapid movement toward shore can occur primarily during storms, particularly northeasters. During such storms, however, the plume is rapidly dispersed and diluted. Therefore, the probability of an identifiable plume containing heavy concentrations of acid waste reaching the shore is quite low.