CORMIX1 ***
DESIGN RECOMMENDATIONS: SUBMERGED SINGLE PORT DISCHARGES:

A reliable environmental analysis and mixing zone prediction is possible only if each design case is evaluated through several iterations of CORMIX1. Small changes in ambient or discharge design conditions can sometimes cause drastic shifts in the applicable flow configuration (flow class) and the size or appearance of mixing zones. Iterative use of CORMIX1 will give information on the sensitivity of predicted results on design and ambient conditions.

Each predictive case should be carefully assessed as to:

- size and shape of RMZ,
- conditions in the TDZ (if present),
- bottom impact of the discharge flow,
- water surface exposure,
- bank attachment, and other factors.

In general, iterations should be conducted in the following order:

A) Discharge design changes (geometry variations)
B) Sensitivity to ambient conditions
C) Discharge flow changes (process variations)

When investigating these variations the CORMIX1 user will quickly appreciate the fact that mixing conditions at short distances (near-field) are usually quite sensitive and controllable. In contrast, mixing conditions at large distances (far-field) often show little sensitivity unless the ambient conditions change substantially or drastic process variations are introduced.

A) DISCHARGE DESIGN CHANGES (GEOMETRY VARIATIONS):

Most of the following recommendations are motivated by the desire of improving conditions in the applicable mixing zones (i.e. minimizing concentrations and/or areal extent):

1) Outfall location: Consider moving the discharge farther offshore to a larger water depth in order to delay flow interaction with the bank and/or surface, and to improve near-field mixing.

2) Height of discharge port: For positively buoyant or neutral discharges it is usually desirable to minimize the port height in order to provide a long submerged jet/plume trajectory. However, undesirable flow bottom attachment may result if the port height is too small. A typical range for port heights is from two to ten diameters. For negatively buoyant discharges, on the other hand, it may be desirable to maximize the port height. Navigational requirements may put further limits on large port heights.

3) Vertical angle of discharge (THETA): Near-field dilution for positively or neutrally buoyant discharges is often improved by providing a near-horizontal discharge. In order to prevent bottom interference a slight upward orientation (in the range of +15 to +30 degrees) may be advisable. In contrast, a vertical or near-vertical angle may be favorable for negatively buoyant discharges.

4) Horizontal angle of discharge (SIGMA): This angle provides the discharge

orientation relative to the ambient current. A co-flow design (angle of about 0 degrees) or a cross-flow design (about 90 or 270 degrees, respectively) are preferable. A counter-flow design (about 180 degrees) is undesirable from the viewpoint of mixing zone predictability and bottom impacts. Cross-flow designs may be particularly effective in optimizing near-field mixing, and if they are chosen, the port should point in the offshore direction.

5) Port diameter/area (discharge velocity): Remember that for a given discharge flow rate the port area and discharge velocity are inversely related: a small discharge port implies a high discharge velocity, and a consequently high discharge momentum flux. Typically, a high velocity discharge will maximize near-field mixing. Note, however, that high velocity discharges a) may lead to unstable near-field flow configurations perhaps involving undesirable mixing patterns, and b) usually have little, if any, effect on dilutions over the far-field where a RMZ may apply. Discharge velocities in typical engineering designs may range from 3 m/s to 8 m/s. Very high velocities may lead to excessive pumping energy requirements. Very low velocities (less than 0.5 m/s) may lead to undesirable sediment accumulation within the discharge pipe.

B) SENSITIVITY TO AMBIENT CONDITIONS:

Variations - of the order of 25 percent - of the following ambient design conditions should be considered:

- ambient velocity (or ambient flowrate),
- ambient depth (or river/tidal stage), and
- ambient density structure (notably density differences).

Such variability is important for two reasons:

1) the usual uncertainty in ambient environmental data, and
2) the schematization employed by CORMIX.

Please refer to the detailed advice on the specification of environmental data, including the density structure, that is available in program element DATIN. In particular, note the advisory comments on stagnant ambient conditions.

C) DISCHARGE FLOW CHANGES (PROCESS VARIATIONS):

Actual process changes can result in variations of one or more of three parameters associated with the discharge: flowrate, density, or pollutant concentration. In some cases, such process changes may be difficult to achieve or too costly. Note, that "off-design" conditions in which a discharge operates below its full capacity also fall into this category.

1) Pollutant mass flux: The total pollutant mass flux is the product of discharge flow (m^3/s) times the discharge pollutant concentration (in arbitrary units). Thus, decreasing the pollutant mass flux will, in general, decrease the resulting pollutant concentration in the near-field and far-field. This occurs, of course, during off-design conditions.

2) Discharge flow: For a given pollutant mass flux, an increase in discharge flow implies an increase in discharge pollutant concentration, and vice versa. For the variety of flow classes contained in CORMIX1 there is no universal rule whether high or low volume discharges are preferable for optimizing near-field mixing. Mostly, the sensitivity is small, and even more so for far-field effects. Note that a change in

discharge flow will influence, in turn, the discharge velocity and hence the momentum flux.

3) Discharge density: The actual density of the discharge flow controls the buoyancy effects relative to the ambient water. Occasionally, the discharge density is controllable through the amount of process heating or cooling occurring prior to discharge. Usually, near-field mixing is enhanced by maximizing the total density difference (positive or negative) between discharge flow and ambient water. In most cases, however, this effect is minor.

END OF DESIGN RECOMMENDATIONS ***