

CORMIX SESSION REPORT:  
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CORMIX: CORNELL MIXING ZONE EXPERT SYSTEM

CORMIX-GI Version 4.1GTR

SITE NAME/LABEL: A-Plant Deep Reservoir  
 DESIGN CASE: Summer Stratified  
 FILE NAME: C:\Program Files\CORMIX-GIv41GTR\Sample

Files\Sample1.prd

Using subsystem CORMIX1: Submerged Single Port Discharges

Start of session: 09/22/2000--06:37:56

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SUMMARY OF INPUT DATA:

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 AMBIENT PARAMETERS:

Cross-section = unbounded  
 Average depth HA = 35 m  
 Depth at discharge HD = 30.5 m  
 Ambient velocity UA = 0.015 m/s  
 Darcy-Weisbach friction factor F = 0.0096  
     Calculated from Manning's n = 0.02  
 Wind velocity UW = 2 m/s  
 Stratification Type STRCND = C  
 Surface temperature = 28.10 degC  
 Bottom temperature = 11 degC  
 Temperature below thermocline = 19.10 degC  
 Calculated FRESH-WATER DENSITY values:  
 Surface density RHOAS = 996.2053 kg/m<sup>3</sup>  
 Bottom density RHOAB = 999.6072 kg/m<sup>3</sup>  
 Stratification height HINT = 15.5 m (pycnocline level)  
 Density below pycnocline RHOAP = 998.3866 kg/m<sup>3</sup>

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 DISCHARGE PARAMETERS:

Submerged Single Port Discharge

Nearest bank = right  
 Distance to bank DISTB = 46 m  
 Port diameter D0 = 0.254 m  
 Port cross-sectional area A0 = 0.0507 m<sup>2</sup>  
 Discharge velocity U0 = 3.02 m/s  
 Discharge flowrate Q0 = 0.153 m<sup>3</sup>/s  
 Discharge port height H0 = 0.6 m  
 Vertical discharge angle THETA = 10 deg  
 Horizontal discharge angle SIGMA = 90 deg  
 Discharge temperature (freshwater) = 20 degC  
     Corresponding density RHO0 = 998.2051 kg/m<sup>3</sup>  
 Density difference DRHO = 1.3548 kg/m<sup>3</sup>  
 Buoyant acceleration GP0 = 0.0133 m/s<sup>2</sup>  
 Discharge concentration C0 = 3500 ppb  
 Surface heat exchange coeff. KS = 0 m/s  
 Coefficient of decay KD = 0 /s

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 DISCHARGE/ENVIRONMENT LENGTH SCALES:

LQ = 0.23 m            Lm = 45.31 m            Lb = 602.58 m  
 LM = 12.43 m           Lm' = 4.95 m            Lb' = 3.12 m

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 NON-DIMENSIONAL PARAMETERS:

Port densimetric Froude number FRO = 51.97

Velocity ratio R = 201.30

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MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:

Toxic discharge = yes  
CMC concentration CMC = 1200 ppb  
CCC concentration CCC = 600 ppb  
Water quality standard specified = given by CCC value  
Regulatory mixing zone = yes  
Regulatory mixing zone specification = width  
Regulatory mixing zone value = 120 m (m<sup>2</sup> if area)  
Region of interest = 3500 m

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HYDRODYNAMIC CLASSIFICATION:

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| FLOW CLASS = S3 |  
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The specified ambient density stratification is important, the discharge near field flow is confined to the lower layer by the ambient density stratification.

Applicable layer depth = lower layer depth = 15.5 m

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MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

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X-Y-Z Coordinate system:

Origin is located at the bottom below the port center:  
46 m from the right bank/shore.  
Number of display steps NSTEP = 10 per module.

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NEAR-FIELD REGION (NFR) CONDITIONS :

Note: The NFR is the zone of strong initial mixing. It has no regulatory implication. However, this information may be useful for the discharge designer because the mixing in the NFR is usually sensitive to the discharge design conditions.

Pollutant concentration at edge of NFR = 90.2667 ppb  
Dilution at edge of NFR = 38.8  
NFR Location: x = 105.55 m  
(centerline coordinates) y = 26.27 m  
z = 3.05 m  
NFR plume dimensions: half-width = 206.30 m  
thickness = 0.96 m

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Buoyancy assessment:

The effluent density is less than the surrounding ambient water density at the discharge level.  
Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards the surface.

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Stratification assessment:

The specified ambient density stratification is dynamically important.  
The discharge near field flow is trapped within the linearly stratified ambient density layer.

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UPSTREAM INTRUSION SUMMARY:

Plume exhibits upstream intrusion due to low ambient velocity or strong discharge buoyancy.  
Intrusion length = 96.54 m

Intrusion stagnation point = -94.14 m  
Intrusion thickness = 1.30 m  
Intrusion half width at impingement = 206.30 m  
Intrusion half thickness at impingement = 0.96 m

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PLUME BANK CONTACT SUMMARY:

Plume in unbounded section contacts nearest bank at 105.55 m downstream.

\*\*\*\*\* TOXIC DILUTION ZONE SUMMARY \*\*\*\*\*

Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA Technical Support Document (TSD) for Water Quality-based Toxics Control, 1991 (EPA/505/2-90-001).

Criterion maximum concentration (CMC) = 1200 ppb  
Corresponding dilution = 2.916667  
The CMC was encountered at the following plume position:

Plume location: x = 0.03 m  
(centerline coordinates) y = 3.93 m  
z = 1.31 m

Plume dimension: half-width = 0.05 m  
thickness = 0.05 m

CRITERION 1: This location is within 50 times the discharge length scale of Lq = 0.23 m.

+++++ The discharge length scale TEST for the TDZ has been SATISFIED. +++++

CRITERION 2: This location is within 5 times the ambient water depth of HD = 30.5 m.

+++++ The ambient depth TEST for the TDZ has been SATISFIED.+++++

CRITERION 3: This location is within one tenth the distance of the extent of the Regulatory Mixing Zone of 105.55 m downstream.

+++++ The Regulatory Mixing Zone TEST for the TDZ has been SATISFIED. +++++

The diffuser discharge velocity is equal to 3.02 m/s.

This exceeds the value of 3.0 m/s recommended in the TSD.

\*\*\* All three CMC criteria for the TDZ are SATISFIED for this discharge. \*\*\*

\*\*\*\*\* REGULATORY MIXING ZONE SUMMARY \*\*\*\*\*

The plume conditions at the boundary of the specified RMZ are as follows:

Pollutant concentration = 90.266693 ppb  
Corresponding dilution = 38.8

Plume location: x = 105.55 m  
(centerline coordinates) y = 26.27 m  
z = 3.05 m

Plume dimensions: half-width = 206.30 m  
thickness = 0.96 m

At this position, the plume is CONTACTING the RIGHT bank.

Furthermore, the CCC for the toxic pollutant has indeed been met within the RMZ. In particular:

The CCC was encountered at the following plume position:

The CCC for the toxic pollutant was encountered at the following plume position:

CCC = 600 ppb  
Corresponding dilution = 5.8

Plume location: x = 0.16 m  
(centerline coordinates) y = 7.82 m  
z = 2.12 m

Plume dimensions: half-width = 0.04 m  
thickness = 0.04 m

\*\*\*\*\* FINAL DESIGN ADVICE AND COMMENTS \*\*\*\*\*

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE.

Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about  $\pm 50\%$  (standard deviation).

As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.