Appendix H

CORMIX Discharge Modeling Evaluation

Environmental Report

in support of the

Port Ambrose Project Application

December 2013

Topic Report 3 – Water and Sediment Quality

Appendix A

CORMIX Discharge Modeling Evaluation of Potential Commissioning Phase Cooling Water Discharges from an LNG Regasification Vessel at the Port Ambrose Deepwater Port

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1.0 Introduction

1.1 Project Overview

Liberty Natural Gas, LLC (Liberty) is proposing to construct, own, and operate a deepwater port, known as Port Ambrose (Port Ambrose, or the Project) in the New York Bight. The Port's two Submerged Turret Loading™ buoy (STL Buoy) STL systems will be located in water depths of approximately 103 feet [ft] (31 meters [m]), in federal waters roughly 19 miles [mi] (30 kilometers [km]) off Jones Beach, New York, and approximately 31 mi (50 km) from the entrance channel to New York Harbor (see Figure 1-1).

The Port Ambrose Project will consist of two basic sets of components:

> **Offloading Buoys**: two STL Buoy systems (collectively, the Port), which will receive and transfer natural gas from purpose-built LNG regasification vessels (LNGRVs) to the pipeline system; and
>
> **Offshore Pipeline Facilities**: two offshore subsea lateral pipelines (Laterals) connected to a subsea natural gas mainline (the Mainline).

Natural gas will be delivered through the STL Buoy systems and Laterals into a buried, 21.67 mi (34.87 km) subsea mainline, which will connect offshore with the existing Transcontinental Gas Pipe Line Company's (Transco's) Lower New York Bay Lateral for delivery to shore. When not in use, each STL Buoy will be lowered to rest on a landing pad on the ocean floor.

The LNGRVs that are currently anticipated to call on the Port will have a cargo capacity of approximately 5.1 million ft^3 (145,000 m^3) of LNG. The vessels will have onboard regasification equipment to convert the LNG into pipeline quality natural gas. Each LNGRV is designed to have a maximum send-out rate of 750 million standard cubic feet per day (MMscf/d). The annual average send-out rate is expected to be approximately 400 MMscf/d.

1.2 Overview LNGRV Cooling Water Discharge

Once the Port has been fully commissioned and commercial operations have commenced, an LNGRV will retrieve and securely moor to an STL Buoy and commence regasification and sendout. During normal operations, LNG vaporization will be accomplished using a "closed loop" system. The closed loop system will use a recirculated water-glycol mixture as an intermediate heating medium, heated by steam generated by the vessel's two auxiliary boilers. Ballast water from the vessel's ballast water tanks will be recirculated for use in cooling the vessel's engines and for other cooling and auxiliary purposes. There will be no discharge of ballast water or cooling water from the LNGRV during the normal operation of the Port.

During the commissioning period, the LNGRV's regasification system is typically operated on an intermittent basis and for limited timeframes (typically on the order of 1 to 2 hours at a time when operating). Due to the limited operation of the regasification system, recirculation of ballast water may not always provide sufficient cooling to meet all of the vessel's cooling water needs. This can particularly be an issue during the summer months when ambient seawater temperatures (and hence ballast water temperature) are the highest. If recirculation of ballast water is determined not to be adequate, seawater will be used to supplement the supply to the vessel's central freshwater coolers, dump condenser and freshwater generators during the commissioning period (a time frame of up to 45 days per LNGRV).

It is estimated that if implementation of once-through cooling is required during this period, the average cooling water intake/discharge rate for a LNGRV could approach 8.2 million gallons per day (mgd) (5,700 gallons per minute [gpm]). The estimated temperature difference between cooling water intake

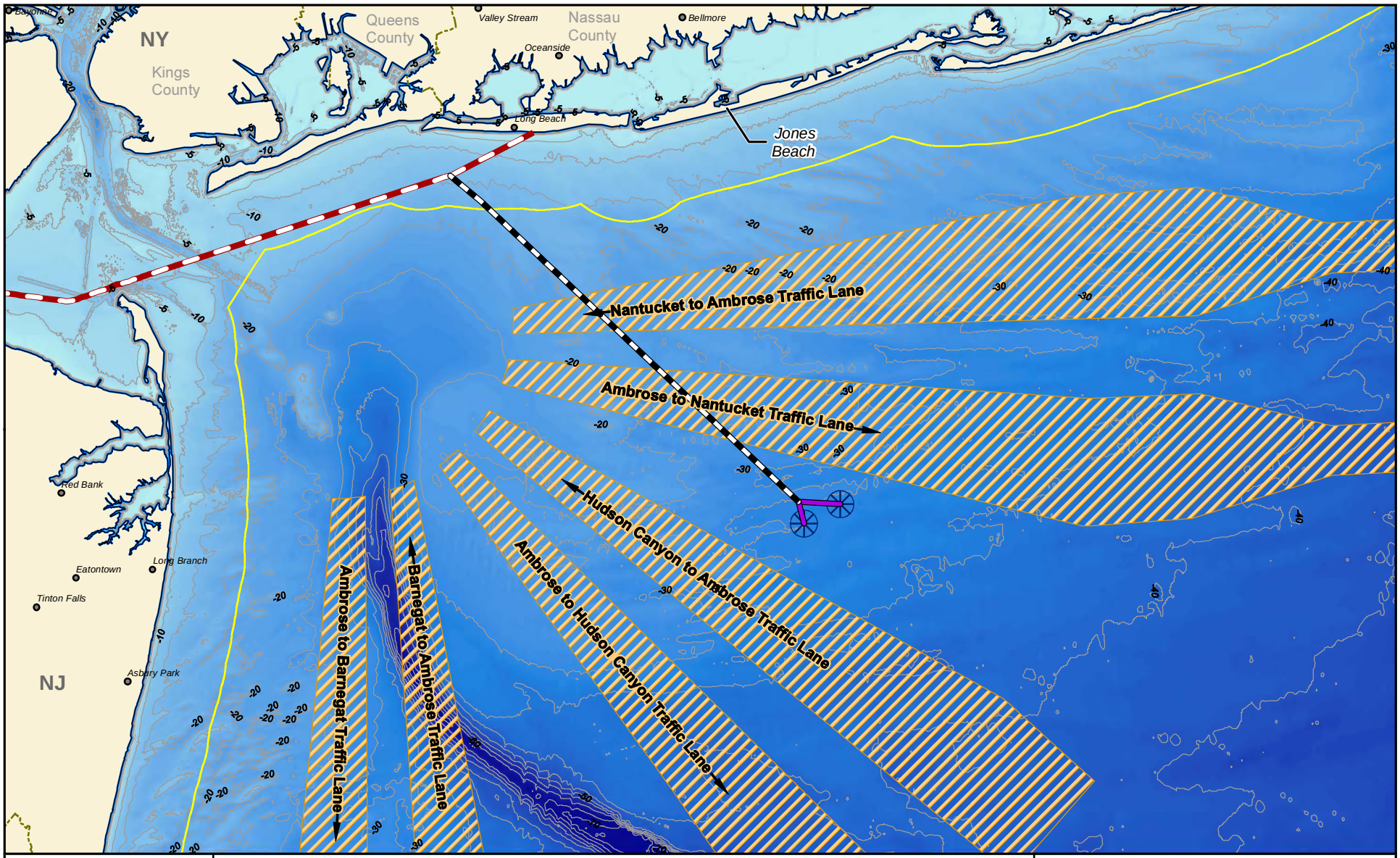
and discharge (ΔT) is anticipated to be in the range of approximately 9° F to 14° F (5° C to 8° C), with a maximum difference of 18° F (10° C). The modeling evaluation that follows predicts discharge thermal plume characteristics associated with discharge at the average flow rate at the maximum anticipated ΔT temperature difference.

On rare occasions, an upset condition can develop during the commissioning period which could require the use of the vessel's auxiliary steam dump condenser. . Although the steam dump condenser is not expected to operate often, it is required to reject heat when the marine boilers must remain operating and the regasification skid is temporarily shut down (this can occur during short shutdowns of the regasification skids during commissioning or during stack emission testing at low gas send-out flows). If the operation of auxiliary steam dump condenser is needed during the commissioning period, for a brief period of time (approximately 1 hour), the seawater intake/discharge rate could increase to as much as 13,900 gpm. In consideration of the anticipated infrequent operation of the auxiliary steam condenser and the short duration of such a discharge if it were to occur, a separate evaluation of the discharge at the higher rate associated with this rare upset condition has not been performed.

If once-through cooling is required during the commissioning period, water will be withdrawn from screened sea chests located along the side hull of the vessel. Discharge of heated cooling water during this period will be by means of an outlet pipe located on the ship bottom, at an approximate depth of 38 ft (11.5 m) below the waterline.

In the evaluation that follows, discharge modeling is performed to assess the magnitude and aerial extent of the thermal plume associated with a potential commissioning period LNGRV cooling water discharge and to characterize the overall dilution of the discharge via mixing with ambient seawater. Modeling is performed using the U.S. EPA-approved Cornell Mixing Zone Expert System or CORMIX model (Jirka et al, 2007).

The Project schedule (as presented in DWP Application Volume II, Topic Report 1) proposes commissioning of LNGRV/STL Buoys will take place from approximately mid-October to early-December 2015. During this timeframe the water column in the Port area is anticipated to be well mixed, uniform conditions typically established during the late-fall and winter, with only minor variation in seawater temperature and salinity from the water surface to the bottom. As there is the potential that the Project schedule could shift, the CORMIX evaluation addresses commissioning discharges occurring during both a fully mixed, uniform temperature/salinity scenario and also during a timeframe when temperature/salinity stratification would be present (e.g., typical summer conditions). The fully mixed, uniform scenario is modeled under "winter" conditions so that the full range of temperature/salinity/currents conditions is captured.



Map Location

Legend

- Mainline
- Laterals
- Existing TRANSCO New York Bay Lateral
- Three Nautical Mile Line
- Traffic Lane
- Bathymetry (5 meter)
- Buoys

Source:
ESRI, MMS, NOAA
Projection: NAD83 State Plane New Jersey FIPS 2900 Feet

N

Date September 2012

Scale 1:400,000

0 2.5 5 10 Nautical Miles

0 2.5 5 10 Nautical Miles

Site Plan

Port Ambrose Project

AECOM

PORTAMBROSE

Figure 1-1

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2.0 Existing Conditions at the Port

2.1 Overview of the Project Area

Figure 2-1 is a project location map that shows the layout of proposed Project with respect to local bathymetry and shows historic water quality and/or current monitoring points referenced in this section. As noted previously, the Port's STL Buoys will be located in water depths of approximately 103 ft (31 m) approximately 19 mi (30 km) off Jones Beach, New York, and approximately 31 mi (50 km) from the entrance channel to New York Harbor.

As shown in Figure 2-2, the Port will be served by two STL Buoys; the center-to-center distance between the two buoy locations is approximately 1.87 mi (3.0 km). LNGRV/STL Buoy commissioning activities will occur sequentially, first at Buoy #1 and then Buoy #2. Given the sequential nature of the commissioning activities and considering the distance between the two buoys, any cooling water discharge from one vessel would not have any impact on seawater temperatures at the adjacent buoy location. Therefore, model predictions associated with the cooling water discharge at a given STL Buoy location are also considered representative of results at the second STL Buoy location.

A detailed description of existing conditions in the vicinity of the Port is provided in Volume II - Topic Report 3 - Water and Sediment Quality of the DWP application. The sections that follow provide an overview of the existing conditions as required to support the selection of input parameters for the CORMIX model.

2.2 Currents

Surface currents in the New York Bight area and in the vicinity of the Port are primarily wind driven. The most comprehensive set of continuous ocean current data for New York Bight in the general vicinity of the Port location was collected as part of a USGS study conducted from December 5, 1999, through April 15, 2000 (Butman et al. 2003; data processed further in Byrnes et al. 2004). In this study, Acoustic Doppler Current Profilers (ADCPs) were deployed at several locations in New York Bight to collect data on surface and near bottom (or subsurface) current speeds and directions. Figure 2-1 depicts the locations where ADCP current measurements were taken and other key monitoring locations in the Bight. Station D, located approximately 10 mi (16 km) west of the Port at a water depth of approximately 85 ft (26 m), is representative of conditions at the Port because it is in the open water portion of the New York Bight and not near any land features or bathymetry features that might cause different circulation patterns. Water depths at Station D are approximately 20 ft less than at the Port, but that is not expected to cause significant differences in current speed and direction between the two locations.

Figures 2-3 and 2-4 present current roses developed using data of the surface currents and bottom currents at Station D, as observed during the 1999-2000 survey (Butman et al. 2003). The directions shown are the directions towards which currents travel. The top current rose in each of these figures represents the hourly averaged currents, with both wind driven and tidal driven components included. The bottom current rose was developed from low-pass filtered data, eliminating the tidal components.

Figure 2-5 presents a wind rose developed using wind data collected at a NOAA National Data Buoy Center (NDBC) Buoy (No. 44025) located approximately 24 mi (39 km) east of Station D and 14 mi (22 km) east of the Port. The directions shown in the wind rose represent the directions towards which wind is traveling. It should be noted that this wind rose direction convention is the opposite of the convention typically used when plotting wind roses; however, Butman et al. (2003) and Byrnes et al. (2004) apparently used this alternative convention so that in their reports the convention used for showing wind roses would be consistent with that used for showing current roses.

Table 2-1 provides a summary of the prevailing winds and current directions (surface and bottom) at Station D, along with maximum and mean current speeds and directions (surface and bottom). As

shown in the wind rose and current rose figures and in the summary data provided in Table 2-1, surface currents in the general Port area during the winter/spring time frame were primarily wind driven. The predominant wind direction during the survey period was towards the southeast, and the predominant surface current direction was similarly towards the southeast and south-southeast. Low pass filtering of the surface data (eliminating tidal current effects) did not significantly change the magnitude or direction of surface currents at Station D, reinforcing the concept of predominantly wind-driven surface currents. Mean surface currents were in the 60 to 70 centimeters per second (cm/s) range (1.2 to 1.4 knots), and maximum currents were in the 100 to 140 cm/s range (1.9 to 2.7 knots).

Table 2-1 Summary of Wind Direction and Current Data at Station D – Dec. 5, 1999, to Apr. 15, 2000

Parameter	Surface Currents Unfiltered (Wind and Tide)	Surface Currents Low Pass Filtered (Wind)	Bottom Currents Unfiltered (Wind and Tide)	Bottom Currents Low Pass Filtered (Wind)
Prevailing Wind Direction	Towards ESE			
Prevailing Current Direction	Towards SE	Towards SE	Towards ESE	Towards SW
Maximum Current	135 cm/s (2.6 kn) towards SE	95 cm/s (1.8 kn) towards SW	35 cm/s (0.7 kn) towards E	21 cm/s (0.4 kn) towards SE
Mean Current	67 cm/s (±23 cm/s) 1.3 knots (±0.4 kn) towards SE	59 cm/s (±17 cm/s) 1.1 kn (±0.3 kn) towards SE	8 cm/s (±5 cm/s) 0.16 kn (±0.1 kn) towards SE	6 cm/s (±4 cm/s) 0.12 kn (±0.08 kn) towards SSE
Source: Butman *et al.* 2003; Byrnes *et al.* 2004.				

Bottom currents at Station D, measured 82 ft (25 m) below the water surface (bws), were significantly lower in velocity than surface currents, with mean velocities in the 6 to 8 cm/s range (0.12 to 0.16 knots). The direction of bottom currents differed somewhat from that of surface currents. There is no definitive indication why this is the case, but it may be due to the lesser influence of winds and the relatively stronger influence of tidal forcing at depth, as well as the influence of sea floor topography on bottom current flow patterns and the Ekman Spiral, a result of the Coriolis Effect on wind driven currents. As was the case with mean current velocities, maximum bottom current velocities were significantly less than surface velocities and were measured in the general range of 20 to 40 cm/s (0.4 to 0.8 knots).

It is important to note that the 1999-2000 surveys were conducted during the winter and spring months. As surface currents are primarily wind driven currents, and (as discussed in detail in Topic Report 3) winds are typically greatest during the winter and spring months (except during tropical storms), these winter/spring currents likely are somewhat greater in magnitude than currents observed during other seasons of the year. Wind direction and associated current direction also tends to be different during the winter and spring months than during the rest of the year. The 1999-2000 survey data suggest that wind direction and associated wind-driven surface current direction are generally towards the south and east (offshore) during the winter/spring months and generally towards the north and west (onshore) during other times of the year.

Figure 2-6 provides profiles of instantaneous current velocity and direction collected on February 10, 2012, at multiple locations in the immediate vicinity of the Port (see Figure 2-1 for locations and Topic Report 4, Biological Resources, Appendix C for the survey report). Data were collected using a boat-mounted ADCP unit. A “bottom tracking” method (hence, the “Ref: Btm” note in the current profile

figures) was used to establish vessel velocity separately and allow for the removal of this movement data from the measured ADCP velocity data, yielding the resultant water column velocity profile.

The instantaneous current velocity measurements taken in January and February 2012 were generally consistent with, although much lower in magnitude than, the winter/spring 1999-2000 data. Observed surface currents were in the general range of 10 to 30 cm/s (0.2 to 0.6 knots), which is less than half of the mean 60 to 70 cm/s range (1.2 to 1.4 knots) of surface currents observed in the earlier, more comprehensive winter/spring survey.

Instantaneous bottom currents were lower, generally in the 5 to 20 cm/s range (0.1 to 0.4 knots), and traveled in a different direction than the surface currents, often in the opposite direction. This reduction of current velocity with depth and variation in flow direction is consistent with the observations of the 1999-2000 survey.

A statistically-based metocean criteria evaluation, provided in Volume III (confidential) [FOE 2008], was performed in support of the Project design to evaluate potential extreme wind, wave, current, and tidal conditions anticipated to occur in the vicinity of the Port. Table 2-2 provides a breakdown of near surface currents by speed and direction in the vicinity of the Port area, developed using sea surface data from Rutgers University's CODAR radar system. The shaded rows represent the dominant current velocity range making up greater than 53 percent of the estimated occurrences.

The metocean data indicate that over 53 percent of the near surface current velocities are estimated to be in the range of 6 to 18 cm/s (0.12 to 0.35 knots), and the weighted mean current velocity is estimated at approximately 16 cm/s (0.31 knots). These CODAR-based surface current velocity estimates are significantly less than the observed winter/spring 1999-2000 surface current velocities and closer to the winter 2012 current velocities. The CODAR current velocities appear to underestimate surface current velocity in the Port area. The CODAR-based current direction estimates indicate no dominant current direction. The flows towards the south (quadrant from SW to SE) occur slightly more frequently than flows in other directions, but the difference is not considered to be significant.

Based on the three sources of current data presented in this section, it can be estimated that surface currents in the vicinity of the Port typically will have velocities in the range of 20 to 40 cm/s (0.4 to 0.8 knots), with higher currents in the range of 60 to 80 cm/s (1.2 to 1.6 knots) during the winter and spring months. Surface currents in the vicinity of the Port are expected to be wind driven and generally will flow towards the south and southeast during the winter and spring months and towards the north and northwest during the summer and fall months. Bottom currents will be less affected by winds, often will flow in a different (and sometimes opposite) direction than the surface current, and typically will have a lower velocity, in the 6 to 8 cm/s range (0.12 to 0.16 knots).

As noted previously, the CORMIX evaluation considers both a fully mixed (uniform temperature/salinity with depth) winter condition and stratified temperature/salinity summer conditions. Also, as the cooling water discharge is anticipated to occur at a depth of approximately 38 ft (11.5 m) bws, plume dissipation of a rising heated plume are anticipated occur in the upper half of the water column, where current velocities will average somewhere between surface velocities and mid-depth velocities. To capture the potential variations of conditions noted above, the range of current velocities applied CORMIX evaluation is between 15 cm/s and 45 cm/s for the "winter" scenario and between 10 cm/s and 30 cm/s for the "summer" scenario.

Table 2-2 Scatter Diagram of Current Speed and Velocity in Port Area Based on CODAR Data

	Direction (towards which currents flow)																
Current Speed (cm/s)	**0 N**	**22.5 NNE**	**45 NE**	**67.5 ENE**	**90 E**	**112.5 ESE**	**135 SE**	**157.5 SSE**	**180 S**	**202.5 SSW**	**225 SW**	**247.5 WSW**	**270 W**	**292.5 WNW**	**315 NW**	**337.5 NNW**	**Sum (%)**
0-3	0.21	0.25	0.17	0.19	0.18	0.19	0.15	0.17	0.23	0.24	0.24	0.20	0.22	0.23	0.18	0.24	3.31
3-6	0.57	0.54	0.54	0.47	0.49	0.44	0.56	0.60	0.59	0.55	0.60	0.66	0.50	0.63	0.54	0.61	8.88
6-9	0.87	0.71	0.73	0.68	0.62	0.72	0.84	0.83	0.85	0.88	0.80	0.89	0.88	0.79	0.79	0.75	12.64
9-12	0.84	0.72	0.83	0.80	0.81	0.93	0.92	0.92	0.86	1.01	1.01	1.04	1.01	0.98	0.80	0.80	14.30
12-15	0.83	0.89	0.80	0.86	0.84	0.87	1.03	0.96	1.00	0.83	0.96	1.09	0.94	0.87	0.81	0.83	14.43
15-18	0.71	0.76	0.76	0.76	0.75	0.79	0.89	0.86	0.80	0.79	0.83	0.82	0.73	0.59	0.69	0.68	12.21
18-21	0.56	0.67	0.75	0.57	0.66	0.71	0.76	0.71	0.69	0.71	0.62	0.61	0.55	0.40	0.55	0.59	10.10
21-24	0.43	0.54	0.59	0.54	0.42	0.60	0.54	0.58	0.58	0.49	0.57	0.55	0.38	0.32	0.28	0.37	7.78
24-27	0.26	0.42	0.43	0.41	0.34	0.41	0.38	0.44	0.35	0.38	0.34	0.39	0.32	0.26	0.24	0.26	5.62
27-30	0.16	0.30	0.34	0.33	0.28	0.29	0.25	0.26	0.30	0.20	0.22	0.21	0.21	0.16	0.13	0.17	3.81
30-33	0.11	0.20	0.23	0.23	0.18	0.17	0.18	0.21	0.20	0.19	0.20	0.14	0.12	0.08	0.05	0.11	2.63
33-36	0.06	0.10	0.15	0.13	0.10	0.14	0.09	0.11	0.09	0.17	0.13	0.09	0.04	0.03	0.03	0.04	1.51
36-39	0.04	0.09	0.09	0.07	0.06	0.05	0.07	0.08	0.09	0.13	0.11	0.06	0.02	0.01	0.02	0.03	1.01
39-42	0.03	0.06	0.06	0.04	0.03	0.03	0.04	0.03	0.06	0.05	0.08	0.03	0.01	0.01	0.01	0.01	0.60
42-45	0.02	0.04	0.03	0.02	0.02	0.02	0.03	0.04	0.03	0.04	0.02	0.02	0.01	0.00	0.00	0.01	0.35
45-48	0.01	0.01	0.03	0.01	0.02	0.01	0.01	0.03	0.03	0.05	0.02	0.01	0.00	0.01	0.00	0.00	0.27
48-51	0.01	0.02	0.01	0.02	0.00	0.00	0.01	0.05	0.03	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.21
51-54	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.12
54-57	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.08
57-60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.05
60-63	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03
63-66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02
66-69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02
69-72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72-75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum %	**5.73**	**6.35**	**6.58**	**6.15**	**5.82**	**6.37**	**6.78**	**6.92**	**6.84**	**6.87**	**6.81**	**6.84**	**5.94**	**5.38**	**5.12**	**5.50**	**100**

Highlighted rows indicate prevailing current speeds; >53 percent of current speeds are in 6 to 18 cm/s range.
Source: Metocean Criteria Study provided in Volume III (confidential) of this application.

2.3 Seawater Temperature

Seawater temperatures in New York Bight vary seasonally and temporally, based on regional currents, freshwater inflow, atmospheric heat exchange, and local weather conditions. During the summer months, radiant heating warms the surface layer of the water column, while bottom waters remain cool. This temperature difference and associated density differences result in the stratification of the water column. The summer season stratification remains in place until surface temperatures cool. Surface cooling and wind cause a mixing of the water column and reduce stratification. Temperature increases during the summer months also are moderated by currents that carry in cool Canadian waters from the north. Coastal runoff also impacts nearshore seawater temperatures.

Records of seawater surface temperature have been recorded at NOAA's Ambrose Light Station, located approximately 22 mi (35 km) northwest of the Port (Figure 2-1). Figure 2-7 presents a quartile plot showing monthly minimum, 25th percentile, median, 75th percentile, and maximum sea surface temperatures at Ambrose Light Station as collected from November 1984 to May 2008 (NOAA 2012a). Median sea surface temperatures at Ambrose Light Station range from a low of approximately 39 degrees Fahrenheit (°F) (4 degrees Celsius [°C]) in February to a high of approximately 72°F (22°C) in August.

Mean surface and bottom water temperature data collected in the vicinity of Ambrose Light Station from 1978 to 1992 indicate that stratification with respect to temperature typically starts in late April and ends in late October (Benway and Jossi 1998). Peak stratification typically occurs in the July to September time frame, when mean surface water temperatures range from 68 to 72°F (20 to 22°C) while temperatures in the bottom waters range from 50 to 57°F (10 to 14°C). During the rest of the year, mean temperatures are similar at the surface and bottom, indicating that the water column is generally well-mixed (Benway and Jossi 1998).

The CORMIX evaluation considers temperature conditions associated with winter conditions (fully mixed, uniform with depth) and summer conditions (stratified, varying with depth). The winter scenario assumes a uniform water column temperature of 42.8° F (6° C). The summer scenario assumes a stratified condition, with water temperature linearly varying from 71.6° F (22° C) at the water surface to 50.0° F (10° C) at a depth of 103 ft (31 m). As discussed in Section 4.2, CORMIX model constraints require that the depth at discharge be extended down to a depth of 116 ft (35 m). The bottom temperature (along with salinity and density) values used in the model are adjusted so that the temperature, salinity and density values at the actual depth of 103 ft (31 m) coincide with those noted above.

2.4 Seawater Salinity

A detailed discussion of salinity in New York Bight is provided in Volume II - Topic Report 3 - Water and Sediment Quality of the DWP application.

Surface salinity in the Port area is anticipated to resemble that of the open ocean, as exemplified in the NOAA NDBC Buoy No. 44025 surface salinity data presented in Table 2-3. NOAA NDBC Buoy No. 44025, shown in the inset in Figure 2-1, is located in the open ocean approximately 14 mi (22 km) east of the Port. Table 2-3 presents a summary of salinity data collected at this buoy in 2008, 2009, and 2010 (NOAA 2012b). Salinity measurements were recorded on an hourly basis (some data gaps exist) at a depth of 3.28 ft (1 m) beneath the water surface. Except for a few anomalously low measurements during July of 2009, surface salinity values at NOAA NDBC Buoy No. 44025 were generally in the range of 31 to 33 parts per thousand (ppt), with a period average value of 32.0 ppt.

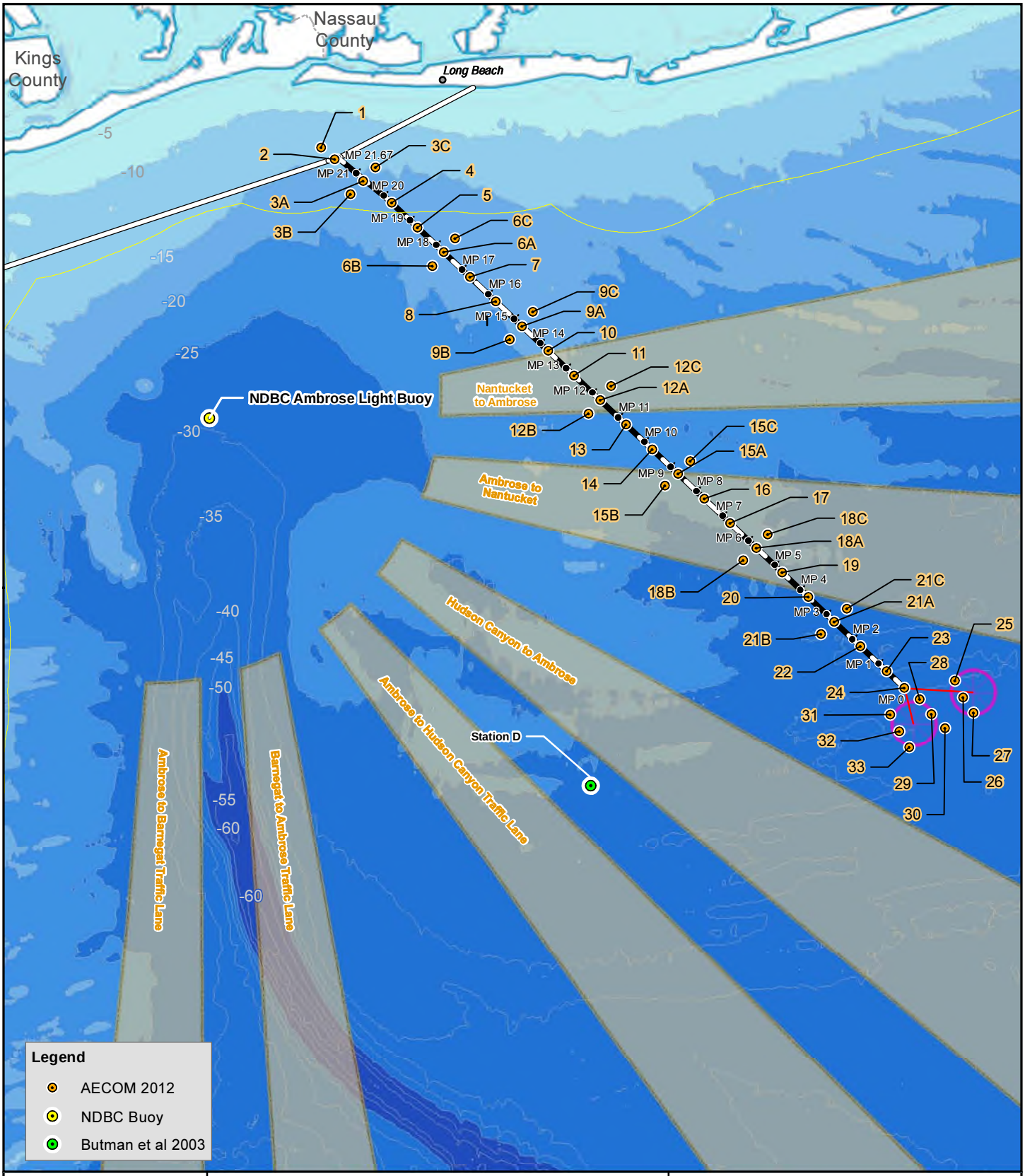
As with temperature, well-mixed water column conditions during the late-fall and winter period are anticipated to result in relatively uniform salinity conditions across the water column. Based on data in Table 2-3 and data collected in the Port area during the winter of 2012, the CORMIX evaluation assumes a uniform salinity of 32 ppt for the winter scenario. During the summer months, a stratified

water column exists with surface salinity typically less and salinity increasing with depth. The CORMIX evaluation a summer commissioning scenario assumes that salinity increases linearly with depth, with a surface salinity of 31.0 ppt and salinity at a depth of 103 feet (31 m) of approximately 32.5 ppt. As discussed above and in Section 4.2, CORMIX model constraints require that the depth at discharge be extended down to a depth of 116 ft (35 m). The bottom salinity (along with temperature and density) values used in the model are revised values, adjusted so that the salinity (and temperature and density) values at the actual bottom depth of 103 ft (31 m) coincide with those noted above.

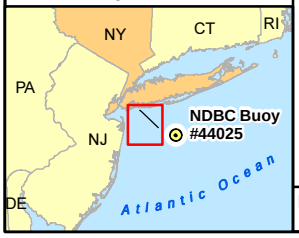
Table 2-3 Summary of Observed Salinity Values at NOAA NDBC Buoy No. 44025 – 2008, 2009, and 2010

Month	2008		2009		2010	
	Average Salinity (ppt)	Salinity Range (min to max) (ppt)	Average Salinity (ppt)	Salinity Range (min to max) (ppt)	Average Salinity (ppt)	Salinity Range (min to max) (ppt)
January	32.2	31.9 to 32.4	32.8	32.1 to 33.4	33.2	32.7 to 33.8
February	32.2	31.4 to 32.5	32.9	32.6 to 33.4	32.9	32.5 to 33.0
March	31.8	30.7 to 32.3	32.7	32.1 to 33.2	32.5	32.5 to 32.5
April	32.0	31.3 to 32.6	32.1	31.7 to 32.7	--	--
May	31.3	30.5 to 32.1	31.5	31.0 to 32.1	--	--
June	30.7	30.3 to 31.0	31.3	30.7 to 31.7	--	--
July	30.8	30.2 to 31.4	30.8	29.2 to 31.4	--	--
August	31.2	30.6 to 31.7	30.5	26.3 to 31.4	--	--
September	31.7	30.3 to 32.7	32.3	30.5 to 33.4	--	--
October	32.2	31.8 to 32.5	32.4	30.7 to 33.0	--	--
November	32.4	32.2 to 32.6	32.4	32.0 to 32.7	--	--
December	32.5	31.6 to 32.9	32.7	31.6 to 33.6	--	--
Annual Average (Annual Range)	31.8	30.2 to 32.9	32.0	26.3 to 33.6	32.9	26.3 to 33.8
Period Average	32.0					
Period Range	26.3 to 33.8					

Salinity measurement recorded at a depth of 1 m (3.28 ft) beneath water surface, generally on an hourly basis.
Source: NOAA 2012b.



Map Location



Legend

- Mainline
- Existing TRANSCO New York Bay Lateral
- Laterals
- Three Nautical Mile Line
- Bathymetry 5m Intervals
- Buoy Locations

N

Source:
ESRI Datalayers, GEODAS, NOAA
Projection: NAD83 State Plane New Jersey FIPS 2900 Feet

Date September 2012

1:240,000 0 1 2 4 Nautical Miles 0 1 2 4 Miles

Offshore Monitoring Locations

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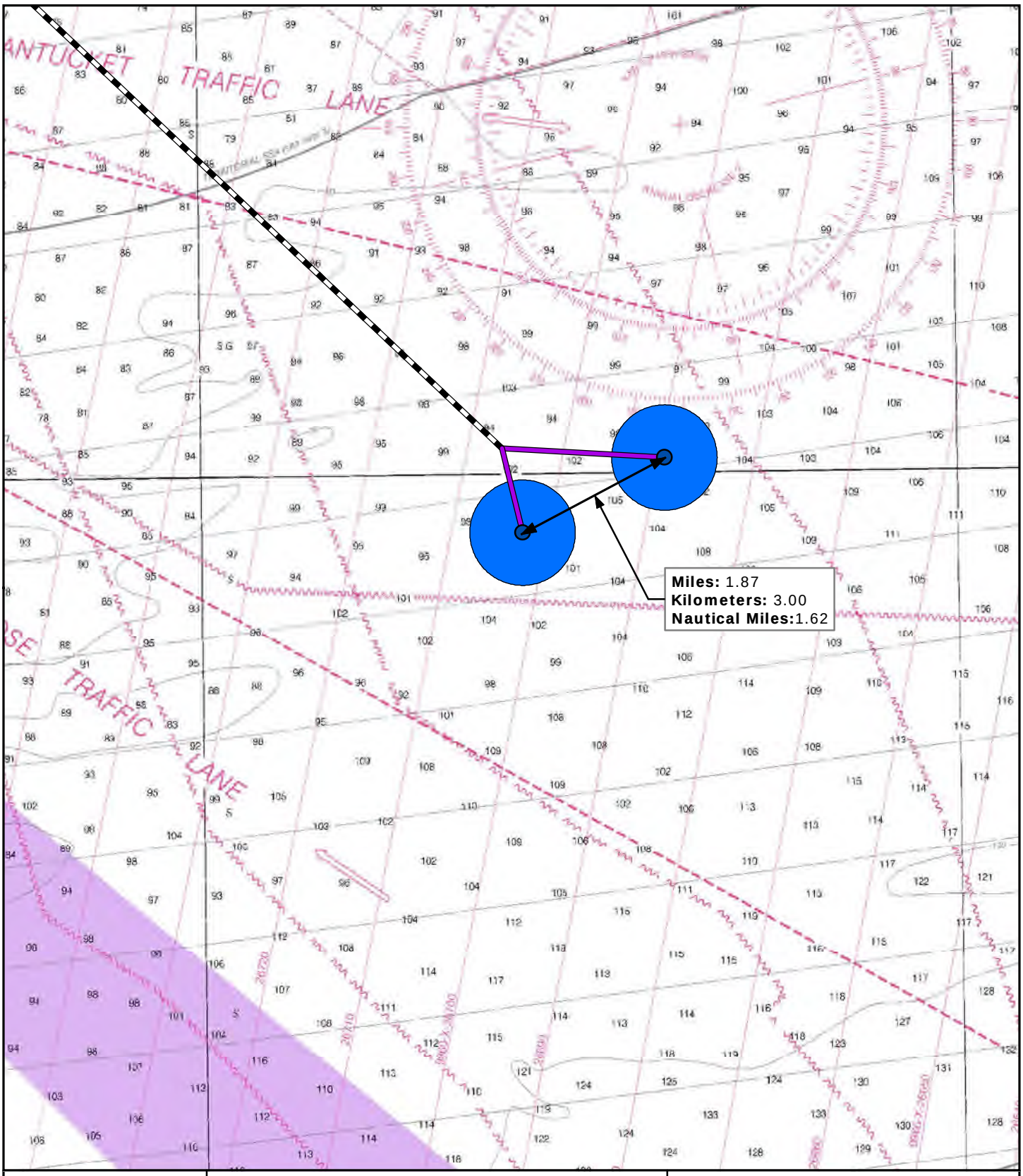
Figure 2-1



Map Location

Legend

- Mainline
- Laterals
- Buoy Location

N

Source:
ESRI Datalayers, NOAA
Projection: NAD83 State Plane New Jersey FIPS 2900 Feet

Date September 2012

1:100,000
Nautical Miles 0 0.5 1 2 0 0.5 1 2 Miles

STL Buoy Spacing

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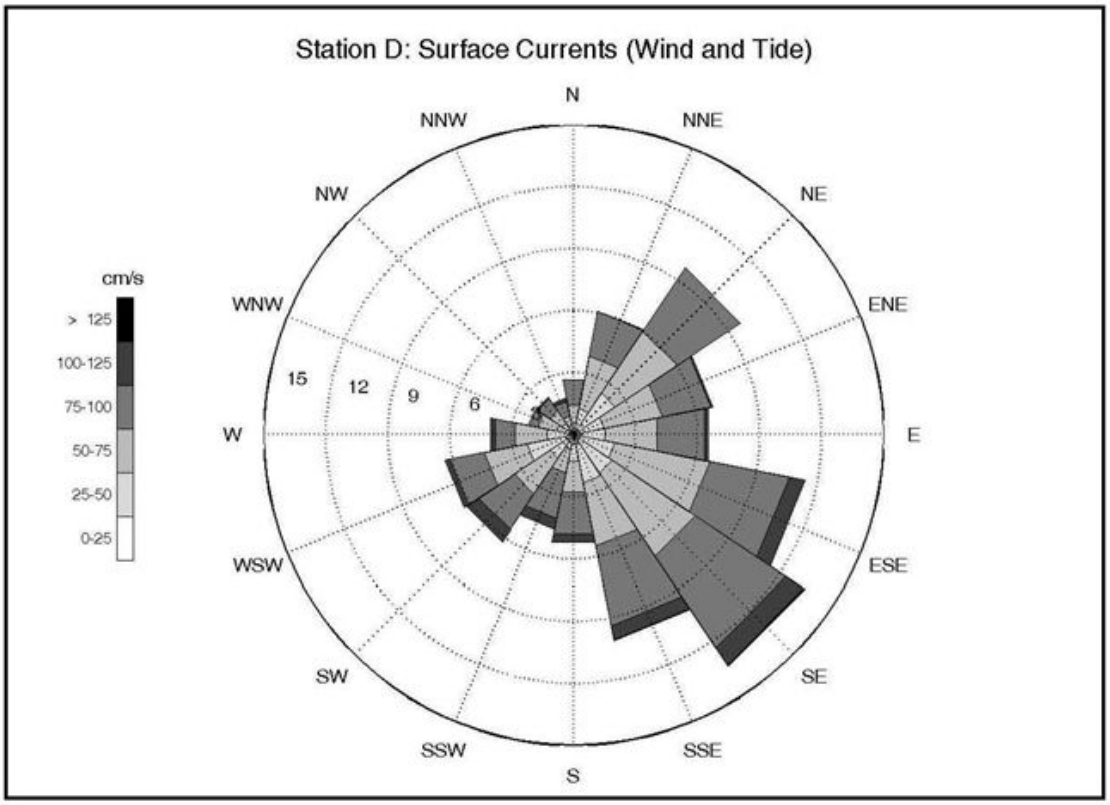
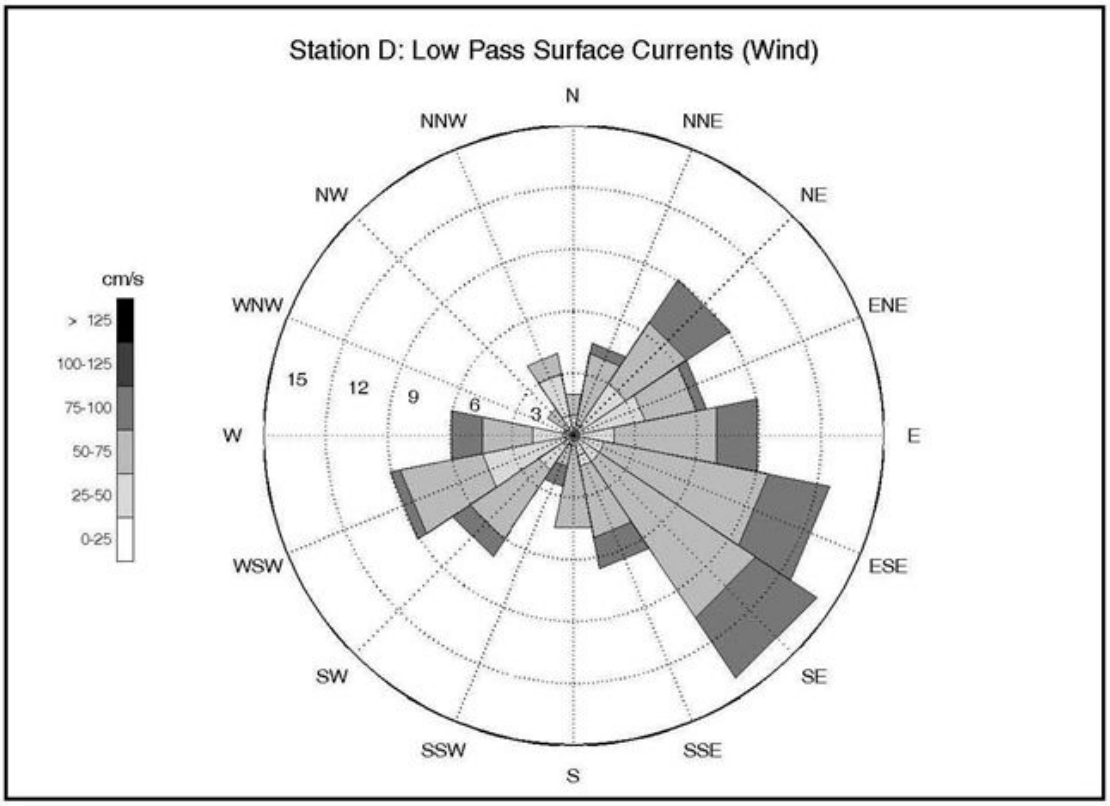
Figure 2-2





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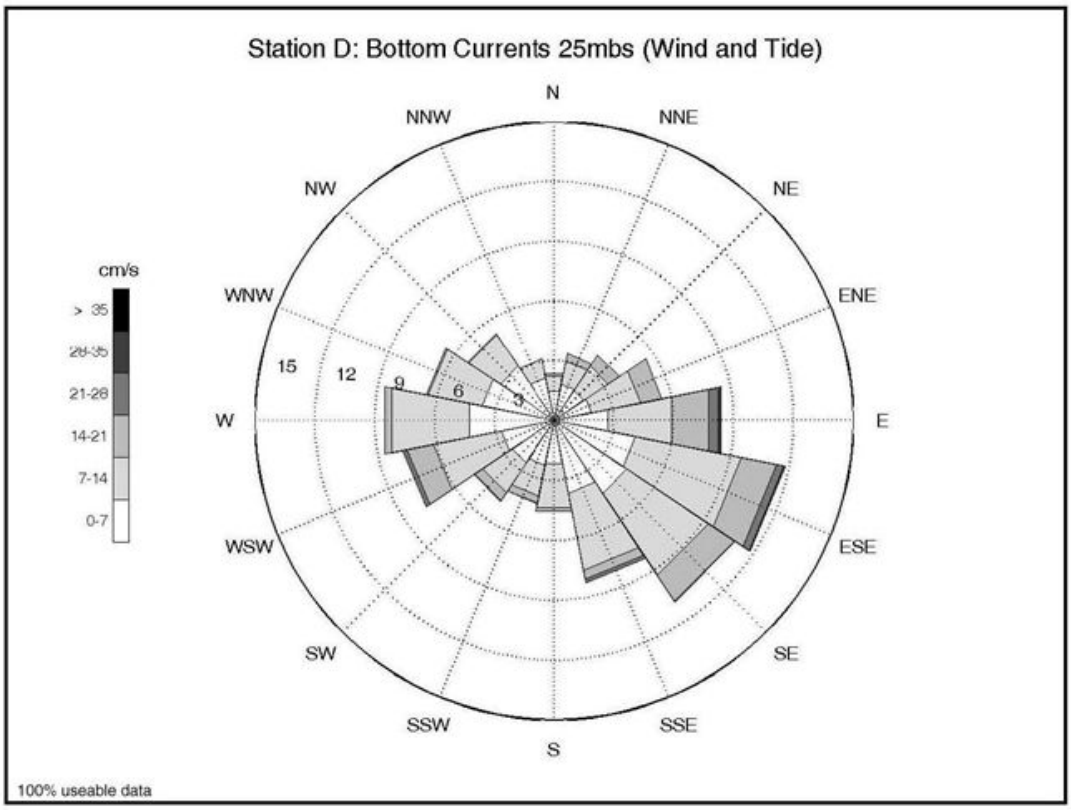
Surface Currents at Station D

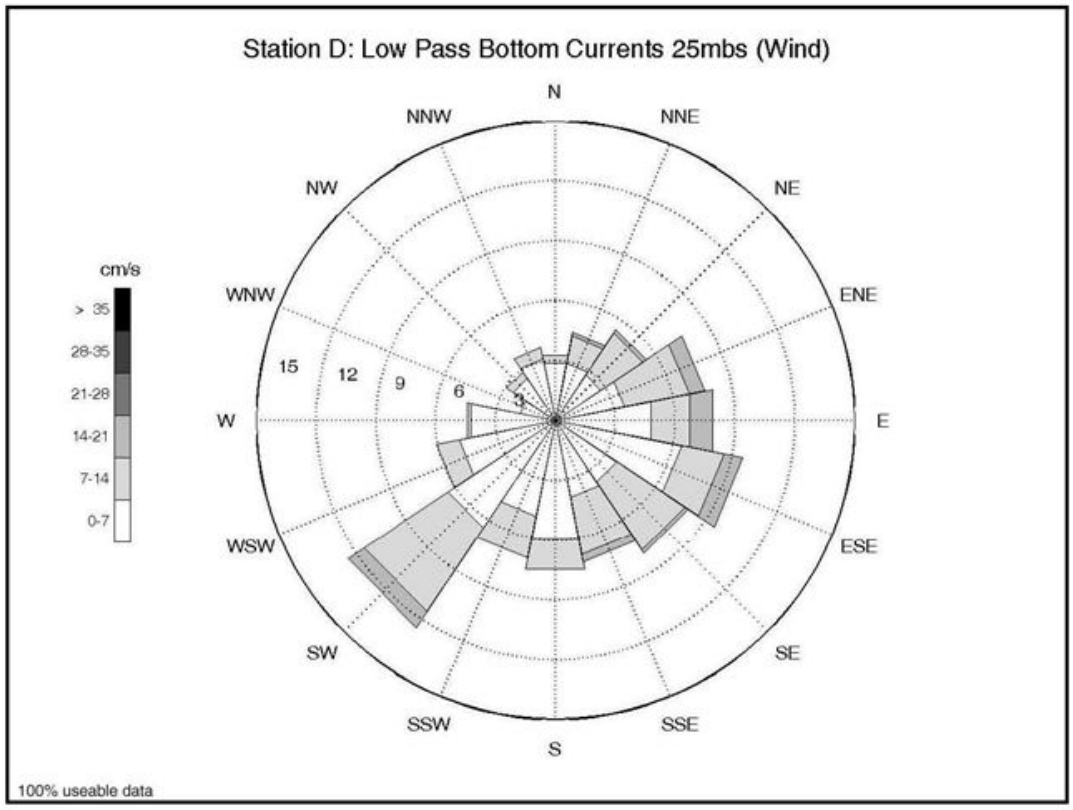
Dec. 5, 1999 to Apr. 15, 2000 (Butman et al., 2003; Byrnes et al., 2004)

(Direction Convention: direction shown is direction towards which current flows)

Port Ambrose Project

Figure 2-3





AECOM

PORTAMBROSE

Bottom Currents at Station D

Dec. 5, 1999 to Apr. 15, 2000
(Butman et al., 2003; Byrnes et al., 2004)

(Direction Convention: direction shown is direction towards which current flows)

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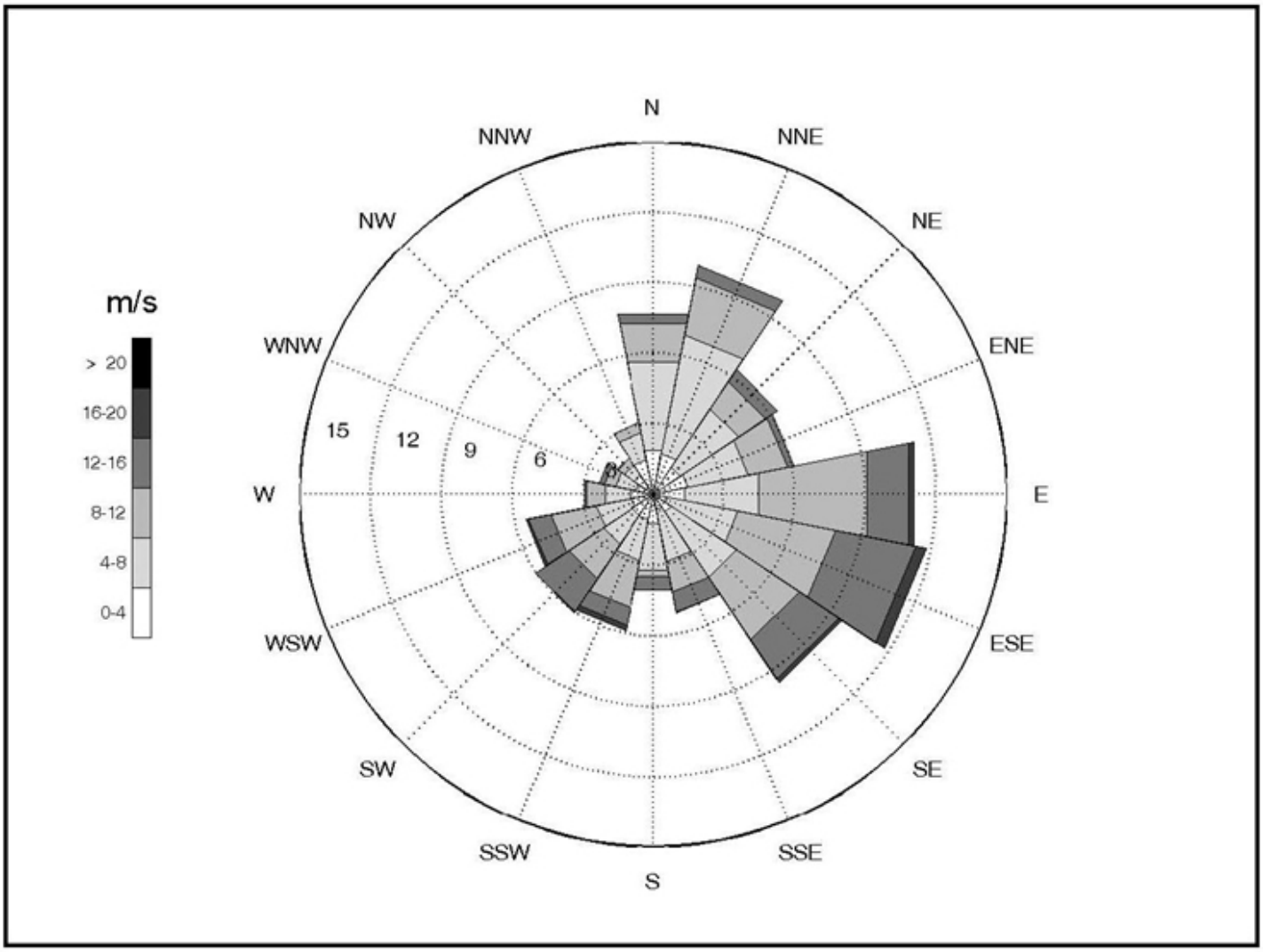
Figure 2-4



AECOM

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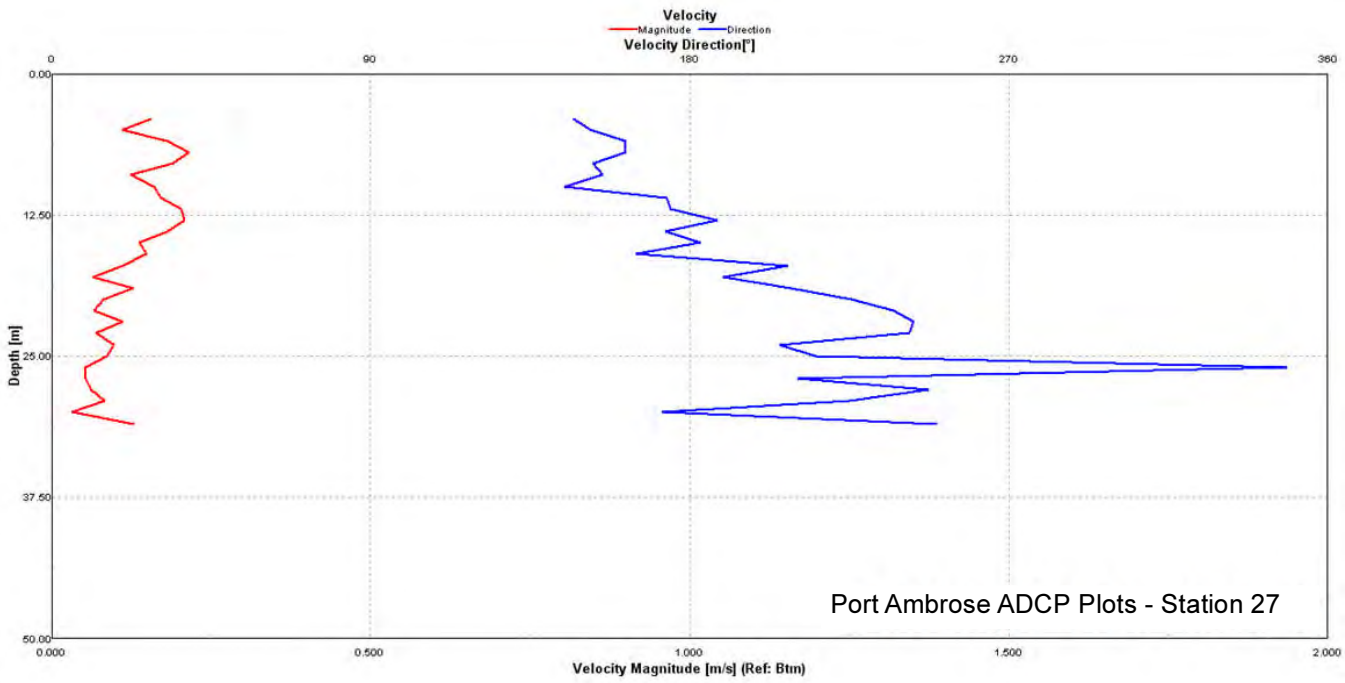
Wind Speed and Direction from NDBC Station No. 44025

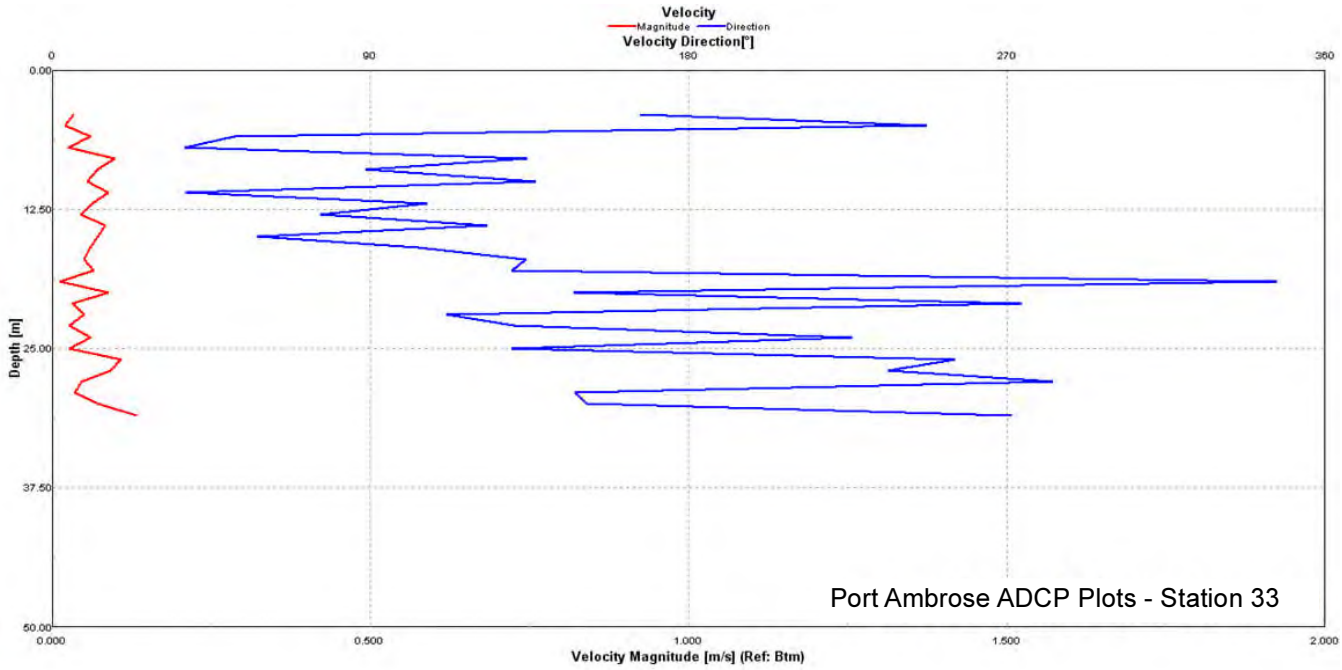
Dec. 1, 1999 to Apr. 30, 2000
(Butman et al., 2003; Byrnes et al., 2004)

(Direction Convention: direction shown is direction from which wind blows)

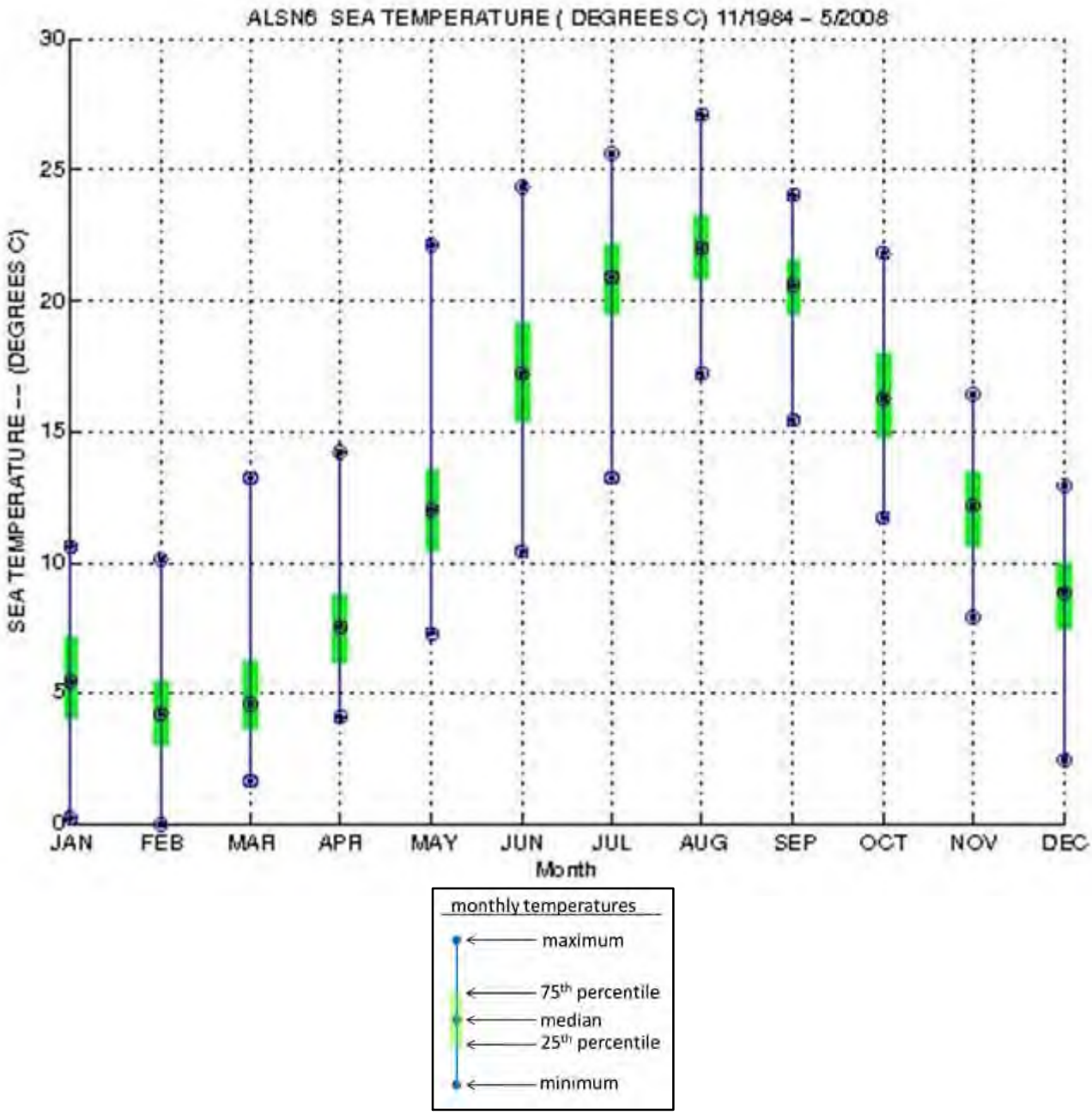
Port Ambrose Project

Figure 2-5





AECOM PORTAMBROSE	**Instantaneous Current Measurements in Vicinity of the Port** **Feb. 10, 2012**	**Port Ambrose Project** **Figure 2-6**



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Sea Surface Temperatures at Ambrose Light Station

Port Ambrose Project

Figure 2-7

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3.0 Description of Commissioning Phase Cooling Water Intake/Discharge

This section provides an overview of the LNGRV proposed for the Project and the assumptions relative to potential commissioning period cooling water intake/discharges used in the CORMIX thermal discharge modeling evaluation.

3.1 Description of LNGRV Intake/Discharges

If once-through cooling is required during the commissioning period, higher seawater intake rates will be achieved by withdrawing water from screened sea chests located along the side hull of the vessel. The typical LNGRV will be equipped with high and low sea chests, centered at approximately 20 ft and 32 ft (6.1 m and 9.8 m) below the waterline, respectively, when the vessel is approximately 50 percent offloaded (i.e., at “half cargo”). The higher seawater intake rates required to support commissioning will be achieved by drawing water through both sets of sea chests.

A typical configuration would have the low sea chest intake screens located on the starboard side of the ship, in the bottom of the vessel’s hull in a near horizontal position. The high sea chest intake screens might typically be located on the port side of the vessel in a near vertical plane in the vessel’s side shell. For the purpose-built vessels proposed for the Liberty DWP, intake screens will be slotted screens with 1-inch high by 12-inch long slots. The combined total open flow area of the low sea chest intake screens on the starboard side of the vessel is estimated at approximately 33.4 square feet (3.10 m^2). The combined total open flow area of the high sea chest intake screens on the port side of the vessel will also be approximately 33.4 ft^2 (3.10 m^2).

Discharge of cooling water from the LNGRV during the commissioning period, if necessary, would occur from an outlet pipe located on the bottom of the ship. When the vessel is at an average draft (i.e., half-full of LNG), the discharge outlet will be located approximately 38 feet (11.5 m) bws. The cooling water will discharge through a pipe anticipated to be approximately 2.3 feet (0.7 m) in diameter and will be oriented vertically downward.

3.2 Cooling Water Flow Rate and Temperature

It is estimated that the average cooling water intake/discharge rate for an LNGRV during the commissioning period could approach 8.2 mgd (5,700 gpm or 1,295 m^3/hr). The estimated temperature difference between cooling water intake and discharge (ΔT) is anticipated to be in the range of approximately 5° C to 8° C (9° F to 14.4° F), with a maximum difference of 10° C (18° F).

The CORMIX evaluation assumes a worst case scenario for both the winter (uniform) and summer (stratified) conditions. The assumed cooling water discharge rate is 5,700 gpm (1,295 m^3/hr) and the assumed temperature rise (ΔT) is 18° F (10° C) above the intake seawater temperature.

As described in Section 1.2, on rare occasions, a short duration (approximately 1 hour) maximum seawater intake/discharge rate of up to 13,900 gpm (3,157 m^3/hr) may occur if the vessel auxiliary steam dump condenser is needed. Although the steam dump condenser is not expected to operate often, it is required to reject heat when the marine boilers must remain operating and the regasification skid is temporarily shut down (this can occur during short shutdowns of the regasification skids during commissioning or during stack emission testing at low gas send-out flows). Operation of the auxiliary steam dump condenser and associated seawater intake/discharge at the higher rate is anticipated to be an infrequent event of brief duration and, therefore, has is not specifically evaluated in this modeling assessment.

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4.0 Discharge Modeling

4.1 The CORMIX Model

Thermal discharge modeling is performed to assess the magnitude and aerial extent of the thermal plume associated with a potential LNGRV/STL Buoy commissioning cooling water discharge and to characterize the overall dilution of the discharge via mixing with ambient seawater. Modeling was performed using the U.S. EPA-approved Cornell Mixing Zone Expert System or CORMIX model (Jirka et al, 2007).

CORMIX is a computer model used to simulate the mixing of discharges with ambient receiving waters. The major emphasis of the model is on the geometry and dilution characteristics of the initial mixing zone, but the system also predicts the behavior of the discharge plume at larger distances.

The mixing behavior of a discharge is governed by the interaction of ambient conditions in the receiving water body and by the discharge characteristics. The ambient conditions in the receiving water body are described by the water body's geometric and dynamic characteristics. Important geometric parameters include plan shape, vertical cross-sections, and bathymetry, especially in the discharge vicinity. Dynamic characteristics are given by the velocity and density distribution in the water body, again primarily in the discharge vicinity.

The discharge conditions relate to the geometric and flux characteristics of the outfall. The flux characteristics are given by the discharge flow rate, by its momentum flux and by its buoyancy flux. The buoyancy flux represents the effect of the relative density difference between the discharge and ambient conditions in combination with the gravitational acceleration. It is a measure of the tendency for the discharge flow to rise (i.e. positive buoyancy) or to fall (i.e. negative buoyancy).

Submerged discharges from a single port outfall are modeled using the CORMIX1 component of the model. The evaluation that follows was performed using the CORMIX1 component of CORMIX Version 5.0. The assumptions, methods, data, and results of the modeling are described in the section that follows.

4.2 Approach and the Conceptual Model

Table 4-1 provides an overview of the conceptual model applied in the CORMIX modeling effort. Two seasonal scenarios are evaluated: a winter condition with a uniform seawater temperature and salinity across the full water column and a summer condition with stratified seawater temperature and salinity (and the resulting density) linearly varying from the water surface to the bottom.

A CORMIX model constraint requires that for near surface discharges, the discharge height above bottom must be greater than two-thirds of the overall water depth. To comply with this constraint, a bottom depth of 116 ft is assumed in the model, rather than the actual bottom depth of 103 ft. This minor change should not affect the results of the Port Ambrose modeling evaluation, as the heated discharge plume is strongly positively buoyant, rapidly rises towards the water surface and does not extend down to the lower depths of the water column. The seawater temperature, salinity and density values for the summer (stratified) scenarios, as presented in Table 4-1, are revised values that have been adjusted to ensure that the that respective conditions across the water column in the model are consistent with the conditions assumed (as described in Section 2) for the 103 ft water column at the Port site.

Modeling is performed using ranges of current velocities typical for the two seasonal scenarios evaluated. The winter (uniform) condition is evaluated using assumed ambient current velocities of 15 cm/s and 45 cm/s, reflecting the range of stronger currents that tend to occur across the top half of the water column during the winter months. Current velocities that are applied for the summer (stratified) conditions range from 10 cm/s to 30 cm/s, reflecting the comparatively lower velocities that exist during the summer months.

Table 4-1 Thermal Discharge Conceptual Model

Parameter	Conceptual Values for Winter Condition	Conceptual Values for Summer Condition
Water depth	116 ft (35.4 m)	116 ft (35.4 m)
Seawater Temperature	42.8º F (6º C) across the full water column	71.6º F (22º C) at surface decreasing linearly to 47.3 ºF (8.5 ºC) at 116 ft
Seawater Density	1025.18 kg/m^3 across full water column (based on salinity of 32 ppt)	1021.17 kg/m^3 f at surface increasing linearly to 1025.37 kg/m^3 at 116 ft (based on salinity of 31 ppt at surface and 32.7 ppt at 116 ft)
Ambient Current Velocity	15 and 45 cm/s; assume cross-flow (current perpendicular to discharge direction)	10 and 30 cm/s; assume cross-flow (current perpendicular to discharge direction)
Discharge Configuration	2.3 ft (0.7 m) diam. pipe discharge in vertical plane (downward) at a depth of 38 ft (11.5 m) bws	2.3 ft (0.7 m) diam. pipe discharge in vertical plane (downward) at a depth of 38 ft (11.5 m) bws
Discharge Rate	5,700 gpm (0.36 m^3/s)	5,700 gpm (0.36 m^3/s)
Intake Temperature	42.8 ºF (6 ºC)	66.2 ºF (19.0 ºC)
Discharge Temperature	18º F (10º C) above intake temperature = 60.8º F (16º C)	18º F (10º C) above intake temperature = 84.2º F (29º C)
Discharge Density	1023.42 kg/m^3	1019.41 kg/m^3

Seawater density is estimated based on seawater temperature and salinity. Discharge density is estimated based on the temperature/salinity of the intake seawater (at an average intake depth of approximately 26 ft [8 m] bws) and an assumed temperature increase (ΔT) of 18º F (10º C).

The discharge configuration consists of a jet discharge at a rate of 5,700 gpm (0.36 m^3/s) via a 2.3 ft (0.7 m) diameter downward oriented outfall pipe located at a depth of 38 ft (11.5 m) bws. As the discharge is in the vertical plane (vertically downward), it is normal to the direction of ambient currents. This results in a “cross-flow” condition in which the positively buoyant discharge plume is deflected only slightly by the ambient current velocity as it rises through the water column.

4.3 Model Predictions

Discharges during the LNGRV/STL Buoy commissioning period will occur in federal waters. The USEPA National Recommended Water Quality Criteria (USEPA 2012) do not assign specific numerical criteria for thermal discharges to marine waters; however, they do make reference to the USEPA Quality Criteria for Water 1986 (also known as the “Gold Book”) (USEPA 1986). The Gold Book provides a criterion for discharges to marine waters, stating “the maximum acceptable increase in the weekly average temperature resulting from the artificial sources is 1.8° F (1° C)”. Based on this USEPA criterion, a temperature increase in excess of 1.8° F (1° C) at the edge of a typical regulatory mixing zone of 328 ft (100 m) not exceed 1.8° F (1° C) is used as a the significance threshold for the thermal discharge modeling evaluation.

4.3.1 Overview of Results

Figures 4-1 through 4-4 present profile views of the predicted discharge plume for the four scenarios evaluated. In each case, the jet momentum of the discharge (discharge velocity of 2.23 ft/s [0.68 m/s]) initially propels the plume downward. As it moves downward, it is slightly deflected in the horizontal plane by the cross flow of the ambient current. The positive buoyancy of the heated plume overtakes the downward jet momentum and reverses the direction of the plume, forcing it to rise toward the water surface. Eventually, the plume mixes with the surface layer, forming a surface plume that spreads and dissipates further with the ambient currents. In all four scenarios, the thermal plume dissipates as it first surges downward through and then rises upward through the water column. As shown in Figures 4-1 through 4-3, in 3 of the 4 scenarios (the exception being the summer, 10 cm/s case), the thermal component of the plume has essentially dissipated, with plume excess temperature dropping below the 1.8° F (1° C) criterion well before it reaches the water surface.

For the lower ambient velocity (10 cm/s) summer (stratified) scenario, due to the combined effect of lower ambient currents (resulting in less entrainment of cooler ambient seawater into the thermal plume) and stratified conditions (waters are warmer towards the surface than at depth), the plume centerline temperature does not drop below the 1.8° F (1° C) criterion until after the rising plume becomes mixed with the water in the upper portion of the water column, creating a surface plume. As described in more detail in the section that follows, although this low current summer condition is predicted to result in the formation of a surface plume, the plume is predicted to be small in areal extent, volume, and magnitude.

4.3.2 Summary of Winter (Uniform) Model Predictions

The winter (uniform) scenarios most closely resemble conditions anticipated if LNGRV/STL Buoy commissioning occurs during the late-fall (October through December) timeframe as currently anticipated. The CORMIX model assesses mixing based on the momentum of the jet discharge (as determined by discharge flow rate and port diameter/configuration) and the density difference between the discharge plume and the ambient water column. As relatively uniform temperature, salinity and density conditions typically exist from late-fall and into the winter months; the winter (uniform) conditions are considered representative.

Plume predictions for the winter scenarios are provided in Table 4-2 and shown in Figure 4-1 (15 cm/s current) and Figure 4-2 (45 cm/s current). The 15 cm/s current scenario represents the low current condition most likely in-place during the late-fall and the 45 cm/s current scenario represents a higher current condition that may be in-place later during the winter season. For both scenarios, the plume discharges from the vessel as a downward moving conical plume, is deflected slightly by cross-flowing ambient currents, and as the positive buoyancy of the heated, less dense plume overtakes the discharge momentum, the plume reverses direction and begins to rise towards the surface.

At the lower (15 cm/s) current velocity, deflection of the plume in the horizontal plane is less than at higher current velocities, as is the rate of entrainment of cooler ambient seawater into the warmer plume. Plume centerline excess temperature is predicted to drop below half of the initial ΔT value (below 9° F [5 °C]) at a depth of 11.7 ft (3.6 m) below and a distance of 3.5 ft (1.1 m) downcurrent from the discharge pipe. The volume of water exposed to temperatures in of 9° F (5 °C) greater than ambient is estimated to be approximately 55 ft^3 (1.6 m^3). The plume is predicted to descend to a maximum depth of 53.6 ft (16.3 m) bws at a distance of 15.5 ft (4.7 m) downcurrent of discharge. The centerline excess temperature in the rising plume is predicted to drop below the 1.8° F (1 °C) thermal criterion at a depth of 41.7 ft (12.7 m) bws and a distance of 49.4 ft (15.1 m) downcurrent of the point of discharge. The volume of water exposed to temperatures in of 1.8° F (1 °C) greater than ambient is estimated to be approximately 2,701 ft^3 (76 m^3). The estimated plume travel time from the point of discharge to the compliance point is predicted to be less than 2 minutes.

Table 4-2 Predicted Thermal Plume Dissipation - Winter (Uniform) Conditions

Location	Winter (Uniform) Conditions Current = 15 cm/s (see Figure 4-1)	Winter (Uniform) Conditions Current = 45 cm/s (see Figure 4-2)
Point of Discharge ΔT = 18° F (10 °C)	discharge depth = 38 ft (11.6 m) bws plume Φ = pipe Φ = 2.3 ft (0.7 m) discharge velocity = 2.23 ft/s (0.68 m/s)	discharge depth = 38 ft (11.6 m) bws plume Φ = pipe Φ = 2.3 ft (0.7 m) discharge velocity = 2.23 ft/s (0.68 m/s)
Plume C_L ΔT < 9° F (< 5 °C)	depth 49.7 ft (15.1 m) bws 3.5 ft (1.1 m) downcurrent of discharge approximate volume of 9° F (5 °C) plume = 55 ft^3 (1.6 m^3)	depth 40.7 ft (12.4 m) bws 2.9 ft (0.9 m) downcurrent of discharge approximate volume of 9° F (< 5 °C) plume = 12 ft^3 (0.3 m^3)
Plume C_L at max. depth	depth 53.6 ft (16.3 m) bws 15.5 ft (4.7 m) downcurrent of discharge ΔT = 5.3° F (2.9 °C)	depth 43.3 ft (13.2 m) bws 24.1 ft (7.3 m) downcurrent of discharge ΔT = 4.2° F (2.3 °C)
Plume C_L ΔT < 1.8° F (< 1 °C)	depth 41.7 ft (12.7 m) bws 49.4 ft (15.1 m) downcurrent of discharge approximate volume of 1.8° F (1 °C) plume = 2,701 ft^3 (76 m^3) approximate plume travel time = 1.5 min.	depth 38.6 ft (11.8 m) bws 89.2 ft (27.2 m) downcurrent of discharge approximate volume of 1.8° F (1 °C) plume = 1,594 ft^3 (45 m^3) approximate plume travel time = 1.1 min.

At the higher (45 cm/s) current velocity, plume deflection is greater, as is the entrainment rate of cooler ambient waters into the warmer discharge plume. Plume centerline excess temperature drops below 9° F (5 °C) over a shorter distance and the estimated volume of water exposed to temperatures of 9° F (5 °C) or greater than ambient is less (approximately 12 ft^3 [0.3 m^3]). The plume does not extend as deep into the water column as predicted for the lower current velocity, but extends a greater distance downcurrent. The centerline excess temperature in the rising plume is predicted to drop below the 1.8° F (1 °C) thermal criterion at a depth of 38.6 ft (11.8 m) bws and a distance of 89.2 ft (27.2 m) downcurrent of the point of discharge. The volume of water exposed to temperatures in of 1.8° F (1 °C) greater than ambient is estimated to be approximately 1,594 ft^3 (46 m^3). The estimated plume travel time from the point of discharge to the compliance point is predicted to be approximately 1 minute.

This evaluation demonstrates that a discharge plume associated with a potential commissioning period cooling water discharge occurring during the relatively uniform water column conditions that are expected to exist during the late-fall and winter months will be small in areal extent, volume and magnitude. Elevated temperatures (in excess of the 1.8° F [1 °C] thermal criterion) are predicted to exist across a limited cross-section of the water column (depths between 34 ft and 54 ft [10 m and 16 m] bws). Organisms potentially drawn into (entrained within) the discharge plume will be subjected to elevated temperatures for a very brief time (less than 2 minutes).

4.3.3 Summary of Summer (Stratified) Model Predictions

Plume predictions for the summer scenarios are provided in Table 4-3 and shown in Figure 4-3 (30 cm/s current) and Figure 4-4 (10 cm/s current). The summer evaluation scenario demonstrates that the aerial extent and magnitude of the thermal plume will be minor, even if stratified conditions exist. For both scenarios, the plume discharges from the vessel as a downward moving conical plume, is deflected slightly by cross-flowing ambient currents, and as the positive buoyancy of the heated, less dense plume overtakes the discharge momentum, the plume reverses direction and begins to rise towards the surface.

Table 4-3 Predicted Thermal Plume Dissipation - Summer (Stratified) Conditions

Location	Summer (Stratified) Conditions Current = 30 cm/s (see Figure 4-3)	Summer (Stratified) Conditions Current = 10 cm/s (see Figure 4-4 and Figure 4-5)
Point of Discharge ΔT = 18° F (10 °C)	discharge depth = 38 ft (11.6 m) bws plume Φ = pipe Φ = 2.3 ft (0.7 m) discharge velocity = 2.23 ft/s (0.68 m/s)	discharge depth = 38 ft (11.6 m) bws plume Φ = pipe Φ = 2.3 ft (0.7 m) discharge velocity = 2.23 ft/s (0.68 m/s)
Plume C_L ΔT < 9° F (< 5 °C)	depth 42.1 ft (12.8 m) bws 3.1 ft (0.9 m) downcurrent of discharge approximate volume of 9° F (5 °C) plume = 20 ft^3 (0.6 m^3)	depth 53.2 ft (16.2 m) bws 4.0 ft (1.2 m) downcurrent of discharge approximate volume of 9° F (< 5 °C) plume = 98 ft^3 (2.8 m^3)
Plume C_L at max. depth	depth 43.8 ft (13.4 m) bws 11.6 ft (3.5 m) downcurrent of discharge ΔT = 6.2° F (3.5 °C)	depth 53.3 ft (16.2 m) bws 4.2 ft (1.3 m) downcurrent of discharge ΔT = 8.9° F (4.9 °C)
Plume C_L ΔT< 1.8° F (< 1 °C)	depth 34.3 ft (10.5 m) bws 56.5 ft (17.2 m) downcurrent of discharge approximate volume of 1.8° F (1 °C) plume = 1,533 ft^3 (43 m^3) approximate plume travel time = 1.0 min.	Prior to reaching 1.8° F (1 °C) ΔT, rising plume mixes with surface layer, forming surface plume; Surface plume ΔT <1.8° F (<1 °C) at 30.2 ft (9.2 m) downcurrent of discharge; approximate volume of 1.8° F (1 °C) plume = 7,495 ft^3 (212 m^3); approximate surface area of 1.8° F (1 °C) surface plume = 716 ft^2 (66 m^2) approximate plume travel time = 1.3 min.

When ambient currents are higher (30 cm/s), the thermal plume for the summer (stratified) conditions closely resembles the winter (uniform) plumes described above. Plume centerline excess temperature is predicted to drop below half of the initial ΔT value (below 9° F [5 °C]) at a depth of 4.1 ft (1.2 m) below and a distance of 3.1 ft (0.9 m) downcurrent from the discharge pipe. The volume of water exposed to temperatures in of 9° F (5 °C) greater than ambient is estimated to be approximately 20 ft^3 (0.6 m^3). The plume is predicted to descend to a maximum depth of 43.8 ft (13.4 m) bws at a distance of 11.6 ft (3.5 m) downcurrent of the discharge. The centerline excess temperature in the rising plume is predicted to drop below the 1.8° F (1 °C) thermal criterion at a depth of 34.3 ft (10.5 m) bws and a distance of 56.5 ft (17.2 m) downcurrent of the point of discharge. The volume of water exposed to temperatures in of 1.8° F (1 °C) greater than ambient is estimated to be approximately 1,533 ft^3 (76 m^3). The estimated plume travel time from the point of discharge to the compliance point is predicted to be approximately 1 minute.

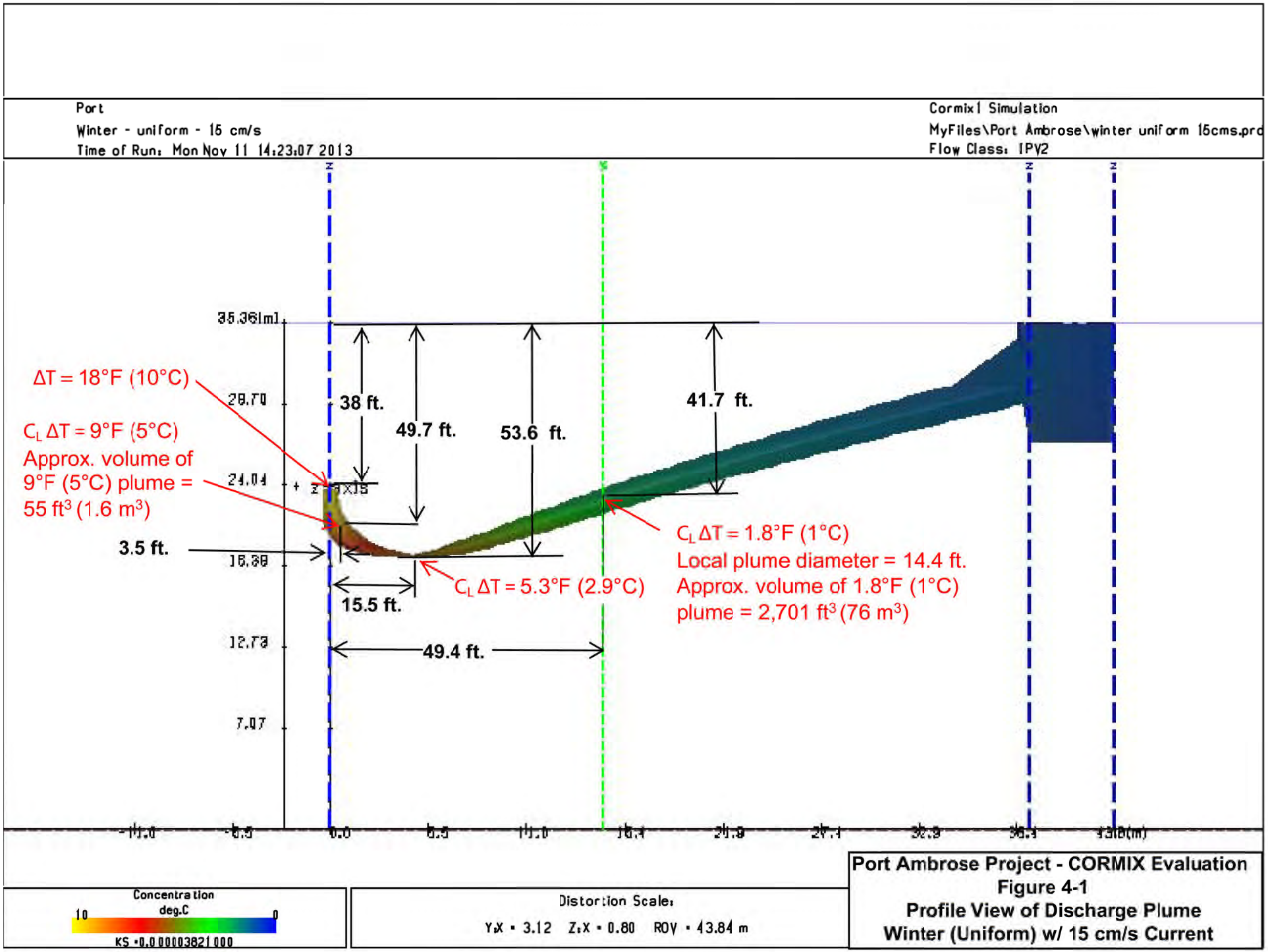
At lower ambient current velocity (10 cm/s), the thermal plume initially resembles winter (uniform) and summer (stratified) 30 cm/s plumes. Plume centerline excess temperature is predicted to drop below half of the initial ΔT value (below 9° F [5 °C]) at a depth of 15.2 ft (4.6 m) below and a distance of 4.0 ft (1.2 m) downcurrent from the discharge pipe. The volume of water exposed to temperatures in of 9° F (5 °C) greater than ambient is estimated to be approximately 98 ft^3 (2.8 m^3). The plume is predicted to descend to a maximum depth of 53.3 ft (16.2 m) bws at a distance of 4.2 ft (1.3 m) downcurrent of the discharge. In this low current scenario the conically-shaped rising plume does not achieve compliance prior to mixing with surficial waters and forming a surface plume. As shown in figure 4-4 and Figure 4-5, the portion of the surface plume with excess temperatures greater than 1.8° F (1° C) extends from 11.7 ft (3.6 m) downcurrent of the discharge to 30.2 ft (9.2 m) downcurrent. The plume width over this area increases from 23.0 ft (7.0 m) to 50.9 ft (15.5 m) and plume thickness increases from 5.3 ft (1.6 m) to 7.8 ft (2.4 m). The surface area of the plume with excess temperatures greater than 1.8° F (1° C) is approximately 716 ft^2 (66 m^2). The volume of water exposed to temperatures in of 1.8° F (1 °C) greater than ambient, including the volume in the rising plume and the volume in the surface plume, is

estimated to be approximately 7,495 ft^3 (212 m^3). The estimated plume travel time from the point of discharge to the compliance point is predicted to be less than 2 minutes.

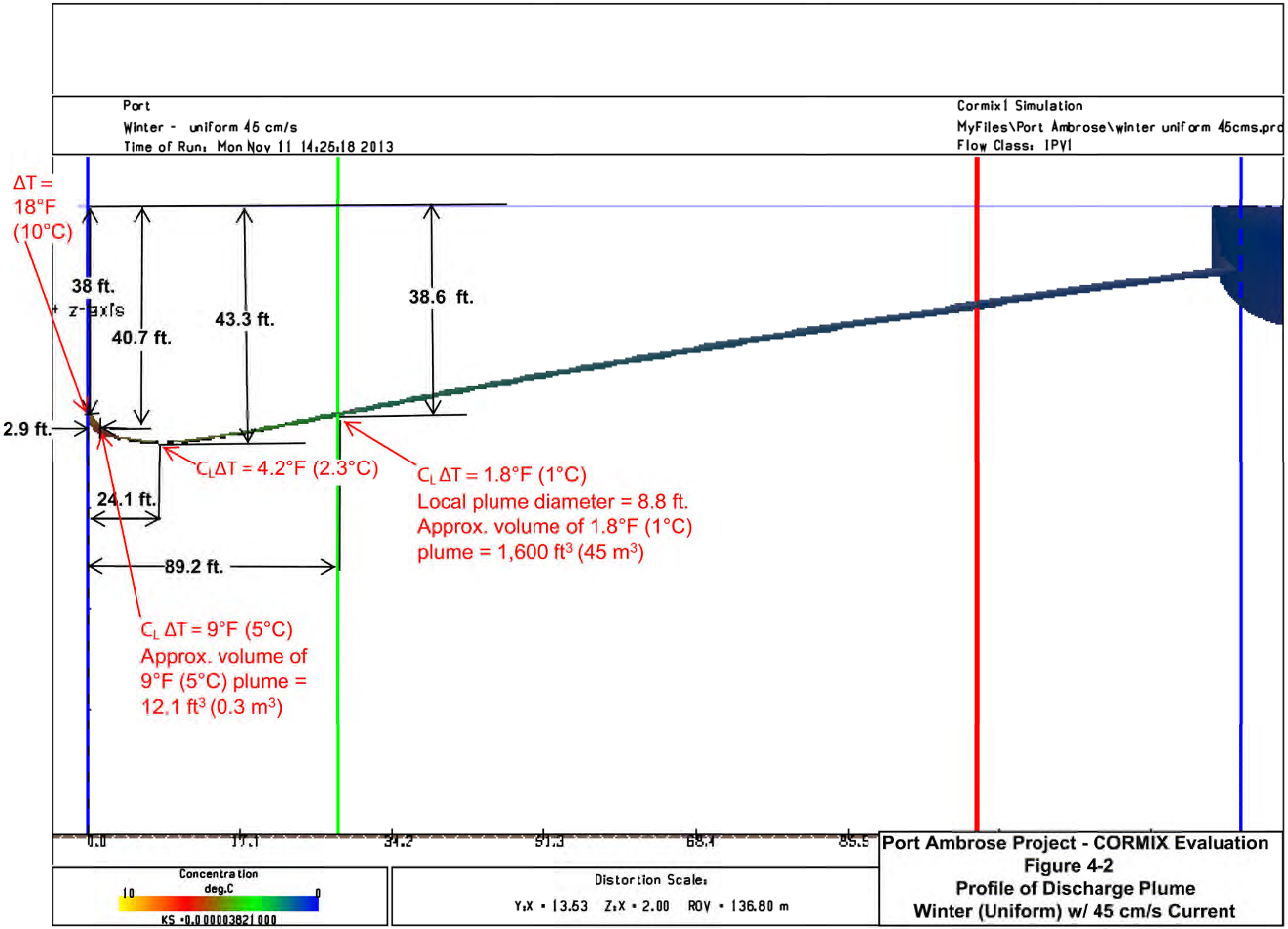
This evaluation demonstrates that if a potential commissioning period cooling water discharge occurs during the summer months when water column, temperature, salinity and density conditions tend to be stratified, the resultant thermal discharge plume will be small areal extent, volume and magnitude and generally comparable to plumes resulting from discharges during non-stratified periods of the year. When current velocity is relatively low (10 cm/s), compliance with 1.8° F (1 °C) ΔT criterion is not expected to occur until after the discharge forms a surface plume. However, the surface plume is predicted to be relatively small in both surface area and volume. In both summer scenarios, organisms potentially drawn into (entrained within) the discharge plume will be subjected to elevated temperatures for a very brief time (less than 2 minutes).

4.3.4 Conclusions

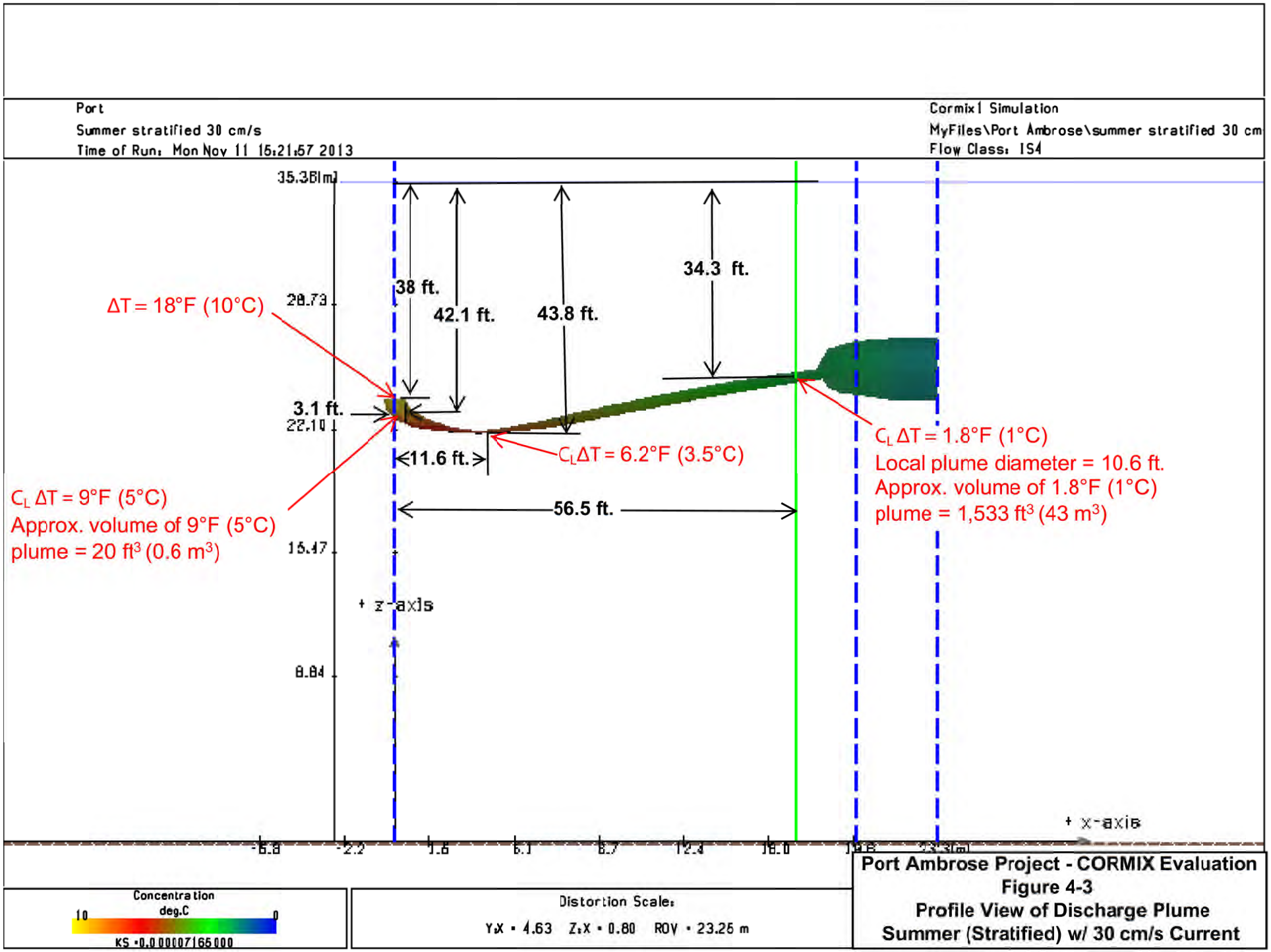
The thermal plume associated with potential LNGRV/STL Buoy commissioning period cooling water discharges is expected to be small both in areal extent and magnitude. This prediction is applicable for across the range seasonal water column conditions (uniform and stratified) and across the range of anticipated current velocities. Compliance with the USEPA's 1.8° F (1° C) excess temperature criterion is predicted to occur within less than 90 ft (27 m) of the point of discharge, which is well within the typical 328 ft (100 m) regulatory mixing zone. Organisms that may be entrained into the discharge plume would be exposed to elevated temperatures for a brief period of time (less than 2 minutes for all scenarios). The intermittent nature and limited duration of potential commissioning period cooling water discharges should further reduce potential impacts.



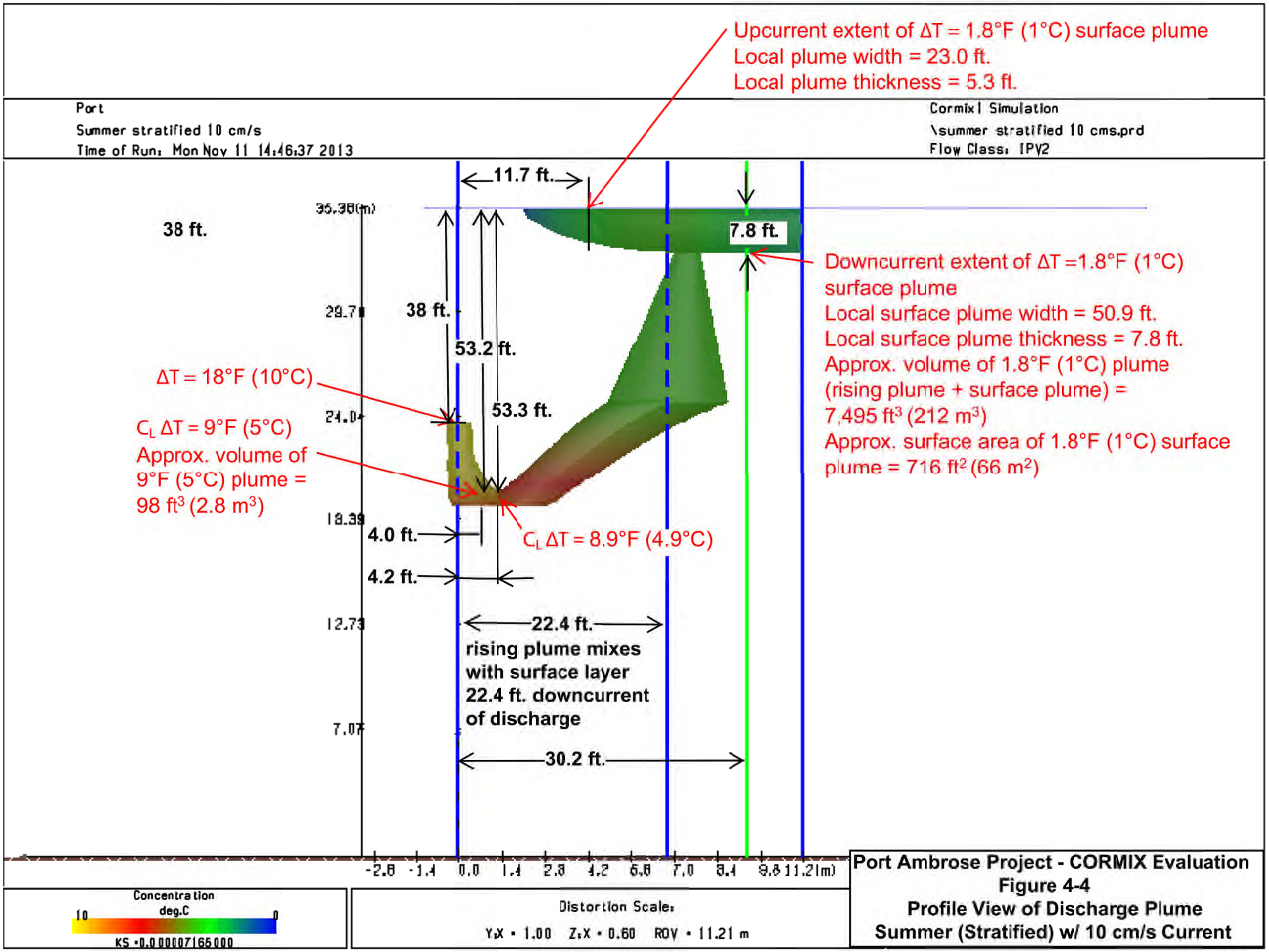
Port Ambrose Project - CORMIX Evaluation
Figure 4-1
Profile View of Discharge Plume
Winter (Uniform) w/ 15 cm/s Current



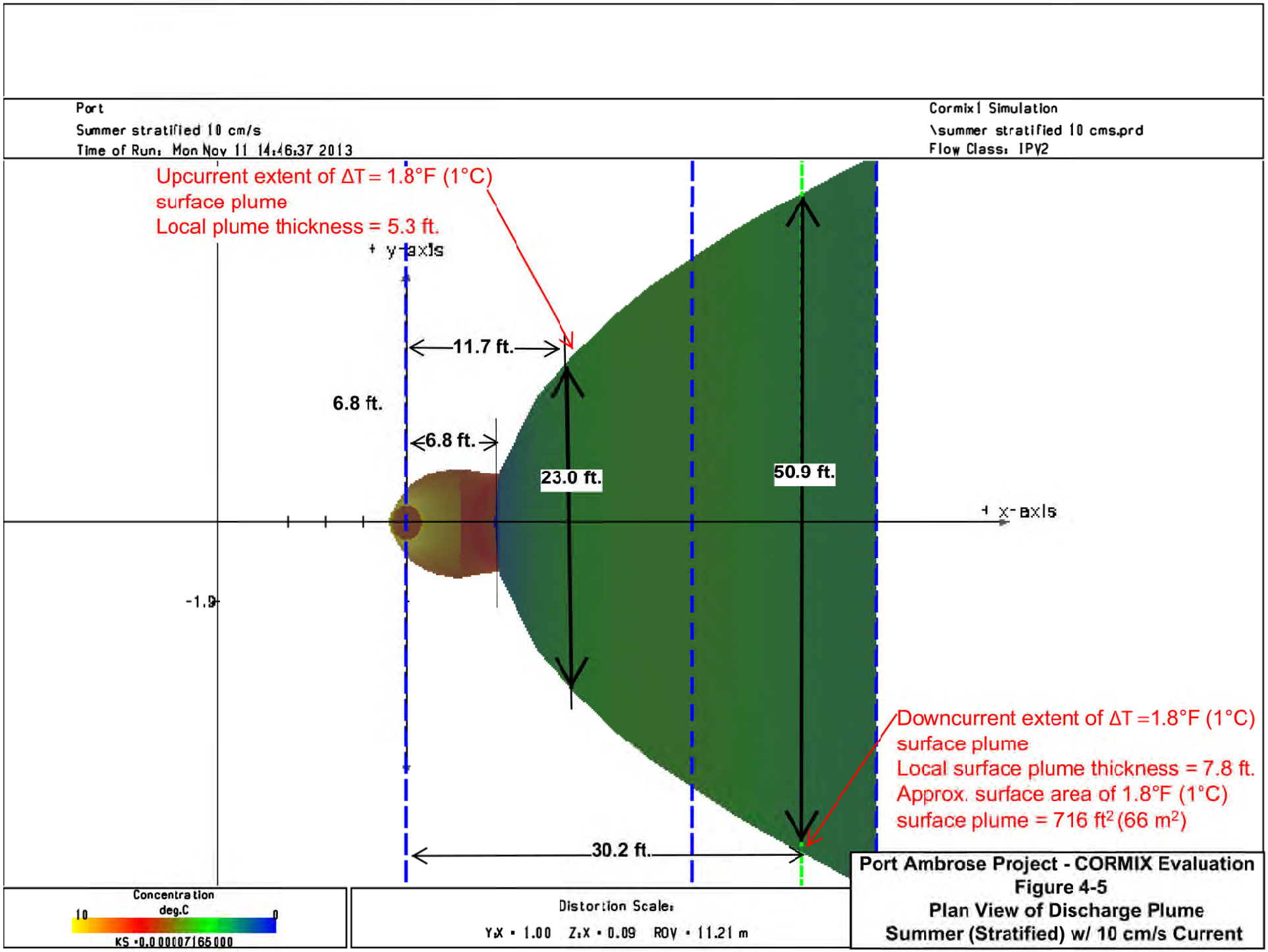
Port Ambrose Project - CORMIX Evaluation
Figure 4-2
Profile of Discharge Plume
Winter (Uniform) w/ 45 cm/s Current



Port Ambrose Project - CORMIX Evaluation
Figure 4-3
Profile View of Discharge Plume
Summer (Stratified) w/ 30 cm/s Current



Port Ambrose Project - CORMIX Evaluation
Figure 4-4
Profile View of Discharge Plume
Summer (Stratified) w/ 10 cm/s Current



Port Ambrose Project - CORMIX Evaluation
Figure 4-5
Plan View of Discharge Plume
Summer (Stratified) w/ 10 cm/s Current

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5.0 References

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Appendix A
CORMIX Model Files

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                        CORMIX MIXING ZONE EXPERT SYSTEM
                            CORMIX Version 5.0GT
                         HYDRO1:Version  March,2007
SITE NAME/LABEL:                Port Ambrose LNGRV Commissioning Cooling Water
Disch
  DESIGN CASE:                  Winter - uniform - 15 cm/s
  FILE NAME:                    C:\Program Files\CORMIX 5.0\MyFiles\Port Ambrose
\winter uniform 15cms.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             11/11/2013--14:23:06
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = unbounded
  Average depth                   HA      = 35.36 m
  Depth at discharge              HD      = 35.36 m
  Ambient velocity                UA      = 0.15 m/s
  Darcy-Weisbach friction factor  F       = 0.0096
    Calculated from Manning's n           = 0.02
  Wind velocity                   UW      = 5 m/s
  Stratification Type             STRCND  = U
  Surface density                 RHOAS   = 1025.1800 kg/m^3
  Bottom density                  RHOAB   = 1025.1800 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                            = left
  Distance to bank                DISTB   = 1000 m
  Port diameter                   D0      = 0.8230 m
  Port cross-sectional area       A0      = 0.5319 m^2
  Discharge velocity              U0      = 0.68 m/s
  Discharge flowrate              Q0      = 0.36 m^3/s
  Discharge port height           H0      = 23.77 m
  Vertical discharge angle        THETA   = -90 deg
  Horizontal discharge angle      SIGMA   = 0 deg
  Discharge density               RHO0    = 1023.42 kg/m^3
  Density difference              DRHO    = 1.7600 kg/m^3
  Buoyant acceleration            GP0     = 0.0168 m/s^2
  Discharge concentration         C0      = 10 deg.C
  Surface heat exchange coeff.    KS      = 0.000004 m/s
  Coefficient of decay            KD      = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.73 m         Lm  = 3.29 m         Lb  = 1.80 m
  LM  = 4.45 m         Lm' = 99999 m         Lb' = 99999 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0     = 5.75
  Velocity ratio                  R       = 4.51
-----------------------------------------------------------------------------
```

```
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = no
  Water quality standard specified         = yes
  Water quality standard          CSTD     = 1 deg.C
  Regulatory mixing zone                   = yes
  Regulatory mixing zone specification     = distance
  Regulatory mixing zone value             = 100 m (m^2 if area)
  Region of interest                       = 1770 m
*******************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS   = IPV2 |
  *-------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 35.36 m
*******************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-------------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
    1000 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-------------------------------------------------------------------------------
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 NFR edge  c = 0.1526 deg.C
  Dilution at edge of NFR              s = 65.5
  NFR Location:                        x = 43.84 m
    (centerline coordinates)           y = 0 m
                                       z = 35.36 m
  NFR plume dimensions:  half-width (bh) = 9.47 m
                          thickness (bv) = 8.31 m
Cumulative travel time:       245.9134 sec.
-------------------------------------------------------------------------------
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.
-------------------------------------------------------------------------------
UPSTREAM INTRUSION SUMMARY:
Plume exhibits upstream intrusion due to low ambient velocity or strong
  discharge buoyancy.
  Intrusion length                        =  0.68 m
  Intrusion stagnation point              =  38.43 m
  Intrusion thickness                     =  8.31 m
  Intrusion half width at impingement     =  9.47 m
```

```
  Intrusion half thickness at impingement =  8.31 m
-------------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 0.127142  deg.C
  Corresponding dilution               s = 78.7
  Plume location:                      x = 100 m
    (centerline coordinates)           y = 0 m
                                       z = 35.36 m
  Plume dimensions:      half-width (bh) = 19.34 m
                          thickness (bv) = 4.89 m
Cumulative travel time:       620.3000 sec.
At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 1  deg.C
  Corresponding dilution               s = 10
  Plume location:                      x = 15.03 m
    (centerline coordinates)           y = 0 m
                                       z = 22.66 m
  Plume dimension:       half-width (bh) = 2.19 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 +-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.
```

```
CORMIX1 PREDICTION FILE:
11111111111111111111111111111111111111111111111111111111111111111111111111111
                        CORMIX MIXING ZONE EXPERT SYSTEM
             Subsystem CORMIX1:  Single Port Discharges
                          CORMIX Version 5.0GT
                       HYDRO1 Version 5.0.0.0 March 2007
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Port Ambrose LNGRV Commissioning Cooling Water Disch
 Design case:       Winter - uniform - 15 cm/s
 FILE NAME:         C:\...5.0\MyFiles\Port Ambrose\winter uniform 15cms.prd
 Time stamp:        Mon Nov 11 14:23:07 2013

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =     35.36  HD     =     35.36
 UA     =      0.150 F      =      0.010 USTAR =0.5189E-02
 UW     =      5.000 UWSTAR=0.5890E-02
 Uniform density environment
 STRCND=  U          RHOAM = 1025.1801

DISCHARGE PARAMETERS (metric units)
 BANK   =  LEFT      DISTB =   1000.00
 D0     =      0.823 A0     =      0.532 H0     =     23.77  SUB0   =     11.58
 THETA =    -90.00  SIGMA =      0.00
 U0     =      0.677 Q0     =      0.360       =0.3600E+00
 RHO0   = 1023.4200  DRHO0 =0.1760E+01  GP0    =0.1684E-01
 C0     =0.1000E+02  CUNITS=  deg.C
 IPOLL =  3          KS     =0.3821E-05  KD     =0.0000E+00

FLUX VARIABLES (metric units)
 Q0     =0.3600E+00  M0     =0.2436E+00  J0     =0.6061E-02  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ     =      0.73  LM     =      4.45  Lm     =      3.29  Lb     =      1.80
                                         Lmp    =  99999.00  Lbp    =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =      5.75  R      =      4.51

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    IPV2   1
 1  Applicable layer depth HS =    35.36  1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     =0.1000E+02  CUNITS=  deg.C
 NTOX   =  0
 NSTD   =  1         CSTD   =0.1000E+01
 REGMZ =  1
 REGSPC=  1          XREG   =    100.00  WREG   =      0.00  AREG   =      0.00
```

```
 XINT  =   1770.00  XMAX  =   1770.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
      1000.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
-------------------------------------------------------------------------------

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
-------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.41

END OF MOD101: DISCHARGE MODULE
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet/plume transition motion in weak crossflow.

 Zone of flow establishment:            THETAE=    -84.75  SIGMAE=      0.00
  LE    =      1.08  XE    =      0.05  YE    =      0.00  ZE    =     22.70

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.41
      0.05     0.00   22.70     1.0 0.100E+02   0.44
      0.07     0.00   22.48     1.0 0.100E+02   0.47
      0.19     0.00   21.85     1.1 0.883E+01   0.56
      0.25     0.00   21.64     1.2 0.831E+01   0.59
      0.40     0.00   21.23     1.4 0.736E+01   0.67
      0.59     0.00   20.85     1.6 0.645E+01   0.75
      0.82     0.00   20.49     1.8 0.558E+01   0.85
      1.11     0.00   20.16     2.1 0.485E+01   0.95
      1.43     0.00   19.88     2.3 0.426E+01   1.04
      1.80     0.00   19.64     2.6 0.383E+01   1.12
      2.18     0.00   19.45     2.8 0.351E+01   1.18
      2.58     0.00   19.29     3.0 0.328E+01   1.24
      3.00     0.00   19.17     3.2 0.313E+01   1.28
      3.42     0.00   19.09     3.3 0.302E+01   1.30
      3.85     0.00   19.03     3.4 0.296E+01   1.32
```

```
     4.28      0.00   19.01      3.4 0.294E+01   1.32
 Minimum jet height has been reached.
     4.71      0.00   19.01      3.4 0.292E+01   1.33
     5.14      0.00   19.04      3.5 0.287E+01   1.34
     5.57      0.00   19.09      3.6 0.280E+01   1.35
     6.00      0.00   19.17      3.7 0.272E+01   1.37
     6.42      0.00   19.26      3.8 0.262E+01   1.39
     6.83      0.00   19.37      4.0 0.251E+01   1.41
     7.25      0.00   19.50      4.2 0.240E+01   1.44
     7.66      0.00   19.64      4.4 0.229E+01   1.47
     8.06      0.00   19.78      4.6 0.218E+01   1.50
     8.47      0.00   19.93      4.8 0.208E+01   1.54
     9.07      0.00   20.17      5.2 0.193E+01   1.59
     9.47      0.00   20.33      5.4 0.184E+01   1.63
     9.87      0.00   20.50      5.7 0.175E+01   1.67
    10.27      0.00   20.66      6.0 0.167E+01   1.70
    10.67      0.00   20.83      6.3 0.159E+01   1.74
    11.06      0.00   21.00      6.6 0.152E+01   1.78
    11.46      0.00   21.17      6.9 0.145E+01   1.82
    11.86      0.00   21.33      7.2 0.138E+01   1.86
    12.26      0.00   21.50      7.6 0.132E+01   1.91
    12.65      0.00   21.67      7.9 0.127E+01   1.95
    13.05      0.00   21.84      8.2 0.122E+01   1.99
    13.45      0.00   22.01      8.6 0.117E+01   2.03
    13.65      0.00   22.09      8.7 0.114E+01   2.05
    14.05      0.00   22.26      9.1 0.110E+01   2.09
    14.45      0.00   22.42      9.5 0.106E+01   2.13
    14.85      0.00   22.59      9.8 0.102E+01   2.17
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.100E+01 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
    15.24      0.00   22.75     10.2 0.980E+00   2.21
    15.64      0.00   22.92     10.6 0.945E+00   2.25
    16.04      0.00   23.08     11.0 0.912E+00   2.30
    16.45      0.00   23.24     11.4 0.881E+00   2.34
    16.85      0.00   23.40     11.7 0.851E+00   2.38
    17.25      0.00   23.56     12.1 0.824E+00   2.42
    17.65      0.00   23.72     12.5 0.797E+00   2.46
    18.05      0.00   23.88     13.0 0.772E+00   2.50
    18.45      0.00   24.03     13.4 0.748E+00   2.54
    18.86      0.00   24.19     13.8 0.725E+00   2.58
    19.26      0.00   24.34     14.2 0.704E+00   2.62
    19.66      0.00   24.50     14.6 0.683E+00   2.66
    20.07      0.00   24.65     15.1 0.664E+00   2.70
    20.47      0.00   24.80     15.5 0.645E+00   2.74
    20.87      0.00   24.95     15.9 0.627E+00   2.78
    21.28      0.00   25.10     16.4 0.610E+00   2.81
    21.68      0.00   25.25     16.8 0.594E+00   2.85
    22.09      0.00   25.40     17.3 0.579E+00   2.89
    22.49      0.00   25.55     17.7 0.564E+00   2.93
```

```
     22.90     0.00   25.70    18.2 0.550E+00   2.97
     23.31     0.00   25.85    18.7 0.536E+00   3.01
     23.71     0.00   25.99    19.1 0.523E+00   3.05
     24.12     0.00   26.14    19.6 0.511E+00   3.08
     24.53     0.00   26.28    20.1 0.498E+00   3.12
     24.93     0.00   26.42    20.5 0.487E+00   3.16
     25.34     0.00   26.57    21.0 0.476E+00   3.20
     25.75     0.00   26.71    21.5 0.465E+00   3.23
     26.16     0.00   26.85    22.0 0.455E+00   3.27
     26.56     0.00   26.99    22.5 0.445E+00   3.31
     26.97     0.00   27.13    23.0 0.435E+00   3.35
     27.38     0.00   27.27    23.5 0.426E+00   3.38
     27.79     0.00   27.41    24.0 0.417E+00   3.42
     28.20     0.00   27.55    24.5 0.409E+00   3.46
     28.61     0.00   27.68    25.0 0.400E+00   3.49
     29.02     0.00   27.82    25.5 0.392E+00   3.53
     29.43     0.00   27.96    26.0 0.385E+00   3.56
     29.84     0.00   28.09    26.5 0.377E+00   3.60
     30.25     0.00   28.23    27.0 0.370E+00   3.64
     30.66     0.00   28.36    27.6 0.363E+00   3.67
     31.07     0.00   28.49    28.1 0.356E+00   3.71
     31.48     0.00   28.63    28.6 0.350E+00   3.74
     31.89     0.00   28.76    29.1 0.343E+00   3.78
     32.30     0.00   28.89    29.7 0.337E+00   3.81
     32.71     0.00   29.02    30.2 0.331E+00   3.85
     33.13     0.00   29.15    30.7 0.325E+00   3.88
     33.54     0.00   29.28    31.3 0.320E+00   3.92
     33.95     0.00   29.41    31.8 0.314E+00   3.95
     34.36     0.00   29.54    32.4 0.309E+00   3.99
     34.77     0.00   29.67    32.9 0.304E+00   4.02
     35.18     0.00   29.80    33.5 0.299E+00   4.06
     35.80     0.00   29.99    34.3 0.291E+00   4.11
     36.22     0.00   30.12    34.9 0.287E+00   4.14
     36.63     0.00   30.25    35.4 0.282E+00   4.18
     37.04     0.00   30.37    36.0 0.278E+00   4.21
     37.46     0.00   30.50    36.6 0.274E+00   4.24
     37.87     0.00   30.62    37.1 0.269E+00   4.28
     38.28     0.00   30.75    37.7 0.265E+00   4.31
     38.70     0.00   30.87    38.3 0.261E+00   4.34
     39.11     0.00   31.00    38.6 0.259E+00   4.36
 Cumulative travel time =         214.3580 sec

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN MOD132: LAYER BOUNDARY IMPINGEMENT/UPSTREAM SPREADING

  Vertical angle of layer/boundary impingement    =      16.66 deg
  Horizontal angle of layer/boundary impingement  =       0.00 deg

 UPSTREAM INTRUSION PROPERTIES:
        Upstream intrusion length                =       0.68 m
```

```
        X-position of upstream stagnation point =      38.43 m
        Thickness in intrusion region           =       8.31 m
        Half-width at downstream end            =       9.47 m
        Thickness at downstream end             =       8.31 m

  Control volume inflow:
       X        Y       Z        S       C       B
     39.11     0.00   31.00    38.6 0.259E+00   4.36

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

       X        Y       Z        S       C       BV       BH      ZU      ZL
     38.43     0.00   35.36  9999.9 0.000E+00   0.00     0.00   35.36   35.36
     38.54     0.00   35.36    77.5 0.129E+00   4.14     1.34   35.36   31.22
     39.07     0.00   35.36    38.6 0.259E+00   8.29     3.25   35.36   27.07
     39.60     0.00   35.36    39.7 0.252E+00   8.31     4.40   35.36   27.05
     40.13     0.00   35.36    43.1 0.232E+00   8.31     5.30   35.36   27.05
     40.66     0.00   35.36    48.0 0.208E+00   8.31     6.08   35.36   27.05
     41.19     0.00   35.36    53.1 0.188E+00   8.31     6.76   35.36   27.05
     41.72     0.00   35.36    57.6 0.174E+00   8.31     7.38   35.36   27.05
     42.25     0.00   35.36    60.9 0.164E+00   8.31     7.95   35.36   27.05
     42.78     0.00   35.36    63.1 0.158E+00   8.31     8.49   35.36   27.05
     43.31     0.00   35.36    64.4 0.155E+00   8.31     8.99   35.36   27.05
     43.84     0.00   35.36    65.5 0.153E+00   8.31     9.47   35.36   27.05
 Cumulative travel time =         245.9135 sec

END OF MOD132: LAYER BOUNDARY IMPINGEMENT/UPSTREAM SPREADING
-------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
-------------------------------------------------------------------------------
BEGIN MOD141: BUOYANT AMBIENT SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

 Plume Stage 1 (not bank attached):
       X        Y       Z        S       C       BV       BH      ZU      ZL
     43.84     0.00   35.36    65.5 0.153E+00   8.31     9.47   35.36   27.05
     61.10     0.00   35.36    70.9 0.141E+00   6.59    12.91   35.36   28.77
     78.37     0.00   35.36    74.8 0.134E+00   5.63    15.93   35.36   29.72
     95.63     0.00   35.36    77.9 0.128E+00   5.01    18.68   35.36   30.35
```

** REGULATORY MIXING ZONE BOUNDARY **
In this prediction interval the plume DOWNSTREAM distance meets or exceeds the regulatory value = 100.00 m.
This is the extent of the REGULATORY MIXING ZONE.

112.89	0.00	35.36	80.6	0.124E+00	4.56	21.23	35.36	30.80
130.15	0.00	35.36	83.0	0.120E+00	4.22	23.63	35.36	31.14
147.41	0.00	35.36	85.2	0.117E+00	3.95	25.91	35.36	31.41
164.67	0.00	35.36	87.2	0.115E+00	3.73	28.08	35.36	31.63
181.93	0.00	35.36	89.1	0.112E+00	3.54	30.16	35.36	31.81
199.20	0.00	35.36	90.9	0.110E+00	3.39	32.17	35.36	31.97
216.46	0.00	35.36	92.7	0.108E+00	3.26	34.11	35.36	32.10
233.72	0.00	35.36	94.4	0.106E+00	3.15	35.99	35.36	32.21
250.98	0.00	35.36	96.1	0.104E+00	3.05	37.82	35.36	32.31
268.24	0.00	35.36	97.8	0.102E+00	2.96	39.60	35.36	32.39
285.50	0.00	35.36	99.5	0.101E+00	2.89	41.33	35.36	32.47
302.77	0.00	35.36	101.1	0.989E-01	2.82	43.03	35.36	32.54
320.03	0.00	35.36	102.8	0.972E-01	2.76	44.68	35.36	32.60
337.29	0.00	35.36	104.5	0.956E-01	2.71	46.30	35.36	32.65
354.55	0.00	35.36	106.3	0.941E-01	2.66	47.89	35.36	32.69
371.81	0.00	35.36	108.0	0.926E-01	2.62	49.45	35.36	32.74
389.07	0.00	35.36	109.8	0.911E-01	2.58	50.98	35.36	32.77
406.34	0.00	35.36	111.6	0.896E-01	2.55	52.48	35.36	32.80
423.60	0.00	35.36	113.5	0.881E-01	2.52	53.96	35.36	32.83
440.86	0.00	35.36	115.4	0.867E-01	2.50	55.41	35.36	32.86
458.12	0.00	35.36	117.3	0.852E-01	2.48	56.85	35.36	32.88
475.38	0.00	35.36	119.3	0.838E-01	2.46	58.26	35.36	32.90
492.64	0.00	35.36	121.3	0.824E-01	2.44	59.65	35.36	32.92
509.90	0.00	35.36	123.4	0.810E-01	2.43	61.02	35.36	32.93
527.17	0.00	35.36	125.5	0.797E-01	2.41	62.37	35.36	32.94
544.43	0.00	35.36	127.7	0.783E-01	2.40	63.71	35.36	32.95
561.69	0.00	35.36	129.9	0.770E-01	2.40	65.03	35.36	32.96
578.95	0.00	35.36	132.2	0.756E-01	2.39	66.33	35.36	32.97
596.21	0.00	35.36	134.5	0.743E-01	2.39	67.62	35.36	32.97
613.47	0.00	35.36	136.9	0.730E-01	2.38	68.89	35.36	32.97
630.74	0.00	35.36	139.4	0.717E-01	2.38	70.15	35.36	32.97
648.00	0.00	35.36	141.9	0.704E-01	2.38	71.40	35.36	32.97
665.26	0.00	35.36	144.5	0.692E-01	2.39	72.63	35.36	32.97
682.52	0.00	35.36	147.1	0.679E-01	2.39	73.86	35.36	32.97
699.78	0.00	35.36	149.8	0.667E-01	2.39	75.07	35.36	32.96
717.04	0.00	35.36	152.6	0.655E-01	2.40	76.27	35.36	32.96
734.31	0.00	35.36	155.4	0.643E-01	2.41	77.45	35.36	32.95
751.57	0.00	35.36	158.3	0.631E-01	2.42	78.63	35.36	32.94
768.83	0.00	35.36	161.3	0.620E-01	2.43	79.80	35.36	32.93
786.09	0.00	35.36	164.3	0.608E-01	2.44	80.96	35.36	32.92
803.35	0.00	35.36	167.4	0.597E-01	2.45	82.11	35.36	32.91
820.61	0.00	35.36	170.6	0.586E-01	2.46	83.25	35.36	32.90
837.87	0.00	35.36	173.8	0.575E-01	2.47	84.38	35.36	32.88
855.14	0.00	35.36	177.2	0.564E-01	2.49	85.50	35.36	32.87
872.40	0.00	35.36	180.5	0.554E-01	2.50	86.61	35.36	32.86
889.66	0.00	35.36	184.0	0.543E-01	2.52	87.72	35.36	32.84
906.92	0.00	35.36	187.5	0.533E-01	2.53	88.82	35.36	32.82
924.18	0.00	35.36	191.1	0.523E-01	2.55	89.91	35.36	32.81

941.44	0.00	35.36	194.8	0.513E-01	2.57	90.99	35.36	32.79
958.71	0.00	35.36	198.6	0.503E-01	2.59	92.07	35.36	32.77
975.97	0.00	35.36	202.4	0.494E-01	2.61	93.14	35.36	32.75
993.23	0.00	35.36	206.3	0.484E-01	2.63	94.20	35.36	32.73
1010.49	0.00	35.36	210.3	0.475E-01	2.65	95.26	35.36	32.71
1027.75	0.00	35.36	214.4	0.466E-01	2.67	96.31	35.36	32.69
1045.01	0.00	35.36	218.5	0.457E-01	2.69	97.35	35.36	32.66
1062.28	0.00	35.36	222.8	0.449E-01	2.72	98.39	35.36	32.64
1079.54	0.00	35.36	227.1	0.440E-01	2.74	99.43	35.36	32.62
1096.80	0.00	35.36	231.5	0.432E-01	2.76	100.45	35.36	32.59
1114.06	0.00	35.36	235.9	0.424E-01	2.79	101.47	35.36	32.57
1131.32	0.00	35.36	240.5	0.416E-01	2.82	102.49	35.36	32.54
1148.58	0.00	35.36	245.1	0.408E-01	2.84	103.50	35.36	32.52
1165.85	0.00	35.36	249.8	0.400E-01	2.87	104.51	35.36	32.49
1183.11	0.00	35.36	254.6	0.392E-01	2.90	105.51	35.36	32.46
1200.37	0.00	35.36	259.5	0.385E-01	2.92	106.51	35.36	32.43
1217.63	0.00	35.36	264.5	0.378E-01	2.95	107.50	35.36	32.40
1234.89	0.00	35.36	269.5	0.371E-01	2.98	108.49	35.36	32.38
1252.15	0.00	35.36	274.6	0.364E-01	3.01	109.47	35.36	32.35
1269.41	0.00	35.36	279.9	0.357E-01	3.04	110.45	35.36	32.32
1286.68	0.00	35.36	285.2	0.350E-01	3.07	111.42	35.36	32.29
1303.94	0.00	35.36	290.6	0.344E-01	3.10	112.39	35.36	32.25
1321.20	0.00	35.36	296.0	0.337E-01	3.13	113.36	35.36	32.22
1338.46	0.00	35.36	301.6	0.331E-01	3.17	114.32	35.36	32.19
1355.72	0.00	35.36	307.3	0.325E-01	3.20	115.28	35.36	32.16
1372.98	0.00	35.36	313.0	0.319E-01	3.23	116.23	35.36	32.13
1390.25	0.00	35.36	318.8	0.313E-01	3.26	117.18	35.36	32.09
1407.51	0.00	35.36	324.8	0.308E-01	3.30	118.13	35.36	32.06
1424.77	0.00	35.36	330.8	0.302E-01	3.33	119.07	35.36	32.02
1442.03	0.00	35.36	336.9	0.297E-01	3.37	120.01	35.36	31.99
1459.29	0.00	35.36	343.1	0.291E-01	3.40	120.95	35.36	31.95
1476.55	0.00	35.36	349.3	0.286E-01	3.44	121.88	35.36	31.92
1493.82	0.00	35.36	355.7	0.281E-01	3.48	122.81	35.36	31.88
1511.08	0.00	35.36	362.2	0.276E-01	3.51	123.74	35.36	31.84
1528.34	0.00	35.36	368.8	0.271E-01	3.55	124.66	35.36	31.81
1545.60	0.00	35.36	375.4	0.266E-01	3.59	125.58	35.36	31.77
1562.86	0.00	35.36	382.2	0.261E-01	3.63	126.50	35.36	31.73
1580.12	0.00	35.36	389.0	0.257E-01	3.66	127.41	35.36	31.69
1597.39	0.00	35.36	395.9	0.252E-01	3.70	128.32	35.36	31.65
1614.65	0.00	35.36	403.0	0.248E-01	3.74	129.23	35.36	31.61
1631.91	0.00	35.36	410.1	0.244E-01	3.78	130.13	35.36	31.58
1649.17	0.00	35.36	417.3	0.239E-01	3.82	131.04	35.36	31.54
1666.43	0.00	35.36	424.6	0.235E-01	3.86	131.93	35.36	31.49
1683.69	0.00	35.36	432.1	0.231E-01	3.90	132.83	35.36	31.45
1700.95	0.00	35.36	439.6	0.227E-01	3.94	133.72	35.36	31.41
1718.22	0.00	35.36	447.2	0.223E-01	3.99	134.61	35.36	31.37
1735.48	0.00	35.36	454.9	0.220E-01	4.03	135.50	35.36	31.33
1752.74	0.00	35.36	462.7	0.216E-01	4.07	136.39	35.36	31.29
1770.00	0.00	35.36	470.6	0.212E-01	4.11	137.27	35.36	31.24

Cumulative travel time = 11753.6328 sec

Simulation limit based on maximum specified distance = 1770.00 m.

```
   This is the REGION OF INTEREST limitation.

END OF MOD141: BUOYANT AMBIENT SPREADING
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
1111111111111111111111111111111111111111111111111111111111111111111111111111111
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                        CORMIX MIXING ZONE EXPERT SYSTEM
                            CORMIX Version 5.0GT
                         HYDRO1:Version  March,2007
SITE NAME/LABEL:                Port Ambrose LNGRV Commissioning Cooling Water
Disch
  DESIGN CASE:                  Winter -  uniform 45 cm/s
  FILE NAME:                    C:\Program Files\CORMIX 5.0\MyFiles\Port Ambrose
\winter uniform 45cms.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             11/11/2013--14:25:18
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = unbounded
  Average depth                   HA      = 35.36 m
  Depth at discharge              HD      = 35.36 m
  Ambient velocity                UA      = 0.45 m/s
  Darcy-Weisbach friction factor  F       = 0.0096
    Calculated from Manning's n           = 0.02
  Wind velocity                   UW      = 5 m/s
  Stratification Type             STRCND  = U
  Surface density                 RHOAS   = 1025.1800 kg/m^3
  Bottom density                  RHOAB   = 1025.1800 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                            = left
  Distance to bank                DISTB   = 1000 m
  Port diameter                   D0      = 0.8230 m
  Port cross-sectional area       A0      = 0.5319 m^2
  Discharge velocity              U0      = 0.68 m/s
  Discharge flowrate              Q0      = 0.36 m^3/s
  Discharge port height           H0      = 23.77 m
  Vertical discharge angle        THETA   = -90 deg
  Horizontal discharge angle      SIGMA   = 0 deg
  Discharge density               RHO0    = 1023.42 kg/m^3
  Density difference              DRHO    = 1.7600 kg/m^3
  Buoyant acceleration            GP0     = 0.0168 m/s^2
  Discharge concentration         C0      = 10 deg.C
  Surface heat exchange coeff.    KS      = 0.000004 m/s
  Coefficient of decay            KD      = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.73 m         Lm  = 1.10 m         Lb  = 0.07 m
  LM  = 4.45 m         Lm' = 99999 m         Lb' = 99999 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0     = 5.75
  Velocity ratio                  R       = 1.50
-----------------------------------------------------------------------------
```

```
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = no
  Water quality standard specified         = yes
  Water quality standard          CSTD     = 1 deg.C
  Regulatory mixing zone                   = yes
  Regulatory mixing zone specification     = distance
  Regulatory mixing zone value             = 100 m (m^2 if area)
  Region of interest                       = 1770 m
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = IPV1 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 35.36 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
    1000 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
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 NFR edge  c = 0.0875 deg.C
  Dilution at edge of NFR              s = 114.3
  NFR Location:                        x = 136.80 m
    (centerline coordinates)           y = 0 m
                                       z = 35.36 m
  NFR plume dimensions:  half-width (bh) = 6.76 m
                          thickness (bv) = 6.76 m
Cumulative travel time:       316.1590 sec.
-----------------------------------------------------------------------------
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.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 0.208048  deg.C
```

```
  Corresponding dilution                s = 48.1
  Plume location:                       x = 100.03 m
    (centerline coordinates)            y = 0 m
                                        z = 29.80 m
  Plume dimensions:      half-width (bh) = 2.92 m
                          thickness (bv) = 2.92 m
Cumulative travel time < 316.1590 sec. (RMZ is within NFR)
At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                  = 1  deg.C
  Corresponding dilution                s = 10
  Plume location:                       x = 27.15 m
    (centerline coordinates)            y = 0 m
                                        z = 23.60 m
  Plume dimension:       half-width (bh) = 1.35 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 +-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.
```

```
CORMIX1 PREDICTION FILE:
1111111111111111111111111111111111111111111111111111111111111111111111111111111
                        CORMIX MIXING ZONE EXPERT SYSTEM
             Subsystem CORMIX1:  Single Port Discharges
                          CORMIX Version 5.0GT
                       HYDRO1 Version 5.0.0.0 March 2007
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CASE DESCRIPTION
 Site name/label:   Port Ambrose LNGRV Commissioning Cooling Water Disch
 Design case:       Winter -  uniform 45 cm/s
 FILE NAME:         C:\...5.0\MyFiles\Port Ambrose\winter uniform 45cms.prd
 Time stamp:        Mon Nov 11 14:25:18 2013

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =     35.36  HD     =     35.36
 UA     =      0.450 F      =      0.010 USTAR =0.1557E-01
 UW     =      5.000 UWSTAR=0.5890E-02
 Uniform density environment
 STRCND=  U         RHOAM = 1025.1801

DISCHARGE PARAMETERS (metric units)
 BANK   =  LEFT      DISTB =   1000.00
 D0     =      0.823 A0     =      0.532 H0     =     23.77  SUB0   =     11.58
 THETA =    -90.00  SIGMA =      0.00
 U0     =      0.677 Q0     =      0.360       =0.3600E+00
 RHO0   = 1023.4200  DRHO0 =0.1760E+01  GP0    =0.1684E-01
 C0     =0.1000E+02  CUNITS=  deg.C
 IPOLL =  3         KS     =0.3821E-05  KD     =0.0000E+00

FLUX VARIABLES (metric units)
 Q0     =0.3600E+00  M0     =0.2436E+00  J0     =0.6061E-02  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ     =      0.73  LM     =      4.45  Lm     =      1.10  Lb     =      0.07
                                         Lmp    =  99999.00  Lbp    =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =      5.75  R      =      1.50

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    IPV1   1
 1  Applicable layer depth HS =    35.36  1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     =0.1000E+02  CUNITS=  deg.C
 NTOX   =  0
 NSTD   =  1         CSTD   =0.1000E+01
 REGMZ =  1
 REGSPC=  1         XREG   =    100.00  WREG   =      0.00  AREG   =      0.00
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 XINT  =   1770.00  XMAX  =   1770.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
      1000.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
-------------------------------------------------------------------------------

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
-------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.41

END OF MOD101: DISCHARGE MODULE
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BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet/plume transition motion in strong crossflow.

 Zone of flow establishment:            THETAE=    -74.60  SIGMAE=      0.00
  LE    =      0.00  XE    =      0.00  YE    =      0.00  ZE    =     23.77

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.43
      0.84     0.00   22.97     2.0 0.504E+01   0.63
      2.10     0.00   22.60     2.7 0.364E+01   0.73
      3.40     0.00   22.40     3.3 0.305E+01   0.79
      4.71     0.00   22.27     3.7 0.273E+01   0.84
      6.03     0.00   22.20     4.0 0.253E+01   0.87
      7.34     0.00   22.16     4.2 0.241E+01   0.89
  Minimum jet height has been reached.
      8.66     0.00   22.15     4.3 0.234E+01   0.90
      9.98     0.00   22.18     4.5 0.225E+01   0.92
     11.29     0.00   22.22     4.7 0.213E+01   0.94
     12.61     0.00   22.29     5.0 0.201E+01   0.96
     13.92     0.00   22.38     5.3 0.189E+01   0.99
     15.23     0.00   22.48     5.7 0.176E+01   1.03
     16.54     0.00   22.58     6.1 0.165E+01   1.06
     17.75     0.00   22.69     6.5 0.155E+01   1.09
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19.06	0.00	22.81	6.9	0.145E+01	1.13
20.37	0.00	22.93	7.4	0.136E+01	1.16
21.68	0.00	23.06	7.8	0.127E+01	1.20
22.99	0.00	23.18	8.3	0.120E+01	1.23
24.30	0.00	23.31	8.9	0.113E+01	1.27
25.61	0.00	23.44	9.4	0.107E+01	1.30
26.92	0.00	23.57	9.9	0.101E+01	1.34

WATER QUALITY STANDARD OR CCC HAS BEEN FOUND

The pollutant concentration in the plume falls below water quality standard or CCC value of 0.100E+01 in the current prediction interval.

This is the spatial extent of concentrations exceeding the water quality standard or CCC value.

28.23	0.00	23.70	10.4	0.958E+00	1.37
29.54	0.00	23.83	11.0	0.910E+00	1.41
30.85	0.00	23.96	11.5	0.866E+00	1.44
32.16	0.00	24.09	12.1	0.826E+00	1.48
33.47	0.00	24.21	12.7	0.789E+00	1.51
34.78	0.00	24.34	13.3	0.754E+00	1.54
35.98	0.00	24.46	13.8	0.725E+00	1.57
37.29	0.00	24.58	14.4	0.695E+00	1.61
38.60	0.00	24.71	15.0	0.667E+00	1.64
39.91	0.00	24.83	15.6	0.642E+00	1.67
41.22	0.00	24.95	16.2	0.618E+00	1.70
42.53	0.00	25.08	16.8	0.595E+00	1.73
43.84	0.00	25.20	17.4	0.574E+00	1.76
45.15	0.00	25.32	18.1	0.554E+00	1.80
46.46	0.00	25.44	18.7	0.535E+00	1.83
47.77	0.00	25.56	19.3	0.518E+00	1.86
49.08	0.00	25.68	20.0	0.501E+00	1.89
50.40	0.00	25.79	20.6	0.485E+00	1.92
51.71	0.00	25.91	21.2	0.471E+00	1.95
52.91	0.00	26.02	21.8	0.458E+00	1.97
54.22	0.00	26.13	22.5	0.444E+00	2.00
55.53	0.00	26.25	23.2	0.432E+00	2.03
56.84	0.00	26.36	23.8	0.420E+00	2.06
58.15	0.00	26.47	24.5	0.408E+00	2.09
59.46	0.00	26.59	25.2	0.397E+00	2.12
60.78	0.00	26.70	25.9	0.387E+00	2.14
62.09	0.00	26.81	26.5	0.377E+00	2.17
63.40	0.00	26.92	27.2	0.367E+00	2.20
64.71	0.00	27.03	27.9	0.358E+00	2.23
66.02	0.00	27.14	28.6	0.350E+00	2.25
67.33	0.00	27.25	29.3	0.341E+00	2.28
68.65	0.00	27.36	30.0	0.333E+00	2.31
69.96	0.00	27.47	30.7	0.326E+00	2.34
71.16	0.00	27.56	31.4	0.319E+00	2.36
72.47	0.00	27.67	32.1	0.312E+00	2.39
73.78	0.00	27.78	32.8	0.305E+00	2.41
75.10	0.00	27.88	33.5	0.298E+00	2.44
76.41	0.00	27.99	34.2	0.292E+00	2.46
77.72	0.00	28.09	35.0	0.286E+00	2.49
79.03	0.00	28.20	35.7	0.280E+00	2.52

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     80.35     0.00   28.30    36.5 0.274E+00   2.54
     81.66     0.00   28.40    37.2 0.269E+00   2.57
     82.97     0.00   28.51    37.9 0.264E+00   2.59
     84.28     0.00   28.61    38.7 0.258E+00   2.62
     85.59     0.00   28.71    39.5 0.253E+00   2.64
     86.91     0.00   28.81    40.2 0.249E+00   2.67
     88.11     0.00   28.90    40.9 0.244E+00   2.69
     89.42     0.00   29.00    41.7 0.240E+00   2.72
     90.73     0.00   29.10    42.5 0.235E+00   2.74
     92.05     0.00   29.20    43.2 0.231E+00   2.77
     93.36     0.00   29.30    44.0 0.227E+00   2.79
     94.67     0.00   29.40    44.8 0.223E+00   2.82
     95.99     0.00   29.50    45.6 0.219E+00   2.84
     97.30     0.00   29.60    46.4 0.216E+00   2.87
     98.61     0.00   29.69    47.2 0.212E+00   2.89
     99.92     0.00   29.79    48.0 0.208E+00   2.91
 ** REGULATORY MIXING ZONE BOUNDARY is within the Near-Field Region **
 In this prediction interval the plume DOWNSTREAM  distance meets or exceeds
 the regulatory value =   100.00 m.
 This is the extent of the REGULATORY MIXING ZONE.
    101.24     0.00   29.89    48.8 0.205E+00   2.94
    102.55     0.00   29.98    49.6 0.202E+00   2.96
    103.86     0.00   30.08    50.4 0.198E+00   2.99
    105.17     0.00   30.17    51.2 0.195E+00   3.01
    106.38     0.00   30.26    52.0 0.192E+00   3.03
    107.69     0.00   30.36    52.8 0.189E+00   3.06
    109.00     0.00   30.45    53.6 0.186E+00   3.08
    110.32     0.00   30.54    54.5 0.184E+00   3.10
    111.63     0.00   30.64    55.3 0.181E+00   3.13
    112.94     0.00   30.73    56.1 0.178E+00   3.15
    114.26     0.00   30.82    57.0 0.175E+00   3.17
    115.57     0.00   30.92    57.8 0.173E+00   3.20
    116.88     0.00   31.01    58.7 0.170E+00   3.22
    118.19     0.00   31.10    59.5 0.168E+00   3.24
    119.51     0.00   31.19    60.4 0.166E+00   3.27
    120.82     0.00   31.28    61.2 0.163E+00   3.29
    122.13     0.00   31.37    62.1 0.161E+00   3.31
    123.45     0.00   31.46    63.0 0.159E+00   3.34
    124.65     0.00   31.55    63.8 0.157E+00   3.36
    125.96     0.00   31.64    64.6 0.155E+00   3.38
    127.28     0.00   31.73    65.5 0.153E+00   3.40
    128.59     0.00   31.82    66.4 0.151E+00   3.43
    129.90     0.00   31.90    67.2 0.149E+00   3.45
 Cumulative travel time =         300.8364 sec

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
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BEGIN MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

  Control volume inflow:
       X        Y       Z        S       C       B
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   129.90     0.00   31.90    67.2 0.149E+00   3.45

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

       X        Y       Z        S       C       BV       BH      ZU      ZL
   126.46     0.00   35.36    67.2 0.149E+00   0.00     0.00   35.36   35.36
   127.49     0.00   35.36    67.2 0.149E+00   4.25     2.14   35.36   31.10
   128.52     0.00   35.36    67.2 0.149E+00   5.04     3.02   35.36   30.32
   129.56     0.00   35.36    67.2 0.149E+00   5.55     3.70   35.36   29.81
   130.59     0.00   35.36    69.1 0.145E+00   5.92     4.28   35.36   29.44
   131.63     0.00   35.36    77.6 0.129E+00   6.20     4.78   35.36   29.16
   132.66     0.00   35.36    89.5 0.112E+00   6.41     5.24   35.36   28.94
   133.70     0.00   35.36   100.2 0.998E-01   6.57     5.66   35.36   28.79
   134.73     0.00   35.36   107.6 0.929E-01   6.68     6.05   35.36   28.68
   135.76     0.00   35.36   111.7 0.896E-01   6.74     6.41   35.36   28.62
   136.80     0.00   35.36   114.3 0.875E-01   6.76     6.76   35.36   28.60
 Cumulative travel time =         316.1588 sec

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH
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** End of NEAR-FIELD REGION (NFR) **
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BEGIN MOD141: BUOYANT AMBIENT SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

 Plume Stage 1 (not bank attached):
       X        Y       Z        S       C       BV       BH      ZU      ZL
   136.80     0.00   35.36   114.3 0.875E-01   6.76     6.76   35.36   28.60
   143.32     0.00   35.36   115.8 0.863E-01   6.54     7.08   35.36   28.81
   149.85     0.00   35.36   117.4 0.852E-01   6.35     7.39   35.36   29.01
   156.38     0.00   35.36   118.8 0.842E-01   6.17     7.70   35.36   29.18
   162.90     0.00   35.36   120.3 0.831E-01   6.02     8.00   35.36   29.34
   169.43     0.00   35.36   121.7 0.822E-01   5.87     8.29   35.36   29.49
   175.95     0.00   35.36   123.1 0.812E-01   5.74     8.58   35.36   29.62
   182.48     0.00   35.36   124.5 0.803E-01   5.62     8.86   35.36   29.74
   189.00     0.00   35.36   125.9 0.795E-01   5.51     9.14   35.36   29.85
   195.53     0.00   35.36   127.2 0.786E-01   5.40     9.42   35.36   29.95
   202.05     0.00   35.36   128.6 0.778E-01   5.31     9.69   35.36   30.05
   208.58     0.00   35.36   129.9 0.770E-01   5.22     9.96   35.36   30.14
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215.10	0.00	35.36	131.3	0.762E-01	5.14	10.22	35.36	30.22
221.63	0.00	35.36	132.6	0.754E-01	5.06	10.48	35.36	30.30
228.15	0.00	35.36	134.0	0.746E-01	4.99	10.74	35.36	30.37
234.68	0.00	35.36	135.4	0.739E-01	4.93	10.99	35.36	30.43
241.21	0.00	35.36	136.8	0.731E-01	4.86	11.25	35.36	30.49
247.73	0.00	35.36	138.1	0.724E-01	4.81	11.49	35.36	30.55
254.26	0.00	35.36	139.5	0.717E-01	4.75	11.74	35.36	30.60
260.78	0.00	35.36	141.0	0.709E-01	4.71	11.98	35.36	30.65
267.31	0.00	35.36	142.4	0.702E-01	4.66	12.22	35.36	30.70
273.83	0.00	35.36	143.8	0.695E-01	4.62	12.46	35.36	30.74
280.36	0.00	35.36	145.3	0.688E-01	4.58	12.70	35.36	30.78
286.88	0.00	35.36	146.8	0.681E-01	4.54	12.93	35.36	30.82
293.41	0.00	35.36	148.3	0.674E-01	4.51	13.16	35.36	30.85
299.93	0.00	35.36	149.8	0.668E-01	4.47	13.39	35.36	30.88
306.46	0.00	35.36	151.3	0.661E-01	4.44	13.62	35.36	30.91
312.98	0.00	35.36	152.9	0.654E-01	4.42	13.85	35.36	30.94
319.51	0.00	35.36	154.4	0.647E-01	4.39	14.07	35.36	30.97
326.04	0.00	35.36	156.0	0.641E-01	4.37	14.29	35.36	30.99
332.56	0.00	35.36	157.7	0.634E-01	4.35	14.51	35.36	31.01
339.09	0.00	35.36	159.3	0.628E-01	4.33	14.73	35.36	31.03
345.61	0.00	35.36	161.0	0.621E-01	4.31	14.95	35.36	31.05
352.14	0.00	35.36	162.7	0.615E-01	4.29	15.16	35.36	31.07
358.66	0.00	35.36	164.4	0.608E-01	4.28	15.38	35.36	31.08
365.19	0.00	35.36	166.1	0.602E-01	4.26	15.59	35.36	31.09
371.71	0.00	35.36	167.9	0.595E-01	4.25	15.80	35.36	31.11
378.24	0.00	35.36	169.7	0.589E-01	4.24	16.01	35.36	31.12
384.76	0.00	35.36	171.6	0.583E-01	4.23	16.22	35.36	31.13
391.29	0.00	35.36	173.4	0.577E-01	4.22	16.42	35.36	31.13
397.81	0.00	35.36	175.3	0.570E-01	4.22	16.63	35.36	31.14
404.34	0.00	35.36	177.2	0.564E-01	4.21	16.83	35.36	31.15
410.87	0.00	35.36	179.2	0.558E-01	4.21	17.04	35.36	31.15
417.39	0.00	35.36	181.2	0.552E-01	4.20	17.24	35.36	31.15
423.92	0.00	35.36	183.2	0.546E-01	4.20	17.44	35.36	31.16
430.44	0.00	35.36	185.2	0.540E-01	4.20	17.64	35.36	31.16
436.97	0.00	35.36	187.3	0.534E-01	4.20	17.84	35.36	31.16
443.49	0.00	35.36	189.4	0.528E-01	4.20	18.03	35.36	31.16
450.02	0.00	35.36	191.5	0.522E-01	4.20	18.23	35.36	31.15
456.54	0.00	35.36	193.7	0.516E-01	4.21	18.42	35.36	31.15
463.07	0.00	35.36	195.9	0.510E-01	4.21	18.62	35.36	31.15
469.59	0.00	35.36	198.1	0.505E-01	4.21	18.81	35.36	31.14
476.12	0.00	35.36	200.4	0.499E-01	4.22	19.00	35.36	31.14
482.64	0.00	35.36	202.7	0.493E-01	4.22	19.19	35.36	31.13
489.17	0.00	35.36	205.0	0.488E-01	4.23	19.38	35.36	31.13
495.70	0.00	35.36	207.4	0.482E-01	4.24	19.57	35.36	31.12
502.22	0.00	35.36	209.8	0.477E-01	4.25	19.76	35.36	31.11
508.75	0.00	35.36	212.3	0.471E-01	4.26	19.95	35.36	31.10
515.27	0.00	35.36	214.7	0.466E-01	4.27	20.13	35.36	31.09
521.80	0.00	35.36	217.2	0.460E-01	4.28	20.32	35.36	31.08
528.32	0.00	35.36	219.8	0.455E-01	4.29	20.50	35.36	31.07
534.85	0.00	35.36	222.4	0.450E-01	4.30	20.69	35.36	31.06
541.37	0.00	35.36	225.0	0.444E-01	4.31	20.87	35.36	31.04
547.90	0.00	35.36	227.7	0.439E-01	4.33	21.05	35.36	31.03

554.42	0.00	35.36	230.4	0.434E-01	4.34	21.23	35.36	31.02
560.95	0.00	35.36	233.1	0.429E-01	4.35	21.41	35.36	31.00
567.47	0.00	35.36	235.9	0.424E-01	4.37	21.59	35.36	30.99
574.00	0.00	35.36	238.7	0.419E-01	4.38	21.77	35.36	30.97
580.53	0.00	35.36	241.5	0.414E-01	4.40	21.95	35.36	30.96
587.05	0.00	35.36	244.4	0.409E-01	4.42	22.13	35.36	30.94
593.58	0.00	35.36	247.3	0.404E-01	4.44	22.30	35.36	30.92
600.10	0.00	35.36	250.3	0.399E-01	4.45	22.48	35.36	30.90
606.63	0.00	35.36	253.3	0.395E-01	4.47	22.66	35.36	30.88
613.15	0.00	35.36	256.3	0.390E-01	4.49	22.83	35.36	30.87
619.68	0.00	35.36	259.4	0.385E-01	4.51	23.00	35.36	30.85
626.20	0.00	35.36	262.5	0.381E-01	4.53	23.18	35.36	30.83
632.73	0.00	35.36	265.7	0.376E-01	4.55	23.35	35.36	30.81
639.25	0.00	35.36	268.9	0.372E-01	4.57	23.52	35.36	30.78
645.78	0.00	35.36	272.1	0.367E-01	4.59	23.69	35.36	30.76
652.30	0.00	35.36	275.4	0.363E-01	4.62	23.86	35.36	30.74
658.83	0.00	35.36	278.7	0.359E-01	4.64	24.03	35.36	30.72
665.36	0.00	35.36	282.1	0.354E-01	4.66	24.20	35.36	30.69
671.88	0.00	35.36	285.5	0.350E-01	4.69	24.37	35.36	30.67
678.41	0.00	35.36	289.0	0.346E-01	4.71	24.54	35.36	30.65
684.93	0.00	35.36	292.4	0.342E-01	4.73	24.71	35.36	30.62
691.46	0.00	35.36	296.0	0.338E-01	4.76	24.88	35.36	30.60
697.98	0.00	35.36	299.5	0.334E-01	4.78	25.04	35.36	30.57
704.51	0.00	35.36	303.2	0.330E-01	4.81	25.21	35.36	30.55
711.03	0.00	35.36	306.8	0.326E-01	4.84	25.38	35.36	30.52
717.56	0.00	35.36	310.5	0.322E-01	4.86	25.54	35.36	30.49
724.08	0.00	35.36	314.3	0.318E-01	4.89	25.70	35.36	30.47
730.61	0.00	35.36	318.0	0.314E-01	4.92	25.87	35.36	30.44
737.13	0.00	35.36	321.9	0.311E-01	4.95	26.03	35.36	30.41
743.66	0.00	35.36	325.7	0.307E-01	4.97	26.19	35.36	30.38
750.19	0.00	35.36	329.7	0.303E-01	5.00	26.36	35.36	30.35
756.71	0.00	35.36	333.6	0.300E-01	5.03	26.52	35.36	30.32
763.24	0.00	35.36	337.6	0.296E-01	5.06	26.68	35.36	30.30
769.76	0.00	35.36	341.7	0.293E-01	5.09	26.84	35.36	30.27
776.29	0.00	35.36	345.7	0.289E-01	5.12	27.00	35.36	30.24
782.81	0.00	35.36	349.9	0.286E-01	5.15	27.16	35.36	30.20
789.34	0.00	35.36	354.1	0.282E-01	5.18	27.32	35.36	30.17

Cumulative travel time = 1766.2469 sec

END OF MOD141: BUOYANT AMBIENT SPREADING

BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = 0.112E+00 m^2/s
Horizontal diffusivity (initial value) = 0.123E+00 m^2/s

Profile definitions:
BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
= or equal to layer depth, if fully mixed
BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
measured horizontally in Y-direction

ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL
789.34	0.00	35.36	354.1	0.282E-01	5.18	27.32	35.36	30.17
799.14	0.00	35.36	356.5	0.280E-01	5.19	27.48	35.36	30.17
808.95	0.00	35.36	358.9	0.279E-01	5.20	27.63	35.36	30.16
818.76	0.00	35.36	361.3	0.277E-01	5.20	27.79	35.36	30.16
828.56	0.00	35.36	363.7	0.275E-01	5.21	27.94	35.36	30.15
838.37	0.00	35.36	366.2	0.273E-01	5.21	28.10	35.36	30.14
848.18	0.00	35.36	368.6	0.271E-01	5.22	28.25	35.36	30.14
857.98	0.00	35.36	371.1	0.269E-01	5.22	28.41	35.36	30.13
867.79	0.00	35.36	373.6	0.268E-01	5.23	28.57	35.36	30.13
877.60	0.00	35.36	376.1	0.266E-01	5.24	28.73	35.36	30.12
887.40	0.00	35.36	378.5	0.264E-01	5.24	28.88	35.36	30.11
897.21	0.00	35.36	381.0	0.262E-01	5.25	29.04	35.36	30.11
907.02	0.00	35.36	383.6	0.261E-01	5.25	29.20	35.36	30.10
916.82	0.00	35.36	386.1	0.259E-01	5.26	29.36	35.36	30.10
926.63	0.00	35.36	388.6	0.257E-01	5.27	29.52	35.36	30.09
936.44	0.00	35.36	391.2	0.256E-01	5.27	29.67	35.36	30.08
946.24	0.00	35.36	393.7	0.254E-01	5.28	29.83	35.36	30.08
956.05	0.00	35.36	396.3	0.252E-01	5.28	29.99	35.36	30.07
965.86	0.00	35.36	398.8	0.251E-01	5.29	30.15	35.36	30.07
975.66	0.00	35.36	401.4	0.249E-01	5.30	30.31	35.36	30.06
985.47	0.00	35.36	404.0	0.247E-01	5.30	30.47	35.36	30.05
995.28	0.00	35.36	406.6	0.246E-01	5.31	30.63	35.36	30.05
1005.08	0.00	35.36	409.2	0.244E-01	5.32	30.79	35.36	30.04
1014.89	0.00	35.36	411.8	0.243E-01	5.32	30.95	35.36	30.03
1024.70	0.00	35.36	414.5	0.241E-01	5.33	31.12	35.36	30.03
1034.50	0.00	35.36	417.1	0.240E-01	5.33	31.28	35.36	30.02
1044.31	0.00	35.36	419.8	0.238E-01	5.34	31.44	35.36	30.02
1054.12	0.00	35.36	422.4	0.237E-01	5.35	31.60	35.36	30.01
1063.92	0.00	35.36	425.1	0.235E-01	5.35	31.76	35.36	30.00
1073.73	0.00	35.36	427.8	0.234E-01	5.36	31.93	35.36	30.00
1083.54	0.00	35.36	430.5	0.232E-01	5.37	32.09	35.36	29.99
1093.34	0.00	35.36	433.2	0.231E-01	5.37	32.25	35.36	29.98
1103.15	0.00	35.36	435.9	0.229E-01	5.38	32.42	35.36	29.98
1112.96	0.00	35.36	438.6	0.228E-01	5.39	32.58	35.36	29.97
1122.76	0.00	35.36	441.4	0.227E-01	5.39	32.75	35.36	29.97
1132.57	0.00	35.36	444.1	0.225E-01	5.40	32.91	35.36	29.96
1142.38	0.00	35.36	446.9	0.224E-01	5.40	33.07	35.36	29.95
1152.18	0.00	35.36	449.6	0.222E-01	5.41	33.24	35.36	29.95
1161.99	0.00	35.36	452.4	0.221E-01	5.42	33.40	35.36	29.94
1171.80	0.00	35.36	455.2	0.220E-01	5.42	33.57	35.36	29.93
1181.60	0.00	35.36	458.0	0.218E-01	5.43	33.74	35.36	29.93
1191.41	0.00	35.36	460.8	0.217E-01	5.44	33.90	35.36	29.92
1201.22	0.00	35.36	463.6	0.216E-01	5.44	34.07	35.36	29.91
1211.02	0.00	35.36	466.4	0.214E-01	5.45	34.23	35.36	29.91
1220.83	0.00	35.36	469.3	0.213E-01	5.46	34.40	35.36	29.90

1230.64	0.00	35.36	472.1	0.212E-01	5.46	34.57	35.36	29.89
1240.44	0.00	35.36	475.0	0.210E-01	5.47	34.74	35.36	29.89
1250.25	0.00	35.36	477.9	0.209E-01	5.48	34.90	35.36	29.88
1260.06	0.00	35.36	480.8	0.208E-01	5.48	35.07	35.36	29.87
1269.86	0.00	35.36	483.7	0.207E-01	5.49	35.24	35.36	29.87
1279.67	0.00	35.36	486.6	0.205E-01	5.50	35.41	35.36	29.86
1289.48	0.00	35.36	489.5	0.204E-01	5.50	35.58	35.36	29.85
1299.28	0.00	35.36	492.4	0.203E-01	5.51	35.75	35.36	29.85
1309.09	0.00	35.36	495.4	0.202E-01	5.52	35.92	35.36	29.84
1318.90	0.00	35.36	498.3	0.201E-01	5.52	36.08	35.36	29.83
1328.70	0.00	35.36	501.3	0.199E-01	5.53	36.25	35.36	29.83
1338.51	0.00	35.36	504.3	0.198E-01	5.54	36.42	35.36	29.82
1348.32	0.00	35.36	507.2	0.197E-01	5.54	36.60	35.36	29.81
1358.12	0.00	35.36	510.2	0.196E-01	5.55	36.77	35.36	29.81
1367.93	0.00	35.36	513.3	0.195E-01	5.56	36.94	35.36	29.80
1377.74	0.00	35.36	516.3	0.194E-01	5.57	37.11	35.36	29.79
1387.54	0.00	35.36	519.3	0.193E-01	5.57	37.28	35.36	29.78
1397.35	0.00	35.36	522.3	0.191E-01	5.58	37.45	35.36	29.78
1407.16	0.00	35.36	525.4	0.190E-01	5.59	37.62	35.36	29.77
1416.96	0.00	35.36	528.5	0.189E-01	5.59	37.79	35.36	29.76
1426.77	0.00	35.36	531.5	0.188E-01	5.60	37.97	35.36	29.76
1436.58	0.00	35.36	534.6	0.187E-01	5.61	38.14	35.36	29.75
1446.38	0.00	35.36	537.7	0.186E-01	5.61	38.31	35.36	29.74
1456.19	0.00	35.36	540.9	0.185E-01	5.62	38.49	35.36	29.74
1466.00	0.00	35.36	544.0	0.184E-01	5.63	38.66	35.36	29.73
1475.80	0.00	35.36	547.1	0.183E-01	5.64	38.83	35.36	29.72
1485.61	0.00	35.36	550.3	0.182E-01	5.64	39.01	35.36	29.71
1495.42	0.00	35.36	553.4	0.181E-01	5.65	39.18	35.36	29.71
1505.22	0.00	35.36	556.6	0.180E-01	5.66	39.36	35.36	29.70
1515.03	0.00	35.36	559.8	0.179E-01	5.66	39.53	35.36	29.69
1524.84	0.00	35.36	563.0	0.178E-01	5.67	39.71	35.36	29.69
1534.64	0.00	35.36	566.2	0.177E-01	5.68	39.88	35.36	29.68
1544.45	0.00	35.36	569.4	0.176E-01	5.69	40.06	35.36	29.67
1554.26	0.00	35.36	572.7	0.175E-01	5.69	40.23	35.36	29.66
1564.06	0.00	35.36	575.9	0.174E-01	5.70	40.41	35.36	29.66
1573.87	0.00	35.36	579.2	0.173E-01	5.71	40.59	35.36	29.65
1583.68	0.00	35.36	582.4	0.172E-01	5.72	40.76	35.36	29.64
1593.48	0.00	35.36	585.7	0.171E-01	5.72	40.94	35.36	29.63
1603.29	0.00	35.36	589.0	0.170E-01	5.73	41.12	35.36	29.63
1613.10	0.00	35.36	592.3	0.169E-01	5.74	41.29	35.36	29.62
1622.90	0.00	35.36	595.6	0.168E-01	5.75	41.47	35.36	29.61
1632.71	0.00	35.36	599.0	0.167E-01	5.75	41.65	35.36	29.60
1642.52	0.00	35.36	602.3	0.166E-01	5.76	41.83	35.36	29.60
1652.32	0.00	35.36	605.7	0.165E-01	5.77	42.00	35.36	29.59
1662.13	0.00	35.36	609.0	0.164E-01	5.78	42.18	35.36	29.58
1671.94	0.00	35.36	612.4	0.163E-01	5.78	42.36	35.36	29.57
1681.74	0.00	35.36	615.8	0.162E-01	5.79	42.54	35.36	29.57
1691.55	0.00	35.36	619.2	0.161E-01	5.80	42.72	35.36	29.56
1701.36	0.00	35.36	622.7	0.161E-01	5.81	42.90	35.36	29.55
1711.16	0.00	35.36	626.1	0.160E-01	5.81	43.08	35.36	29.54
1720.97	0.00	35.36	629.5	0.159E-01	5.82	43.26	35.36	29.54
1730.78	0.00	35.36	633.0	0.158E-01	5.83	43.44	35.36	29.53

```
   1740.58     0.00   35.36   636.5 0.157E-01   5.84    43.62   35.36   29.52
   1750.39     0.00   35.36   640.0 0.156E-01   5.84    43.80   35.36   29.51
   1760.20     0.00   35.36   643.5 0.155E-01   5.85    43.98   35.36   29.50
   1770.00     0.00   35.36   647.0 0.155E-01   5.86    44.16   35.36   29.50
 Cumulative travel time =        3945.4949 sec

 Simulation limit based on maximum specified distance =   1770.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111
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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                        CORMIX MIXING ZONE EXPERT SYSTEM
                            CORMIX Version 5.0GT
                         HYDRO1:Version  March,2007
SITE NAME/LABEL:                Port Ambrose LNGRV Commissioning Cooling Water
Disch
  DESIGN CASE:                  Summer stratified 10 cm/s
  FILE NAME:                    C:\Program Files\CORMIX 5.0\MyFiles\Port Ambrose
\summer stratified 10 cms.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             11/11/2013--14:46:37
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = unbounded
  Average depth                   HA      = 35.36 m
  Depth at discharge              HD      = 35.36 m
  Ambient velocity                UA      = 0.1 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  = A
  Surface density                 RHOAS   = 1021.17 kg/m^3
  Bottom density                  RHOAB   = 1025.3700 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                            = left
  Distance to bank                DISTB   = 1000 m
  Port diameter                   D0      = 0.8230 m
  Port cross-sectional area       A0      = 0.5319 m^2
  Discharge velocity              U0      = 0.68 m/s
  Discharge flowrate              Q0      = 0.36 m^3/s
  Discharge port height           H0      = 23.77 m
  Vertical discharge angle        THETA   = -90 deg
  Horizontal discharge angle      SIGMA   = 0 deg
  Discharge density               RHO0    = 1019.41 kg/m^3
  Density difference              DRHO    = 3.8600 kg/m^3
  Buoyant acceleration            GP0     = 0.0301 m/s^2
  Discharge concentration         C0      = 10 deg.C
  Surface heat exchange coeff.    KS      = 0.000007 m/s
  Coefficient of decay            KD      = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.73 m         Lm  = 4.94 m         Lb  = 13.32 m
  LM  = 3.01 m         Lm' = 99999 m         Lb' = 99999 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0     = 3.88
  Velocity ratio                  R       = 6.77
-----------------------------------------------------------------------------
```

```
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = yes
  Water quality standard          CSTD   = 1 deg.C
  Regulatory mixing zone                 = yes
  Regulatory mixing zone specification   = distance
  Regulatory mixing zone value           = 100 m (m^2 if area)
  Region of interest                     = 1770 m
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS   = IPV2 |
  *-------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.  The ambient density stratification at the
  discharge site is relatively weak and unimportant so the discharge flow
  penetrates to the surface and/or breaks down the existing stratification
  through vigorous mixing.
  Applicable layer depth = water depth = 35.36 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
    1000 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
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 NFR edge  c = 0.8642 deg.C
  Dilution at edge of NFR              s = 11.6
  NFR Location:                        x = 11.21 m
    (centerline coordinates)           y = 0 m
                                       z = 35.36 m
  NFR plume dimensions:  half-width (bh) = 8.78 m
                          thickness (bv) = 2.37 m
Cumulative travel time:       88.6071 sec.
-----------------------------------------------------------------------------
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.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is weak relative to the
  discharge conditions and is dynamically unimportant. The discharge will
  behave as if the ambient were unstratified.
```

```
-------------------------------------------------------------------------------
UPSTREAM INTRUSION SUMMARY:
Plume exhibits upstream intrusion due to low ambient velocity or strong
  discharge buoyancy.
  Intrusion length                        =  4.74 m
  Intrusion stagnation point              =  2.07 m
  Intrusion thickness                     =  2.37 m
  Intrusion half width at impingement     =  8.78 m
  Intrusion half thickness at impingement =  2.37 m
-------------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************* TOXIC DILUTION ZONE SUMMARY *************************
No TDZ was specified for this simulation.
*********************** REGULATORY MIXING ZONE SUMMARY ************************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 0.597985  deg.C
  Corresponding dilution               s = 16.7
  Plume location:                      x = 100 m
    (centerline coordinates)           y = 0 m
                                       z = 35.36 m
  Plume dimensions:      half-width (bh) = 37.38 m
                          thickness (bv) = 0.81 m
Cumulative travel time:       976.5397 sec.
At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 1  deg.C
  Corresponding dilution               s = 10
  Plume location:                      x = 9.19 m
    (centerline coordinates)           y = 0 m
                                       z = 35.36 m
  Plume dimensions:      half-width (bh) = 7.75 m
                          thickness (bv) = 2.37 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 +-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.
```

```
CORMIX1 PREDICTION FILE:
1111111111111111111111111111111111111111111111111111111111111111111111111111111
                        CORMIX MIXING ZONE EXPERT SYSTEM
             Subsystem CORMIX1:  Single Port Discharges
                          CORMIX Version 5.0GT
                       HYDRO1 Version 5.0.0.0 March 2007
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Port Ambrose LNGRV Commissioning Cooling Water Disch
 Design case:       Summer stratified 10 cm/s
 FILE NAME:         C:\...MyFiles\Port Ambrose\summer stratified 10 cms.prd
 Time stamp:        Mon Nov 11 14:46:37 2013

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =     35.36  HD     =     35.36
 UA     =      0.100 F      =      0.010 USTAR =0.3459E-02
 UW     =      2.000 UWSTAR=0.2198E-02
 Density stratified environment
 STRCND=  A          RHOAM = 1023.2700
 RHOAS = 1021.1700  RHOAB = 1025.3700  RHOAH0= 1022.5458  E     =0.1136E-02

DISCHARGE PARAMETERS (metric units)
 BANK   =  LEFT      DISTB =   1000.00
 D0     =      0.823 A0     =      0.532 H0     =     23.77  SUB0  =     11.58
 THETA =    -90.00  SIGMA =      0.00
 U0     =      0.677 Q0     =      0.360       =0.3600E+00
 RHO0   = 1019.4100  DRHO0 =0.3136E+01  GP0    =0.3007E-01
 C0     =0.1000E+02  CUNITS=  deg.C
 IPOLL =  3          KS     =0.7165E-05  KD     =0.0000E+00

FLUX VARIABLES (metric units)
 Q0     =0.3600E+00  M0     =0.2436E+00  J0     =0.1083E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ     =      0.73  LM     =      3.01  Lm     =      4.94  Lb     =     13.32
                                         Lmp    =  99999.00  Lbp    =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =      3.88  R      =      6.77

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    IPV2   1
 1  Applicable layer depth HS =    35.36  1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     =0.1000E+02  CUNITS=  deg.C
 NTOX   =  0
 NSTD   =  1         CSTD   =0.1000E+01
 REGMZ =  1
```

```
 REGSPC=  1         XREG  =    100.00  WREG  =      0.00  AREG  =      0.00
 XINT  =   1770.00  XMAX  =   1770.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
      1000.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
-------------------------------------------------------------------------------

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
-------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.41

END OF MOD101: DISCHARGE MODULE
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet/plume transition motion in weak crossflow.

 Zone of flow establishment:            THETAE=    -86.50  SIGMAE=      0.00
  LE    =      1.75  XE    =      0.05  YE    =      0.00  ZE    =     22.03

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.41
      0.05     0.00   22.03     1.0 0.100E+02   0.42
      0.06     0.00   21.97     1.0 0.100E+02   0.43
      0.07     0.00   21.86     1.0 0.100E+02   0.44
      0.07     0.00   21.74     1.0 0.100E+02   0.45
      0.08     0.00   21.63     1.0 0.100E+02   0.47
      0.10     0.00   21.46     1.0 0.100E+02   0.49
      0.12     0.00   21.35     1.0 0.100E+02   0.50
      0.13     0.00   21.23     1.0 0.100E+02   0.52
      0.15     0.00   21.12     1.0 0.980E+01   0.53
      0.17     0.00   21.01     1.0 0.961E+01   0.55
      0.19     0.00   20.89     1.1 0.943E+01   0.56
      0.21     0.00   20.78     1.1 0.925E+01   0.58
      0.23     0.00   20.67     1.1 0.905E+01   0.60
      0.26     0.00   20.56     1.1 0.885E+01   0.62
```

0.28	0.00	20.45	1.2	0.863E+01	0.64
0.31	0.00	20.34	1.2	0.841E+01	0.67
0.35	0.00	20.23	1.2	0.819E+01	0.70
0.38	0.00	20.12	1.3	0.795E+01	0.73
0.42	0.00	20.01	1.3	0.771E+01	0.76
0.47	0.00	19.91	1.3	0.746E+01	0.80
0.51	0.00	19.80	1.4	0.721E+01	0.84
0.57	0.00	19.70	1.4	0.694E+01	0.88
0.62	0.00	19.60	1.5	0.666E+01	0.93
0.69	0.00	19.51	1.6	0.638E+01	0.99
0.76	0.00	19.42	1.6	0.608E+01	1.05
0.84	0.00	19.34	1.7	0.579E+01	1.11
0.93	0.00	19.27	1.8	0.551E+01	1.18
0.97	0.00	19.23	1.9	0.538E+01	1.21
1.07	0.00	19.18	1.9	0.517E+01	1.26
1.18	0.00	19.14	2.0	0.502E+01	1.29
1.29	0.00	19.12	2.0	0.496E+01	1.31

Minimum jet height has been reached.

1.41	0.00	19.12	2.0	0.496E+01	1.30
1.52	0.00	19.14	2.0	0.498E+01	1.28
1.63	0.00	19.17	2.0	0.498E+01	1.26
1.73	0.00	19.22	2.0	0.496E+01	1.24
1.83	0.00	19.28	2.0	0.493E+01	1.22
1.92	0.00	19.35	2.1	0.487E+01	1.20
2.01	0.00	19.42	2.1	0.480E+01	1.18
2.10	0.00	19.49	2.1	0.473E+01	1.17
2.18	0.00	19.57	2.2	0.464E+01	1.16
2.26	0.00	19.65	2.2	0.456E+01	1.16
2.34	0.00	19.74	2.2	0.447E+01	1.15
2.41	0.00	19.82	2.3	0.438E+01	1.15
2.49	0.00	19.91	2.3	0.429E+01	1.15
2.56	0.00	20.00	2.4	0.420E+01	1.15
2.63	0.00	20.09	2.4	0.412E+01	1.15
2.70	0.00	20.18	2.5	0.403E+01	1.16
2.77	0.00	20.27	2.5	0.395E+01	1.16
2.84	0.00	20.36	2.6	0.386E+01	1.17
2.91	0.00	20.45	2.6	0.378E+01	1.17
2.98	0.00	20.54	2.7	0.370E+01	1.18
3.05	0.00	20.63	2.8	0.363E+01	1.19
3.12	0.00	20.72	2.8	0.355E+01	1.20
3.19	0.00	20.81	2.9	0.348E+01	1.21
3.26	0.00	20.90	2.9	0.341E+01	1.21
3.33	0.00	20.99	3.0	0.334E+01	1.22
3.40	0.00	21.08	3.1	0.327E+01	1.23
3.46	0.00	21.17	3.1	0.320E+01	1.24
3.53	0.00	21.27	3.2	0.314E+01	1.26
3.60	0.00	21.36	3.3	0.307E+01	1.27
3.67	0.00	21.45	3.3	0.301E+01	1.28
3.74	0.00	21.54	3.4	0.295E+01	1.29
3.81	0.00	21.63	3.5	0.289E+01	1.30
3.88	0.00	21.72	3.5	0.283E+01	1.32
3.95	0.00	21.81	3.6	0.278E+01	1.33

```
      4.02     0.00   21.90     3.7 0.272E+01   1.34
      4.09     0.00   21.99     3.7 0.267E+01   1.36
      4.16     0.00   22.08     3.8 0.262E+01   1.37
      4.23     0.00   22.17     3.9 0.257E+01   1.39
      4.30     0.00   22.26     4.0 0.252E+01   1.40
      4.38     0.00   22.35     4.0 0.247E+01   1.42
      4.48     0.00   22.48     4.2 0.240E+01   1.44
      4.56     0.00   22.57     4.2 0.236E+01   1.45
      4.63     0.00   22.65     4.3 0.231E+01   1.47
      4.71     0.00   22.74     4.4 0.227E+01   1.49
      4.78     0.00   22.83     4.5 0.223E+01   1.50
      4.85     0.00   22.91     4.6 0.219E+01   1.52
      4.93     0.00   23.00     4.7 0.215E+01   1.54
      5.00     0.00   23.08     4.7 0.211E+01   1.55
      5.08     0.00   23.17     4.8 0.207E+01   1.57
      5.16     0.00   23.25     4.9 0.203E+01   1.59
      5.24     0.00   23.34     5.0 0.200E+01   1.61
      5.31     0.00   23.42     5.1 0.196E+01   1.62
      5.39     0.00   23.51     5.2 0.193E+01   1.64
      5.47     0.00   23.59     5.3 0.189E+01   1.66
      5.55     0.00   23.67     5.4 0.186E+01   1.68
      5.63     0.00   23.75     5.5 0.183E+01   1.70
      5.71     0.00   23.83     5.6 0.180E+01   1.72
      5.79     0.00   23.91     5.7 0.177E+01   1.74
      5.87     0.00   23.99     5.8 0.173E+01   1.76
      5.96     0.00   24.07     5.9 0.170E+01   1.78
      6.04     0.00   24.15     6.0 0.168E+01   1.80
      6.12     0.00   24.23     6.1 0.165E+01   1.82
      6.21     0.00   24.30     6.2 0.162E+01   1.84
      6.29     0.00   24.38     6.3 0.159E+01   1.86
      6.38     0.00   24.46     6.4 0.157E+01   1.88
      6.46     0.00   24.53     6.5 0.155E+01   1.90
      6.55     0.00   24.60     6.6 0.152E+01   1.92
      6.64     0.00   24.68     6.7 0.150E+01   1.94
      6.73     0.00   24.75     6.8 0.148E+01   1.96
      6.82     0.00   24.82     6.8 0.147E+01   1.97
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =          44.6950 sec

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN MOD132: LAYER BOUNDARY IMPINGEMENT/UPSTREAM SPREADING

  Vertical angle of layer/boundary impingement    =      38.75 deg
  Horizontal angle of layer/boundary impingement  =       0.00 deg

 UPSTREAM INTRUSION PROPERTIES:
        Upstream intrusion length                =       4.74 m
        X-position of upstream stagnation point =       2.07 m
        Thickness in intrusion region            =       2.37 m
        Half-width at downstream end             =       8.78 m
```

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        Thickness at downstream end              =       2.37 m

  Control volume inflow:
       X         Y        Z         S        C        B
     6.82      0.00    24.82      6.8 0.147E+01    1.97

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

       X         Y        Z         S        C        BV        BH       ZU       ZL
     2.07      0.00    35.36  9999.9 0.000E+00    0.00      0.00    35.36    35.36
     2.26      0.00    35.36    27.7 0.361E+00    0.58      1.24    35.36    34.77
     3.15      0.00    35.36    11.5 0.868E+00    1.40      3.02    35.36    33.95
     4.05      0.00    35.36     8.7 0.115E+01    1.85      4.08    35.36    33.51
     4.94      0.00    35.36     7.5 0.132E+01    2.14      4.92    35.36    33.22
     5.84      0.00    35.36     7.0 0.143E+01    2.31      5.64    35.36    33.05
     6.73      0.00    35.36     6.8 0.147E+01    2.37      6.27    35.36    32.99
     7.63      0.00    35.36     7.4 0.135E+01    2.37      6.85    35.36    32.99
     8.52      0.00    35.36     9.0 0.112E+01    2.37      7.38    35.36    32.99
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.100E+01 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
     9.42      0.00    35.36    10.4 0.961E+00    2.37      7.87    35.36    32.99
    10.31      0.00    35.36    11.2 0.893E+00    2.37      8.34    35.36    32.99
    11.21      0.00    35.36    11.6 0.864E+00    2.37      8.78    35.36    32.99
 Cumulative travel time =          88.6071 sec

END OF MOD132: LAYER BOUNDARY IMPINGEMENT/UPSTREAM SPREADING
-------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
-------------------------------------------------------------------------------
BEGIN MOD141: BUOYANT AMBIENT SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

 Plume Stage 1 (not bank attached):
       X         Y        Z         S        C        BV        BH       ZU       ZL
    11.21      0.00    35.36    11.6 0.864E+00    2.37      8.78    35.36    32.99
    28.79      0.00    35.36    13.6 0.735E+00    1.46     16.71    35.36    33.89
```

46.38	0.00	35.36	14.7	0.679E+00	1.16	22.89	35.36	34.20
63.97	0.00	35.36	15.5	0.644E+00	0.99	28.18	35.36	34.37
81.56	0.00	35.36	16.2	0.619E+00	0.88	32.89	35.36	34.47
99.15	0.00	35.36	16.7	0.599E+00	0.81	37.18	35.36	34.55

** REGULATORY MIXING ZONE BOUNDARY **

In this prediction interval the plume DOWNSTREAM distance meets or exceeds the regulatory value = 100.00 m.

This is the extent of the REGULATORY MIXING ZONE.

116.73	0.00	35.36	17.2	0.583E+00	0.75	41.14	35.36	34.61
134.32	0.00	35.36	17.6	0.569E+00	0.71	44.83	35.36	34.65
151.91	0.00	35.36	18.0	0.557E+00	0.67	48.30	35.36	34.69
169.50	0.00	35.36	18.3	0.546E+00	0.64	51.59	35.36	34.72
187.09	0.00	35.36	18.6	0.536E+00	0.61	54.70	35.36	34.74
204.67	0.00	35.36	19.0	0.527E+00	0.59	57.68	35.36	34.76
222.26	0.00	35.36	19.3	0.518E+00	0.57	60.53	35.36	34.78
239.85	0.00	35.36	19.6	0.510E+00	0.56	63.26	35.36	34.80
257.44	0.00	35.36	19.9	0.503E+00	0.54	65.90	35.36	34.81
275.03	0.00	35.36	20.2	0.496E+00	0.53	68.44	35.36	34.83
292.61	0.00	35.36	20.5	0.489E+00	0.52	70.90	35.36	34.84
310.20	0.00	35.36	20.7	0.482E+00	0.51	73.28	35.36	34.85
327.79	0.00	35.36	21.0	0.475E+00	0.50	75.59	35.36	34.86
345.38	0.00	35.36	21.3	0.469E+00	0.49	77.84	35.36	34.86
362.97	0.00	35.36	21.6	0.462E+00	0.49	80.02	35.36	34.87
380.55	0.00	35.36	21.9	0.456E+00	0.48	82.15	35.36	34.88
398.14	0.00	35.36	22.2	0.450E+00	0.47	84.23	35.36	34.88
415.73	0.00	35.36	22.5	0.444E+00	0.47	86.27	35.36	34.89
433.32	0.00	35.36	22.8	0.438E+00	0.46	88.25	35.36	34.89
450.90	0.00	35.36	23.1	0.432E+00	0.46	90.20	35.36	34.90
468.49	0.00	35.36	23.4	0.427E+00	0.46	92.10	35.36	34.90
486.08	0.00	35.36	23.7	0.421E+00	0.45	93.97	35.36	34.90
503.67	0.00	35.36	24.1	0.415E+00	0.45	95.81	35.36	34.90
521.26	0.00	35.36	24.4	0.410E+00	0.45	97.61	35.36	34.91
538.84	0.00	35.36	24.7	0.404E+00	0.45	99.38	35.36	34.91
556.43	0.00	35.36	25.1	0.399E+00	0.45	101.12	35.36	34.91
574.02	0.00	35.36	25.4	0.393E+00	0.44	102.83	35.36	34.91
591.61	0.00	35.36	25.8	0.388E+00	0.44	104.51	35.36	34.91
609.20	0.00	35.36	26.1	0.382E+00	0.44	106.17	35.36	34.91
626.78	0.00	35.36	26.5	0.377E+00	0.44	107.81	35.36	34.91
644.37	0.00	35.36	26.9	0.372E+00	0.44	109.42	35.36	34.91
661.96	0.00	35.36	27.3	0.366E+00	0.44	111.01	35.36	34.91
679.55	0.00	35.36	27.6	0.361E+00	0.44	112.58	35.36	34.91
697.14	0.00	35.36	28.0	0.356E+00	0.44	114.13	35.36	34.91
714.72	0.00	35.36	28.5	0.351E+00	0.44	115.67	35.36	34.91
732.31	0.00	35.36	28.9	0.346E+00	0.44	117.18	35.36	34.91
749.90	0.00	35.36	29.3	0.341E+00	0.44	118.68	35.36	34.91
767.49	0.00	35.36	29.7	0.336E+00	0.45	120.16	35.36	34.91
785.08	0.00	35.36	30.2	0.331E+00	0.45	121.62	35.36	34.91
802.66	0.00	35.36	30.6	0.326E+00	0.45	123.07	35.36	34.91
820.25	0.00	35.36	31.1	0.321E+00	0.45	124.51	35.36	34.91
837.84	0.00	35.36	31.6	0.316E+00	0.45	125.93	35.36	34.91
855.43	0.00	35.36	32.0	0.312E+00	0.45	127.33	35.36	34.90
873.02	0.00	35.36	32.5	0.307E+00	0.45	128.73	35.36	34.90

890.60	0.00	35.36	33.0	0.302E+00	0.46	130.11	35.36	34.90
908.19	0.00	35.36	33.5	0.298E+00	0.46	131.48	35.36	34.90
925.78	0.00	35.36	34.0	0.293E+00	0.46	132.84	35.36	34.90
943.37	0.00	35.36	34.6	0.289E+00	0.46	134.19	35.36	34.89
960.96	0.00	35.36	35.1	0.284E+00	0.47	135.52	35.36	34.89
978.54	0.00	35.36	35.6	0.280E+00	0.47	136.85	35.36	34.89
996.13	0.00	35.36	36.2	0.276E+00	0.47	138.17	35.36	34.89
1013.72	0.00	35.36	36.8	0.271E+00	0.47	139.47	35.36	34.88
1031.31	0.00	35.36	37.3	0.267E+00	0.48	140.77	35.36	34.88
1048.90	0.00	35.36	37.9	0.263E+00	0.48	142.06	35.36	34.88
1066.48	0.00	35.36	38.5	0.259E+00	0.48	143.34	35.36	34.87
1084.07	0.00	35.36	39.1	0.255E+00	0.49	144.61	35.36	34.87
1101.66	0.00	35.36	39.8	0.251E+00	0.49	145.88	35.36	34.87
1119.25	0.00	35.36	40.4	0.247E+00	0.49	147.14	35.36	34.86
1136.83	0.00	35.36	41.0	0.243E+00	0.50	148.38	35.36	34.86
1154.42	0.00	35.36	41.7	0.239E+00	0.50	149.63	35.36	34.86
1172.01	0.00	35.36	42.3	0.236E+00	0.51	150.86	35.36	34.85
1189.60	0.00	35.36	43.0	0.232E+00	0.51	152.09	35.36	34.85
1207.19	0.00	35.36	43.7	0.228E+00	0.51	153.31	35.36	34.84
1224.77	0.00	35.36	44.4	0.225E+00	0.52	154.53	35.36	34.84
1242.36	0.00	35.36	45.1	0.221E+00	0.52	155.74	35.36	34.84
1259.95	0.00	35.36	45.8	0.218E+00	0.53	156.94	35.36	34.83
1277.54	0.00	35.36	46.5	0.214E+00	0.53	158.14	35.36	34.83
1295.13	0.00	35.36	47.3	0.211E+00	0.53	159.33	35.36	34.82
1312.71	0.00	35.36	48.0	0.208E+00	0.54	160.51	35.36	34.82
1330.30	0.00	35.36	48.8	0.204E+00	0.54	161.69	35.36	34.81
1347.89	0.00	35.36	49.6	0.201E+00	0.55	162.87	35.36	34.81
1365.48	0.00	35.36	50.4	0.198E+00	0.55	164.04	35.36	34.80
1383.07	0.00	35.36	51.2	0.195E+00	0.56	165.20	35.36	34.80
1400.65	0.00	35.36	52.0	0.192E+00	0.56	166.37	35.36	34.79
1418.24	0.00	35.36	52.8	0.189E+00	0.57	167.52	35.36	34.79
1435.83	0.00	35.36	53.6	0.186E+00	0.57	168.67	35.36	34.78
1453.42	0.00	35.36	54.5	0.183E+00	0.58	169.82	35.36	34.78
1471.00	0.00	35.36	55.4	0.180E+00	0.58	170.96	35.36	34.77
1488.59	0.00	35.36	56.2	0.177E+00	0.59	172.10	35.36	34.77
1506.18	0.00	35.36	57.1	0.175E+00	0.59	173.24	35.36	34.76
1523.77	0.00	35.36	58.0	0.172E+00	0.60	174.37	35.36	34.76
1541.36	0.00	35.36	58.9	0.169E+00	0.60	175.50	35.36	34.75
1558.94	0.00	35.36	59.8	0.167E+00	0.61	176.62	35.36	34.75
1576.53	0.00	35.36	60.8	0.164E+00	0.62	177.74	35.36	34.74
1594.12	0.00	35.36	61.7	0.161E+00	0.62	178.86	35.36	34.74
1611.71	0.00	35.36	62.7	0.159E+00	0.63	179.97	35.36	34.73
1629.30	0.00	35.36	63.7	0.157E+00	0.63	181.08	35.36	34.72
1646.88	0.00	35.36	64.7	0.154E+00	0.64	182.18	35.36	34.72
1664.47	0.00	35.36	65.7	0.152E+00	0.64	183.29	35.36	34.71
1682.06	0.00	35.36	66.7	0.149E+00	0.65	184.39	35.36	34.71
1699.65	0.00	35.36	67.7	0.147E+00	0.66	185.48	35.36	34.70
1717.23	0.00	35.36	68.8	0.145E+00	0.66	186.58	35.36	34.69
1734.82	0.00	35.36	69.8	0.143E+00	0.67	187.67	35.36	34.69
1752.41	0.00	35.36	70.9	0.141E+00	0.68	188.75	35.36	34.68
1770.00	0.00	35.36	72.0	0.138E+00	0.68	189.84	35.36	34.67

Cumulative travel time = 17676.5391 sec

```
 Simulation limit based on maximum specified distance =   1770.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD141: BUOYANT AMBIENT SPREADING
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                        CORMIX MIXING ZONE EXPERT SYSTEM
                            CORMIX Version 5.0GT
                         HYDRO1:Version  March,2007
SITE NAME/LABEL:                Port Ambrose LNGRV Commissioning Cooling Water
Disch
  DESIGN CASE:                  Summer stratified 30 cm/s
  FILE NAME:                    C:\Program Files\CORMIX 5.0\MyFiles\Port Ambrose
\summer stratified 30 cms.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             11/11/2013--15:21:57
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = unbounded
  Average depth                   HA      = 35.36 m
  Depth at discharge              HD      = 35.36 m
  Ambient velocity                UA      = 0.3 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  = A
  Surface density                 RHOAS   = 1021.17 kg/m^3
  Bottom density                  RHOAB   = 1025.3700 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                            = left
  Distance to bank                DISTB   = 1000 m
  Port diameter                   D0      = 0.8230 m
  Port cross-sectional area       A0      = 0.5319 m^2
  Discharge velocity              U0      = 0.68 m/s
  Discharge flowrate              Q0      = 0.36 m^3/s
  Discharge port height           H0      = 23.77 m
  Vertical discharge angle        THETA   = -90 deg
  Horizontal discharge angle      SIGMA   = 0 deg
  Discharge density               RHO0    = 1019.41 kg/m^3
  Density difference              DRHO    = 3.1359 kg/m^3
  Buoyant acceleration            GP0     = 0.0301 m/s^2
  Discharge concentration         C0      = 10 deg.C
  Surface heat exchange coeff.    KS      = 0.000007 m/s
  Coefficient of decay            KD      = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.73 m         Lm  = 1.65 m         Lb  = 0.40 m
  LM  = 3.33 m         Lm' = 3.83 m         Lb' = 4.10 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0     = 4.30
  Velocity ratio                  R       = 2.26
-----------------------------------------------------------------------------
```

```
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = no
  Water quality standard specified         = yes
  Water quality standard          CSTD     = 1 deg.C
  Regulatory mixing zone                   = yes
  Regulatory mixing zone specification     = distance
  Regulatory mixing zone value             = 100 m (m^2 if area)
  Region of interest                       = 1770 m
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS   = IS4 |
  *-------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 35.36 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
    1000 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
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 NFR edge  c = 0.5153 deg.C
  Dilution at edge of NFR              s = 19.4
  NFR Location:                        x = 23.25 m
    (centerline coordinates)           y = 0 m
                                       z = 25.35 m
  NFR plume dimensions:  half-width (bh) = 3.41 m
                          thickness (bv) = 3.41 m
Cumulative travel time:       79.5798 sec.
-----------------------------------------------------------------------------
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.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
```

```
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 0.354019  deg.C
  Corresponding dilution               s = 28.2
  Plume location:                      x = 100 m
    (centerline coordinates)           y = 0 m
                                       z = 25.35 m
  Plume dimensions:      half-width (bh) = 14.28 m
                          thickness (bv) = 1.19 m
Cumulative travel time:       335.4175 sec.
At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 1  deg.C
  Corresponding dilution               s = 10
  Plume location:                      x = 17.20 m
    (centerline coordinates)           y = 0 m
                                       z = 24.91 m
  Plume dimension:       half-width (bh) = 1.62 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 +-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.
```

```
CORMIX1 PREDICTION FILE:
1111111111111111111111111111111111111111111111111111111111111111111111111111111
                        CORMIX MIXING ZONE EXPERT SYSTEM
             Subsystem CORMIX1:  Single Port Discharges
                          CORMIX Version 5.0GT
                       HYDRO1 Version 5.0.0.0 March 2007
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Port Ambrose LNGRV Commissioning Cooling Water Disch
 Design case:       Summer stratified 30 cm/s
 FILE NAME:         C:\...MyFiles\Port Ambrose\summer stratified 30 cms.prd
 Time stamp:        Mon Nov 11 15:21:57 2013

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =     35.36  HD     =     35.36
 UA     =      0.300 F      =      0.010 USTAR =0.1038E-01
 UW     =      2.000 UWSTAR=0.2198E-02
 Density stratified environment
 STRCND=  A         RHOAM = 1023.2700
 RHOAS = 1021.1700  RHOAB = 1025.3700  RHOAH0= 1022.5458  E     =0.1136E-02

DISCHARGE PARAMETERS (metric units)
 BANK   =  LEFT      DISTB =   1000.00
 D0     =      0.823 A0     =      0.532 H0     =     23.77  SUB0  =     11.58
 THETA =    -90.00  SIGMA =      0.00
 U0     =      0.677 Q0     =      0.360       =0.3600E+00
 RHO0   = 1019.4100  DRHO0 =0.3136E+01  GP0    =0.3007E-01
 C0     =0.1000E+02  CUNITS=  deg.C
 IPOLL =  3         KS     =0.7165E-05  KD     =0.0000E+00

FLUX VARIABLES (metric units)
 Q0     =0.3600E+00  M0     =0.2436E+00  J0     =0.1083E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ     =      0.73  LM     =      3.33  Lm     =      1.65  Lb     =      0.40
                                         Lmp    =      3.83  Lbp    =      4.10

NON-DIMENSIONAL PARAMETERS
 FR0    =      4.30  R      =      2.26

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    IS4    1
 1  Applicable layer depth HS =    35.36  1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     =0.1000E+02  CUNITS=  deg.C
 NTOX   =  0
 NSTD   =  1         CSTD   =0.1000E+01
 REGMZ =  1
```

```
 REGSPC=  1         XREG  =    100.00  WREG  =      0.00  AREG  =      0.00
 XINT  =   1770.00  XMAX  =   1770.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
      1000.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
-------------------------------------------------------------------------------

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
-------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.41

END OF MOD101: DISCHARGE MODULE
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Plume-like motion in linear stratification with strong crossflow.

 Zone of flow establishment:            THETAE=    -79.60  SIGMAE=      0.00
  LE    =      0.00  XE    =      0.00  YE    =      0.00  ZE    =     23.77

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)

       X        Y       Z        S       C       B
      0.00     0.00   23.77     1.0 0.100E+02   0.43
      0.02     0.00   23.67     1.0 0.100E+02   0.45
      0.08     0.00   23.47     1.0 0.965E+01   0.48
      0.17     0.00   23.28     1.2 0.862E+01   0.53
      0.27     0.00   23.10     1.3 0.762E+01   0.57
      0.40     0.00   22.94     1.5 0.675E+01   0.62
      0.56     0.00   22.80     1.7 0.605E+01   0.66
      0.72     0.00   22.67     1.8 0.551E+01   0.70
      0.90     0.00   22.56     2.0 0.508E+01   0.74
      1.09     0.00   22.47     2.1 0.476E+01   0.76
      1.28     0.00   22.38     2.2 0.450E+01   0.79
      1.48     0.00   22.31     2.3 0.430E+01   0.81
      1.67     0.00   22.25     2.4 0.413E+01   0.83
      1.88     0.00   22.20     2.5 0.398E+01   0.84
      2.08     0.00   22.15     2.6 0.386E+01   0.85
```

2.29	0.00	22.11	2.7	0.376E+01	0.87
2.60	0.00	22.07	2.7	0.365E+01	0.88
2.80	0.00	22.05	2.8	0.359E+01	0.89
3.01	0.00	22.03	2.8	0.354E+01	0.89
3.22	0.00	22.02	2.9	0.351E+01	0.90
3.43	0.00	22.01	2.9	0.348E+01	0.90
3.53	0.00	22.01	2.9	0.348E+01	0.90

Minimum jet height has been reached.

3.74	0.00	22.01	2.9	0.346E+01	0.90
3.95	0.00	22.02	2.9	0.343E+01	0.91
4.16	0.00	22.03	2.9	0.339E+01	0.91
4.37	0.00	22.04	3.0	0.335E+01	0.92
4.58	0.00	22.06	3.0	0.330E+01	0.92
4.79	0.00	22.08	3.1	0.325E+01	0.93
4.99	0.00	22.11	3.1	0.319E+01	0.94
5.20	0.00	22.14	3.2	0.313E+01	0.94
5.41	0.00	22.18	3.3	0.307E+01	0.95
5.61	0.00	22.21	3.3	0.301E+01	0.96
5.82	0.00	22.25	3.4	0.294E+01	0.97
6.02	0.00	22.29	3.5	0.288E+01	0.98
6.23	0.00	22.34	3.6	0.282E+01	0.99
6.43	0.00	22.38	3.6	0.275E+01	1.00
6.63	0.00	22.43	3.7	0.269E+01	1.01
6.84	0.00	22.47	3.8	0.263E+01	1.02
7.04	0.00	22.52	3.9	0.257E+01	1.03
7.24	0.00	22.57	4.0	0.251E+01	1.04
7.45	0.00	22.62	4.1	0.245E+01	1.05
7.65	0.00	22.68	4.2	0.239E+01	1.06
7.85	0.00	22.73	4.3	0.233E+01	1.07
8.05	0.00	22.78	4.4	0.228E+01	1.09
8.26	0.00	22.83	4.5	0.222E+01	1.10
8.46	0.00	22.89	4.6	0.217E+01	1.11
8.66	0.00	22.94	4.7	0.212E+01	1.12
8.86	0.00	22.99	4.8	0.207E+01	1.14
9.06	0.00	23.04	4.9	0.202E+01	1.15
9.27	0.00	23.10	5.1	0.197E+01	1.16
9.47	0.00	23.15	5.2	0.193E+01	1.17
9.67	0.00	23.20	5.3	0.189E+01	1.19
9.87	0.00	23.26	5.4	0.184E+01	1.20
10.07	0.00	23.31	5.5	0.180E+01	1.21
10.28	0.00	23.36	5.7	0.176E+01	1.22
10.48	0.00	23.41	5.8	0.173E+01	1.24
10.68	0.00	23.47	5.9	0.169E+01	1.25
10.88	0.00	23.52	6.0	0.166E+01	1.26
11.09	0.00	23.57	6.2	0.162E+01	1.28
11.29	0.00	23.62	6.3	0.159E+01	1.29
11.49	0.00	23.67	6.4	0.156E+01	1.30
11.69	0.00	23.72	6.5	0.153E+01	1.31
11.90	0.00	23.77	6.7	0.150E+01	1.33
12.10	0.00	23.82	6.8	0.147E+01	1.34
12.30	0.00	23.87	6.9	0.144E+01	1.35
12.51	0.00	23.92	7.1	0.142E+01	1.36

```
     12.71     0.00   23.97     7.2 0.139E+01   1.38
     12.91     0.00   24.01     7.3 0.137E+01   1.39
     13.12     0.00   24.06     7.5 0.134E+01   1.40
     13.32     0.00   24.11     7.6 0.132E+01   1.41
     13.52     0.00   24.15     7.7 0.130E+01   1.42
     13.73     0.00   24.20     7.8 0.127E+01   1.44
     13.93     0.00   24.25     8.0 0.125E+01   1.45
     14.14     0.00   24.29     8.1 0.123E+01   1.46
     14.34     0.00   24.34     8.2 0.121E+01   1.47
     14.54     0.00   24.38     8.4 0.120E+01   1.48
     14.75     0.00   24.42     8.5 0.118E+01   1.49
     14.95     0.00   24.47     8.6 0.116E+01   1.50
     15.16     0.00   24.51     8.7 0.114E+01   1.52
     15.36     0.00   24.55     8.9 0.113E+01   1.53
     15.57     0.00   24.59     9.0 0.111E+01   1.54
     15.77     0.00   24.64     9.1 0.110E+01   1.55
     15.98     0.00   24.68     9.3 0.108E+01   1.56
     16.18     0.00   24.72     9.4 0.107E+01   1.57
     16.39     0.00   24.76     9.5 0.105E+01   1.58
     16.59     0.00   24.80     9.6 0.104E+01   1.59
     16.80     0.00   24.84     9.8 0.102E+01   1.60
     17.00     0.00   24.88     9.9 0.101E+01   1.61
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.100E+01 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
     17.21     0.00   24.91    10.0 0.999E+00   1.62
     17.41     0.00   24.95    10.1 0.987E+00   1.63
     17.72     0.00   25.01    10.3 0.970E+00   1.65
     17.93     0.00   25.04    10.4 0.959E+00   1.66
     18.13     0.00   25.08    10.6 0.948E+00   1.67
     18.34     0.00   25.12    10.7 0.937E+00   1.67
     18.55     0.00   25.15    10.8 0.927E+00   1.68
     18.75     0.00   25.19    10.9 0.917E+00   1.69
     18.96     0.00   25.22    11.0 0.908E+00   1.70
     19.16     0.00   25.25    11.1 0.898E+00   1.71
     19.37     0.00   25.29    11.2 0.889E+00   1.72
     19.58     0.00   25.32    11.4 0.880E+00   1.73
     19.78     0.00   25.35    11.4 0.876E+00   1.73
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =          68.0269 sec

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

  Control volume inflow:
       X         Y        Z         S        C        B
     19.78     0.00   25.35    11.4 0.876E+00   1.73
```

```
 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

       X         Y        Z         S        C        BV        BH       ZU       ZL
     18.05     0.00    25.35    11.4 0.876E+00   0.00      0.00    25.35    25.35
     18.57     0.00    25.35    11.4 0.876E+00   2.15      1.08    26.43    24.28
     19.09     0.00    25.35    11.4 0.876E+00   2.54      1.53    26.62    24.08
     19.61     0.00    25.35    11.4 0.876E+00   2.80      1.87    26.75    23.95
     20.13     0.00    25.35    11.7 0.853E+00   2.99      2.16    26.85    23.86
     20.65     0.00    25.35    13.2 0.759E+00   3.13      2.41    26.92    23.79
     21.17     0.00    25.35    15.2 0.658E+00   3.24      2.64    26.97    23.73
     21.69     0.00    25.35    17.0 0.587E+00   3.32      2.85    27.01    23.69
     22.21     0.00    25.35    18.3 0.547E+00   3.37      3.05    27.04    23.67
     22.73     0.00    25.35    19.0 0.527E+00   3.40      3.24    27.05    23.65
     23.25     0.00    25.35    19.4 0.515E+00   3.41      3.41    27.06    23.65
 Cumulative travel time =          79.5798 sec

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH
-------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
-------------------------------------------------------------------------------
BEGIN MOD142: BUOYANT TERMINAL LAYER SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

 Plume Stage 1 (not bank attached):
       X         Y        Z         S        C        BV        BH       ZU       ZL
     23.25     0.00    25.35    19.4 0.515E+00   3.41      3.41    27.06    23.65
     40.72     0.00    25.35    23.3 0.429E+00   1.98      7.05    26.34    24.36
     58.18     0.00    25.35    25.2 0.396E+00   1.58      9.60    26.14    24.56
     75.65     0.00    25.35    26.6 0.375E+00   1.36     11.72    26.03    24.67
     93.12     0.00    25.35    27.8 0.359E+00   1.23     13.60    25.97    24.74
 ** REGULATORY MIXING ZONE BOUNDARY **
 In this prediction interval the plume DOWNSTREAM  distance meets or exceeds
 the regulatory value =   100.00 m.
 This is the extent of the REGULATORY MIXING ZONE.
    110.59     0.00    25.35    28.9 0.346E+00   1.13     15.30    25.92    24.79
    128.05     0.00    25.35    29.9 0.334E+00   1.06     16.89    25.88    24.82
    145.52     0.00    25.35    30.9 0.323E+00   1.01     18.38    25.86    24.85
    162.99     0.00    25.35    32.0 0.313E+00   0.97     19.80    25.84    24.87
    180.46     0.00    25.35    33.0 0.303E+00   0.94     21.17    25.82    24.88
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197.92	0.00	25.35	34.1	0.293E+00	0.91	22.49	25.81	24.90
215.39	0.00	25.35	35.2	0.284E+00	0.89	23.78	25.80	24.91
232.86	0.00	25.35	36.4	0.275E+00	0.87	25.04	25.79	24.92
250.33	0.00	25.35	37.6	0.266E+00	0.86	26.27	25.78	24.92
267.79	0.00	25.35	38.8	0.257E+00	0.85	27.49	25.78	24.93
285.26	0.00	25.35	40.1	0.249E+00	0.84	28.69	25.77	24.93
302.73	0.00	25.35	41.5	0.241E+00	0.83	29.88	25.77	24.94
320.20	0.00	25.35	42.9	0.233E+00	0.83	31.06	25.77	24.94
337.66	0.00	25.35	44.3	0.226E+00	0.83	32.23	25.76	24.94
355.13	0.00	25.35	45.8	0.218E+00	0.82	33.40	25.76	24.94
372.60	0.00	25.35	47.3	0.211E+00	0.82	34.56	25.76	24.94
390.07	0.00	25.35	48.9	0.205E+00	0.82	35.72	25.76	24.94
407.53	0.00	25.35	50.5	0.198E+00	0.82	36.88	25.76	24.94
425.00	0.00	25.35	52.1	0.192E+00	0.82	38.04	25.76	24.94
442.47	0.00	25.35	53.8	0.186E+00	0.82	39.20	25.76	24.94
459.94	0.00	25.35	55.5	0.180E+00	0.82	40.35	25.76	24.94
477.40	0.00	25.35	57.2	0.175E+00	0.83	41.52	25.77	24.94
494.87	0.00	25.35	59.0	0.170E+00	0.83	42.68	25.77	24.94
512.34	0.00	25.35	60.8	0.165E+00	0.83	43.84	25.77	24.94
529.81	0.00	25.35	62.6	0.160E+00	0.83	45.01	25.77	24.93
547.27	0.00	25.35	64.5	0.155E+00	0.84	46.18	25.77	24.93
564.74	0.00	25.35	66.4	0.151E+00	0.84	47.36	25.77	24.93
582.21	0.00	25.35	68.3	0.146E+00	0.84	48.53	25.77	24.93
599.68	0.00	25.35	70.2	0.142E+00	0.85	49.72	25.78	24.93
617.14	0.00	25.35	72.2	0.139E+00	0.85	50.90	25.78	24.93
634.61	0.00	25.35	74.2	0.135E+00	0.85	52.09	25.78	24.92
652.08	0.00	25.35	76.2	0.131E+00	0.86	53.28	25.78	24.92
669.55	0.00	25.35	78.3	0.128E+00	0.86	54.48	25.78	24.92
687.01	0.00	25.35	80.4	0.124E+00	0.87	55.68	25.79	24.92
704.48	0.00	25.35	82.5	0.121E+00	0.87	56.89	25.79	24.92
721.95	0.00	25.35	84.6	0.118E+00	0.87	58.10	25.79	24.92
739.42	0.00	25.35	86.7	0.115E+00	0.88	59.31	25.79	24.91
756.88	0.00	25.35	88.9	0.112E+00	0.88	60.53	25.79	24.91
774.35	0.00	25.35	91.1	0.110E+00	0.89	61.76	25.79	24.91
791.82	0.00	25.35	93.3	0.107E+00	0.89	62.98	25.80	24.91
809.29	0.00	25.35	95.6	0.105E+00	0.89	64.22	25.80	24.91
826.75	0.00	25.35	97.8	0.102E+00	0.90	65.45	25.80	24.90
844.22	0.00	25.35	100.1	0.999E-01	0.90	66.69	25.80	24.90
861.69	0.00	25.35	102.4	0.976E-01	0.90	67.94	25.80	24.90
879.16	0.00	25.35	104.8	0.954E-01	0.91	69.19	25.81	24.90
896.62	0.00	25.35	107.1	0.934E-01	0.91	70.44	25.81	24.90
914.09	0.00	25.35	109.5	0.913E-01	0.92	71.70	25.81	24.89
931.56	0.00	25.35	111.9	0.894E-01	0.92	72.96	25.81	24.89
949.03	0.00	25.35	114.3	0.875E-01	0.92	74.23	25.81	24.89
966.50	0.00	25.35	116.7	0.857E-01	0.93	75.50	25.82	24.89
983.96	0.00	25.35	119.2	0.839E-01	0.93	76.78	25.82	24.89
1001.43	0.00	25.35	121.7	0.822E-01	0.94	78.06	25.82	24.88
1018.90	0.00	25.35	124.2	0.805E-01	0.94	79.34	25.82	24.88
1036.37	0.00	25.35	126.7	0.789E-01	0.94	80.63	25.82	24.88
1053.83	0.00	25.35	129.2	0.774E-01	0.95	81.92	25.83	24.88
1071.30	0.00	25.35	131.8	0.759E-01	0.95	83.22	25.83	24.88
1088.77	0.00	25.35	134.4	0.744E-01	0.95	84.52	25.83	24.88

1106.24	0.00	25.35	137.0	0.730E-01	0.96	85.82	25.83	24.87
1123.70	0.00	25.35	139.6	0.716E-01	0.96	87.13	25.83	24.87
1141.17	0.00	25.35	142.2	0.703E-01	0.96	88.45	25.83	24.87
1158.64	0.00	25.35	144.9	0.690E-01	0.97	89.76	25.84	24.87
1176.11	0.00	25.35	147.6	0.678E-01	0.97	91.08	25.84	24.87
1193.57	0.00	25.35	150.3	0.665E-01	0.98	92.41	25.84	24.86
1211.04	0.00	25.35	153.0	0.654E-01	0.98	93.74	25.84	24.86
1228.51	0.00	25.35	155.7	0.642E-01	0.98	95.07	25.84	24.86
1245.98	0.00	25.35	158.5	0.631E-01	0.99	96.40	25.85	24.86
1263.44	0.00	25.35	161.2	0.620E-01	0.99	97.74	25.85	24.86
1280.91	0.00	25.35	164.0	0.610E-01	0.99	99.09	25.85	24.86
1298.38	0.00	25.35	166.8	0.599E-01	1.00	100.43	25.85	24.85
1315.85	0.00	25.35	169.7	0.589E-01	1.00	101.79	25.85	24.85
1333.31	0.00	25.35	172.5	0.580E-01	1.00	103.14	25.85	24.85
1350.78	0.00	25.35	175.4	0.570E-01	1.01	104.50	25.86	24.85
1368.25	0.00	25.35	178.3	0.561E-01	1.01	105.86	25.86	24.85
1385.72	0.00	25.35	181.2	0.552E-01	1.01	107.23	25.86	24.85
1403.18	0.00	25.35	184.1	0.543E-01	1.02	108.59	25.86	24.84
1420.65	0.00	25.35	187.0	0.535E-01	1.02	109.97	25.86	24.84
1438.12	0.00	25.35	190.0	0.526E-01	1.02	111.34	25.86	24.84
1455.59	0.00	25.35	192.9	0.518E-01	1.03	112.72	25.87	24.84
1473.05	0.00	25.35	195.9	0.510E-01	1.03	114.11	25.87	24.84
1490.52	0.00	25.35	198.9	0.503E-01	1.03	115.49	25.87	24.84
1507.99	0.00	25.35	201.9	0.495E-01	1.04	116.88	25.87	24.83
1525.46	0.00	25.35	205.0	0.488E-01	1.04	118.27	25.87	24.83
1542.92	0.00	25.35	208.0	0.481E-01	1.04	119.67	25.87	24.83
1560.39	0.00	25.35	211.1	0.474E-01	1.05	121.07	25.88	24.83
1577.86	0.00	25.35	214.2	0.467E-01	1.05	122.47	25.88	24.83
1595.33	0.00	25.35	217.3	0.460E-01	1.05	123.88	25.88	24.83
1612.79	0.00	25.35	220.4	0.454E-01	1.06	125.29	25.88	24.82
1630.26	0.00	25.35	223.6	0.447E-01	1.06	126.70	25.88	24.82
1647.73	0.00	25.35	226.7	0.441E-01	1.06	128.12	25.88	24.82
1665.20	0.00	25.35	229.9	0.435E-01	1.06	129.53	25.88	24.82
1682.66	0.00	25.35	233.1	0.429E-01	1.07	130.96	25.89	24.82
1700.13	0.00	25.35	236.3	0.423E-01	1.07	132.38	25.89	24.82
1717.60	0.00	25.35	239.5	0.418E-01	1.07	133.81	25.89	24.82
1735.07	0.00	25.35	242.8	0.412E-01	1.08	135.24	25.89	24.81
1752.53	0.00	25.35	246.0	0.406E-01	1.08	136.67	25.89	24.81
1770.00	0.00	25.35	249.3	0.401E-01	1.08	138.11	25.89	24.81

Cumulative travel time = 5902.0840 sec

Simulation limit based on maximum specified distance = 1770.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD142: BUOYANT TERMINAL LAYER SPREADING

CORMIX1: Single Port Discharges End of Prediction File

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