Smoke Testing 1

Smoke Testing

Prepared for:

City of Bay City

SHN Consulting Engineers & Geologists, Inc.

275 Market Avenue
Coos Bay, OR 97420-2219
541/266-9890

November 2015

611013.151

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CONSULTING ENGINEERS & GEOLOGISTS, INC.

275 Market Avenue• Coos Bay, Oregon 97420-2228 • Phone: 541/266-9890 • FAX: 541/266-9496•shninfo@shn-engr.com

Reference: 611013.151

November 16, 2015

Mr. Brian Bettis
City of Bay City
PO Box 3309
Bay City, OR 97107

Subject: Smoke Testing Results, City of Bay City

Dear Brian:

SHN Consulting Engineers & Geologists, Inc. (SHN) performed smoke testing of the collection system for the City of Bay City (City) on August 24th-25th, 2015. Enclosed are the findings and recommendations, including two bound copies for your records and one reproducible copy for distribution to private property owners.

Please feel free to contact me at 541-266-9890 if you have any questions.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.

Steven K. Donovan, PE
Principal Engineer

NJN:SKD:dkl

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275 Market Avenue• Coos Bay, Oregon 97420-2228 • Phone: 541/266-9890 • FAX: 541/266-9496•shninfo@shn-engr.com

Reference: 611013.151

Smoke Testing

Prepared for:

City of Bay City
PO Box 3309
Bay City, OR 97107

Prepared by:
Consulting Engineers & Geologists, Inc.
275 Market Avenue
Coos Bay, OR 97420-2228
541-266-9890

November 2015

QA/QC: SKD

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Table of Contents

List of Illustrations

Acronyms and Abbreviations

City	City of Bay City
EPA	Environmental Protection Agency
SHN	SHN Consulting Engineers & Geologists, Inc.

1.0 Smoke Testing Procedure

Smoke testing is an Environmental Protection Agency (EPA) recommended procedure to identify flaws in a sewage system. To smoke test sewers, a motorized fan is placed over selected manholes forcing air through the pipes. A smoke bomb is placed on the suction side of the fan which allows the fan to inject smoke into the pipes. A properly functioning sewage system would dissipate the smoke out of the venting systems on the roofs of occupant's homes. Smoke that escapes in any other areas are general indications of a potential inflow source or as health hazards for occupants of homes without proper ventilation.

Smoke testing for the City of Bay City (City) was conducted on August 24th-25th of 2015. Conditions were moderate and sunny on both days. A total of 33 smoke bomb locations were tested for proper coverage of the entire town.

2.0 Smoke Testing Results

As shown on Figure 1, a total of 17 major problems and numerous minor problems were encountered during the test event. The test results located six major areas of inflow from structural damage in sewer pipe, manhole, or combined storm/wastewater cross connections. These areas of damage are highlighted with red arrows on the basin maps and should be the City's highest priority repair issues.

The second priority problem areas consist of broken laterals and roof drains connected to the sewer. These areas are highlighted in orange and could be significantly leading to inflow. There are 11 orange arrows located in three main areas. These must be fixed promptly as they can be large area drains and a major source of inflow during rainfall events. Because these problems reside on private property, the corrections may require the City to take enforcement action against the residents.

Finally, the yellow arrows mark uncapped cleanouts and venting issues that are not leading to a large portion of inflow but may be a health and safety concern for occupants. Improper venting can lead to sewer gasses within the house where occupants could be exposed.

Reports are attached in Appendix A for each of these areas describing the problem, where it is located, and a recommendation to fix the problem. A map of the North and South basins are also included in the report to show locations that may be experiencing high flows due to the inflow problems indicated.

2.1 List of No-Smoke Houses

These houses did not have smoke exiting their roofs meaning one of three possibilities:

- They do not have their house vented or properly vented
- There is a sag in their lateral causing the smoke to be blocked.
- The sewage is being pumped uphill

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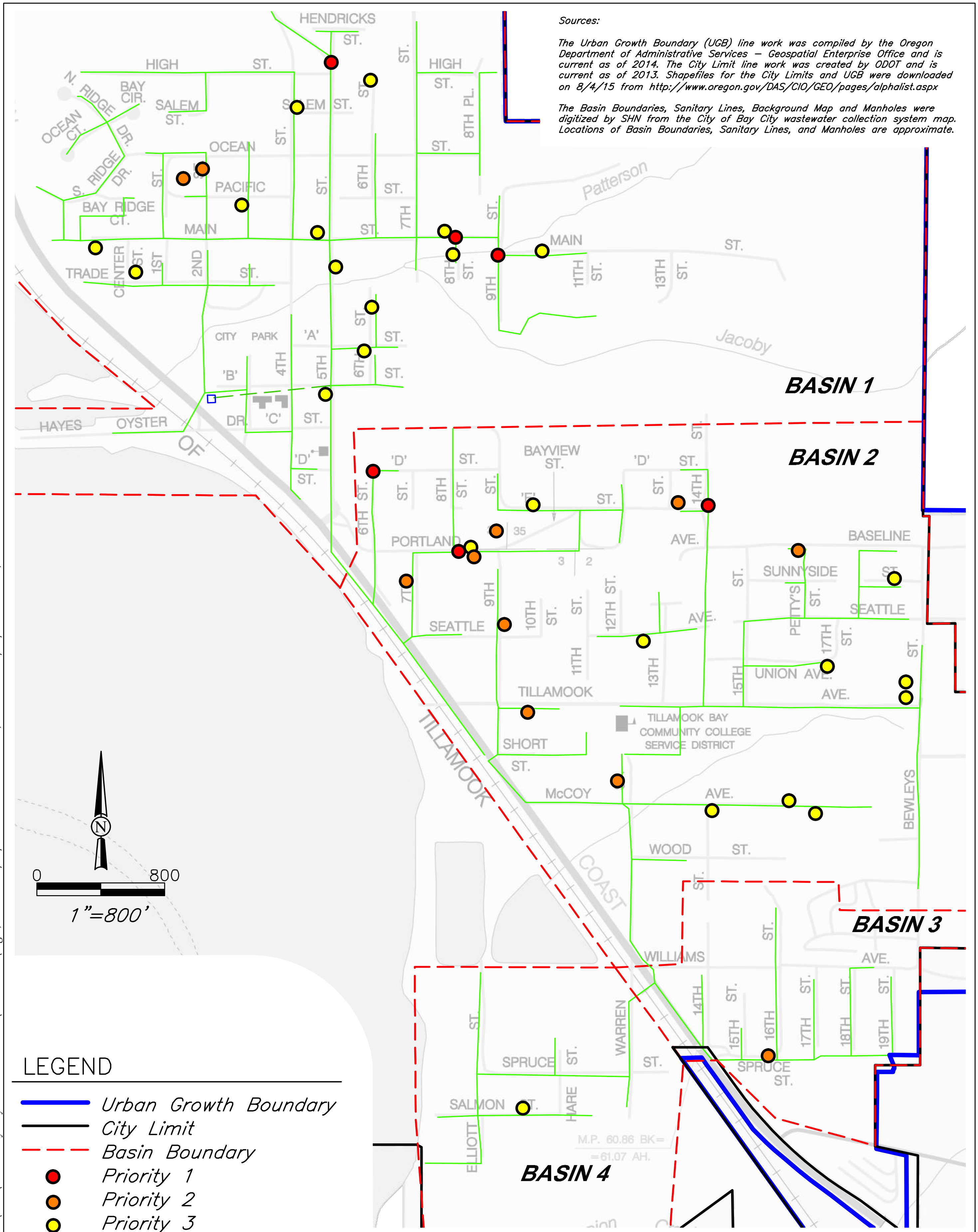

SHN Consulting Engineers & Geologists, Inc.

City of Bay City
Wastewater Facilities Plan
Bay City, Oregon

Collection System Evaluation
Smoke Testing Results
SHN 611013

November 2015 | 611013-SMOKE TEST RESULTS | Figure 1

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A fourth, less likely issue, could be that the lateral is blocked by roots or broken. If this were the case, the occupants would have a noticeably limited use of the plumbing. Caution must be taken when vactoring next to these properties due to the suction that the vactor creates forcing blowback into the plumbing of the house. This could cause sewage to splash back into the home and residents must be warned to close toilets until the vactor has passed.

Houses With No Sign of Smoke Exiting Roof Vents

- 9975 6th Ave.
- Duplex on 7th St.
- 9955 5th Ave.
- 10135 4th St.
- 10120 4th St.
- 5170 High St.
- 5035 S Ridge Dr.
- 9280 5th St.
- 9275 5th St.
- Pacific Oyster
- 12th St. Brown House
- 7990 18th St.
- 7965 19th St.
- 7850 19th St.
- 8595 Bewleys
- 8390 Bewleys
- 7860 Warren
- 4600 Salmon
- 4715 Salmon
- 5620 A St.
- 9670 Dewpoint
- 8970 15th St.
- 6880 Baseline
- 9435 5th St.
- 9075 12th
- 5195 Seattle
- 9930 3rd St.
- 7865 14th St.
- 7825 14th St.

In summary, there were 17 defects requiring correction to reduce extraneous flow. A document for each defect is attached to this report outlining where the defect is located and possible causes of the defect. A smoke testing result form is also attached that can be sent to property owners notifying them of the problem. Removal of inflow sources is the least expensive corrective measure to lower I/I in a sewer system. Not only is it economical, but removing these identified sources will have an exceptional impact on the reduction of I/I.

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A

Smoke Testing Results Forms

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SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-24-2015

Street Location: 5970 Main St.
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
In front of deck

Probable Cause
No cleanout cap

Recommendations
Replace broken cleanout cap.

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275 Market Avenue
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Phone: 541-266-9890

Photo No: 1

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date:

Street Location: 8th Street Manhole

Owner:

Observer: Cody L.

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

No smoke coming out of manhole on 8th Street. Put smoker on manhole at 8th Street and Main.

Probable Cause

Dip or collapse in main

Recommendations

TV line to see what is causing blockage

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Phone: 541-266-9890

Photo No: 2

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-24-2015

Street Location: 9660 8th Street
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
No cap on cleanout

Probable Cause
Missing cleanout cap

Recommendations
Replace missing cap on cleanout.

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Photo No: 3

Project No. 611013
Task: 151

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SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-24-2015

Street Location: 5680 Main Street

Owner:

Observer: Cody L.

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Cleanout in demolished house site.

Probable Cause

No cap on cleanout

Recommendations

Repair broken cleanout

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275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 4

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-24-2015

Street Location: Cleanout at end of 6th St.
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Cap is open on cleanout

Probable Cause
Open Cap

Recommendations
Close cap on cleanout.

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Photo No: 5

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date:
Time:

Street Location: West side of 5th
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Leak north of Ocean Street before Hendricks Street

Probable Cause
Unknown

Recommendations
Check area for cleanout and TV pipe.

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Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 6

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-25-2015

Street Location: 2nd Street east of 5365

Owner:

Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Smoke coming out of ground next to power pole guy wire.

Probable Cause

Possible roots from stump.

Recommendations

Inspect pipe

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Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 7

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-24-2015

Street Location: Empty lot on 1st Street
Owner:
Observer: Cody L.

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

To the east side of 1st Street
At 1st and Pacific.

Probable Cause

Too brushy to determine
Location of smoke source.
Possible cleanout

Recommendations

Inspect area for cleanout

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275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 8

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-24-2015

Street Location: 9590 6th Street

Owner:

Observer: Cody L.

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Black pipe on side of house

Probable Cause

Vent comes out on the side of the house.

Recommendations

Not a problem

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275 Market Avenue

Coos Bay, OR 97420

Phone: 541-266-9890

Photo No: 9

Project No. 611013

Task: 151

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SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-24-2015

Street Location: 9360 5th Street
Owner:
Observer: Cody L.

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Smoke through bathroom sink.

Probable Cause

No trap in sink

Recommendations

Install trap

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Phone: 541-266-9890

Photo No: 10

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-24-2015

Street Location: E St. between 9th & 11th

Owner:

Observer: Cody L.

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Hole in ground.

Probable Cause

Cleanout with no lid.

Recommendations

Replace lid on cleanout.

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Photo No: 11

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-25-2015

Street Location: Between 8th & 9th

Owner:

Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Manhole with AC patch. Trench patch has smoke Leaking out of cracks. Also, 2" PVC pipe with smoke between houses 6050 8th & 6075 8th.

Probable Cause
Cracks in manhole Casing.

Recommendations
Repair/replace manhole and or sealant

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Photo No: 12

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Street Location: Empty lot next to 6075 8th Street

Date: 8-25-2015

Owner:

Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Hole with smoke coming out of ground

Probable Cause
Broken lateral

Recommendations
Repair lateral

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Phone: 541-266-9890

Photo No: 13

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-25-2015

Street Location: Manhole at 7th & D St

Owner:

Observer: Cody L.

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Smoke leaking out of Manhole rim on the side.

Probable Cause

Sealant is missing

Recommendations

Seal manhole

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Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 14

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date:
Time:

Street Location: 8855 9th Street
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Coming up in yard. All of piping up to cleanout is smoking heavily (bricks, concrete, planter box, and retaining wall)

Probable Cause
Lateral is broken in multiple places

Recommendations
Replace lateral

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Phone: 541-266-9890

Photo No: 15

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-25-2015

Street Location: 6425 Seattle Street

Owner:

Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Probable Cause

Broken cleanout cap.

Recommendations

Replace cleanout cap.

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Photo No: 16

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 8870 Bewley Street
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
½ way down Sunny Side 10' off of the road. Leak could be cleanout

Probable Cause
Broken cleanout cap.

Recommendations
Replace cleanout cap.

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Photo No: 17

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6795 McCoy
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Probable Cause
No cleanout lid.

Recommendations
Cap cleanout.

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Photo No: 18

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6780 McCoy
Owner:
Observer: Cody L.

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Probable Cause
No cleanout lid.

Recommendations
Replace cleanout lid.

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275 Market Avenue
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Phone: 541-266-9890

Photo No: 19

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Street Location: 6190 Main Street
Date:
Owner:
Time:
Observer: Nate Nissen

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Square roof vent on northwest
Side leaking smoke.

Probable Cause
Not properly vented

Recommendations
Vent through roof

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Photo No: 27
Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-24-2015

Street Location: 9th and Main Street

Owner:

Observer: Nate Nissen

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Water coming into main
from stream culvert that runs
under 9th

Probable Cause

Crack in main

Recommendations

Repair main

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275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 28

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

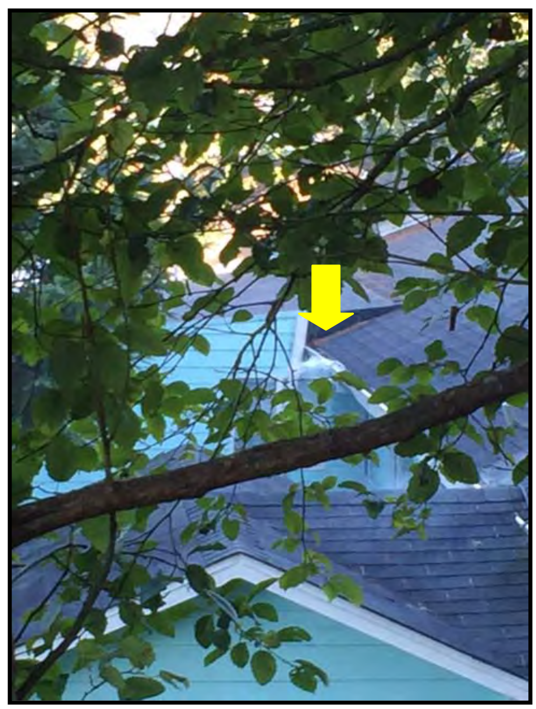
Street Location: 6085 Portland Street
Owner:
Observer: Nate Nissen

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Smoke coming out of gutter.

Probable Cause
Gutter hooked up to sewer

Recommendations
Separate gutter and sewer



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Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 35

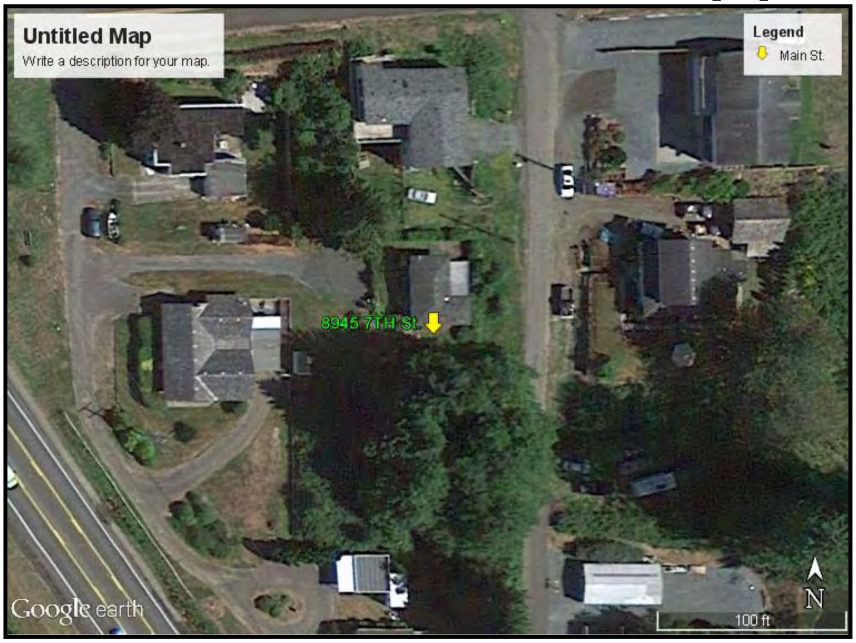
Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 8945 7th Street
Owner:
Observer: Nate Nissen

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)



Observed Smoke Return
Smoke out of lawn on south side of house.

Probable Cause
Broken lateral

Recommendations
Replace lateral

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Photo No: 36

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6525 E. Street
Owner:
Observer: Nate Nissen

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Ditch is leaking in front of house across from manhole.

Probable Cause

Broken lateral

Recommendations

Repair lateral

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275 Market Avenue
Coos Bay, OR 97420
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Photo No: 37

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6765 Baseline
Owner:
Observer: Nate Nissen

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Smoke exiting out of water meter box.

Probable Cause
Lateral leaking by water box

Recommendations
Inspect water box and lateral repair if necessary

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275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 38

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-25-2015

Street Location: 8680 Bewley

Owner:

Observer: Nate Nissen

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Probable Cause

Cleanout not capped.

Recommendations

Replace cap on cleanout.

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Photo No: 39

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6625 McCoy
Owner:
Observer: Nate Nissen

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Smoke coming out of shop roofline.

Probable Cause
Vent exiting roof or not properly vented

Recommendations
Vent through roof

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Photo No: 40

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6395 Short Street
Owner:
Observer: Nate Nissen

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Smoke exiting vent on south-east side of house. Also exiting gutter line on the south side of the house

Probable Cause
Gutters draining into cleanout

Recommendations
Separate gutter and cleanout

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Photo No: 41

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-24-2015

Street Location: 9635 5th Street

Owner:

Observer: Walter White

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Vent pipe does not go above eave.

Probable Cause

Vent pipe does not go above eave.

Recommendations

Vent around eave.

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Photo No: 52

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-24-2015

Street Location: 10035 4th Street

Owner:

Observer: Walter White

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

Smoke coming out of crawlspace under house

Probable Cause

Not properly vented/ Possible broken lateral

Recommendations

Inspect lateral and vent

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Phone: 541-266-9890

Photo No: 53

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-24-2015

Street Location: 5415-5515 Pacific
Owner:
Observer: Walter White

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Smoke from 4" PVC
in empty lot

Probable Cause

Recommendations
Cap cleanout

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Photo No: 56

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-24-2015

Street Location: 9635 Trade
Owner:
Observer: Walter White

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
No cleanout cover south side of house.

Probable Cause

Recommendations
Cap cleanout

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Phone: 541-266-9890

Photo No: 57
Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6195 Tillamook
Owner:
Observer: Walter White

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Broken cleanout cover on the West side. Smoke from under House and cracks in sidewalk NE corner of house.

Probable Cause
Broken lateral

Recommendations
Repair lateral

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Photo No: 61

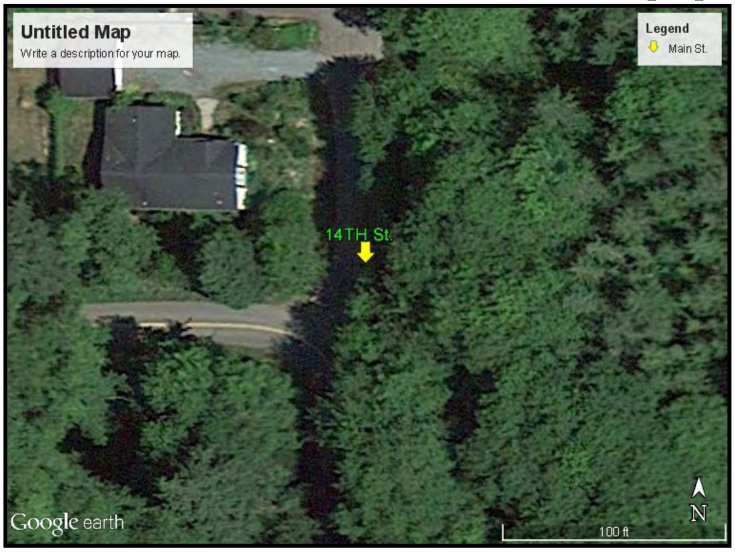
Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: SE Corner E & 14th St.
Owner:
Observer: Walter White

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)



Observed Smoke Return
Manhole leaking out of side ring.

Probable Cause
No sealant around ring.

Recommendations
Manhole needs to be sealed.

SHN
Consulting Engineers & Geologists, Inc.
275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 64

Project No. 611013
Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-25-2015

Street Location: 6825 Union

Owner:

Observer: Walter White

LOCATION OF RETURN

(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

No cleanout cover on the
North side – old home site
East of existing house.

Probable Cause

Recommendations

Cap cleanout

Consulting Engineers & Geologists, Inc.
275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 65

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**

Date: 8-25-2015

Street Location: 8630 Bewely

Owner:

Observer: Walter White

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return

No cleanout cover on the west side of house.

Probable Cause

Recommendations

Cap cleanout

Consulting Engineers & Geologists, Inc.
275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 66

Project No. 611013

Task: 151

SMOKE TESTING RESULTS

Client: **Bay City**
Date: 8-25-2015

Street Location: 6760 Spruce St.
Owner:
Observer: Brian Bettis

LOCATION OF RETURN
(location of MH, street, house no., areas of smoke escape, photo, etc.)

Observed Smoke Return
Smoke exiting gutter

Probable Cause
Gutter hooked to cleanout

Recommendations
Separate gutter from cleanout

Consulting Engineers & Geologists, Inc.
275 Market Avenue
Coos Bay, OR 97420
Phone: 541-266-9890

Photo No: 67

Project No. 611013
Task: 151

B

Sample Notification Form Letter

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City of Bay City
P.O. Box 3309
Bay City, OR 97107
(503)-377-2179

Date_______________________

Owner____

Address____

City, State____

Subject Property____

Dear Property Owner:

The Wastewater Treatment Plant experiences extremely high flows during the winter months. This can, in large part, be attributed to "holes" in the sewage collection and piping system including laterals to properties served by the system. In an effort to locate these holes and reduce the high seasonal inflows, the City of Bay City recently undertook a smoke testing project in your neighborhood. The project included pumping smoke into manholes and observing where the smoke escapes from the system. If smoke is observed leaving the sewer system through a "hole," surface and/or groundwater is capable of entering the system through the same "hole." The potential for one of these infiltration "holes" was discovered on your property and requires your attention to correct the problem.

Some of the problems discovered are directly related to the infiltration waters that overload the sewer system during the winter months. Other problems are related to plumbing deficiencies outside the home, which should be corrected.

A side benefit of the smoke testing project was that, in some cases, smoke was observed not venting from homes properly. While this could be a result of a sag or unused element in the household plumbing, it could also represent a potential health risk. If a household sewer system is not functioning properly, harmful sewer gases may find their way into the house. This type of plumbing deficiency should be corrected immediately.

The following sheet includes a checklist of potential problems discovered during the smoke testing project. If a problem is marked with an X, it requires the action described immediately after the marked description.

If, for some reason, you are unable to correct the problem in the time suggested, please contact the City. We are interested in correcting these problems and will help in any way we can to do that.

1._____MAY NOT HAVE A PERMITTED SEWER CONNECTION ON RECORD.
Please contact the City to discuss this matter.

2._____RVS OR ADDITIONAL HOOK-UP INTO SEWER SYSTEM.
Notification is hereby given to remove.

3._____PIPING OR LATERAL PIPE PROBLEMS ON SITE.
Have plumbing inspection by qualified person. Report result to City within four (4) weeks of this notice.

4._____RAIN GUTTERS CONNECTED TO SEWER SYSTEM.
Immediate removal of roof drains from sewer system required. City personnel will be on site within two (2) weeks of the date of this notice to inspect the outfall of the roof drain system to confirm disconnection.

5._____AREA DRAIN OR OTHER SURFACE DRAINAGE SYSTEM TIED INTO SEWER SYSTEM.
Immediate removal of area drains from sewer system required. City personnel will be on site within two (2) weeks of the date of this notice to inspect the area drain to confirm disconnection.

6._____UNCAPPED OR OPEN SEWER LATERAL CLEANOUT.
Immediate cap of lateral cleanout required with watertight cap. City personnel will be on site within four (4) weeks of the date of this notice to inspect the cleanout to confirm capping.

7._____SMOKE INSIDE HOUSE OR BUILDING.
Have inspection and repairs performed by qualified person. Sewer gas passing into the home can pose a serious health risk.

8._____OTHER PROBLEM.
____
____
____

Please note that any of these problems are of a serious nature. Any items marked with an X require your immediate attention and cooperation. Please call the City at 503-377-2179 if you have any questions. By reducing these high seasonal inflows to the sewer system, we can help reduce unnecessary sewer treatment costs, maintain the highest levels of sewer system performance, and keep our sewer rates as low as possible.

Thank you for your help in this matter.

Sincerely,

City of Bay City

Cleaning – TV Results 2

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City of Bay City
TV/Cleanning Results
November 2015

Manhole #	Feet	Pipe Size	Description	Comments	Total feet Televised
02-01		***15"***	***Reinforced Concrete Pipe***	***Elliot Street***	
@	0.0		Access Point - Manhole	Upstream MH 02	0.0
@	362.5		Access Point - Manhole	Downstream MH 01	362.5
03-02		***15"***	***Reinforced Concrete Pipe***	***Elliot Street***	
@	0.0		Access Point - Manhole	Upstream MH 03	0.0
@	37.4	4"	Tap-Factory Made	Service Left @ 9:00	37.4
@	293.7		Access Point - Manhole	Downstream MH 02	293.7
04-03		***15"***	***Reinforced Concrete Pipe***	***Spruce Street***	
@	0.0		Access Point - Manhole	Upstream MH	0.0
@	54.1	4"	Tap-Factory Made	Service Right @ 2:00	54.1
@	58.1	4"	Tap-Factory Made	Service Left @ 9:00	58.1
@	115.1	4"	Tap-Break-in/Hammer	Service Left @ 10:00	115.5
@	162.8	4"	Tap-Factory Made	Service Left @ 9:00	162.8
@	186.7	4"	Tap-Factory Made	Service Right @ 3:00	186.7
@	238.2	4"	Tap-Factory Made	Service Left @ 9:00	238.2
@	317.8	4"	Tap-Factory Made	Service Left @ 9:00	317.8
@	320.0	4"	Tap-Factory Made	Service Left @ 9:00	320.0
@	464.6		Access Point - Manhole	Downstream MH 03	464.6
05-04		***15"***	***Reinforced Concrete Pipe***	***Spruce Street***	
@	0.0		Access Point - Manhole	Upstream MH	0.0
@	85.5	4"	Tap-Factory Made	Service Right @ 3:00	85.5
@	173.7	4"	Tap-Factory Made	Service Left @ 9:00	173.7
@	192.1	4"	Tap-Factory Made	Service Right @ 3:00	192.1
@	245.9	4"	Tap-Factory Made	Service Right @ 3:00	245.9
@	253.8	4"	Tap-Factory Made	Service Left @ 9:00	253.8
@	291.8	4"	Tap-Factory Made	Service Right @ 3:00	291.8
@	316.1	4"	Tap-Factory Made	Service Right @ 3:00	316.1
@	490.8		Access Point - Manhole	Downstream MH 04	490.8
06-05		***15"***	***Reinforced Concrete Pipe***	***Warren Street***	
@	0.0		Access Point - Manhole	Upstream MH 06	0.0
@	28.3	4"	Tap-Factory Made	Service Right @ 2:00	28.3
@	158.3	4"	Tap-Break-in/Hammer	Service Right @ 1:00	158.3
@	168.4	4"	Tap-Factory Made	Service Left @ 10:00	168.4
@	189.2	4"	Tap-Factory Made	Service Left @ 9:00	189.2
@	211.3	4"	Tap-Factory Made	Service Left @ 9:00	211.3
@	283.8	4"	Tap-Factory Made	Service Right @ 3:00	283.8
@	338.8	4"	Tap-Factory Made	Service Left @ 9:00	338.8
@	503.0		Access Point - Manhole	Downstream MH 05	503.0
07-06		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 07	0.0
@	170.3		Access Point - Manhole	Downstream MH 06	170.3

City of Bay City
TV/Cleanning Results
November 2015

Manhole #	Feet	Pipe Size	Description	Comments	Total feet Televised
07A-07		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 07A	0.0
@	72.3		Access Point - Manhole	Downstream MH 07	72.3
08-07		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 08	0.0
@	31.6		Access Point - Manhole	Downstream MH 07	31.6
08A-08		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 08A	0.0
@	34.9		Access Point - Manhole	Downstream MH 08	34.9
09-08A		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 09	0.0
@	4.5		Access Point - Manhole	Downstream MH 08A	4.5
10-09		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 10	0.0
@	253.2	4"	Tap-Factory Made	Service Left @ 9:00	253.2
@	415.5	4"	Tap-Factory Made	Service Left @ 10:00	415.5
	510.8		Access Point - Manhole	Downstream MH 09	510.8
11-10		***15"***	***Reinforced Concrete Pipe***	***Warren Street***	
@	0.0		Access Point - Manhole	Upstream MH 11	0.0
@	76.1	4"	Tap-Factory Made	Service Right @ 3:00	76.1
@	130.5	4"	Tap-Factory Made	Service Left @ 9:00	130.5
@	331.2		Access Point - Manhole	Downstream MH 10	331.2
12-11		***15"***	***Reinforced Concrete Pipe***	***Warren Street***	
@	46.5		Access Point - Manhole	Downstream MH 12	46.5
@	0.0		Access Point - Manhole	Upstream MH 11	0.0
12A-12		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 12A	0.0
@	45.6	4"	Tap-Factory Made	Service Left @ 9:00	45.6
@	160.3	4"	Tap-Factory Made	Service Left @ 9:00	160.3
@	286.1		Access Point - Manhole	Downstream MH 12	286.1
13A-12A		***15"***	***Reinforced Concrete Pipe***	***McCoy Ave***	
@	0.0		Access Point - Manhole	Upstream MH 13A	0.0
@	41.8	4"	Tap-Factory Made	Service Left @ 9:00	41.8
@	102.5	4"	Tap-Factory Made	Service Left @ 9:00	102.5
@	168.6	4"	Tap-Factory Made	Service Right @ 3:00	168.6
@	216.9	4"	Tap-Factory Made	Service Left @ 9:00	216.9
@	223.0	4"	Tap-Factory Made	Service Right @ 3:00	223.0
@	305.4		Access Point - Manhole	Downstream MH 12A	305.4
13A-13		***15"***	***Pre-stressed Concrete Cylinder Pipe***	***US Highway 101***	
@	0.0		Access Point - Manhole	Upstream MH 13A	0.0
@	217.8	4"	Tap-Factory Made	Service Left @ 10:00	217.8
@	289.7		Access Point - Manhole	Downstream MH 13	289.7

City of Bay City
TV/Cleanning Results
November 2015

Manhole #	Feet	Pipe Size	Description	Comments	Total feet Televised
14B-13		***15"***	***Reinforced Concrete Pipe***	***US Highway 101***	
@	0.0		Access Point - Manhole	Upstream MH 14B	0.0
@	345.8		Access Point - Manhole	Downstream MH 13	345.8
14C-13		***15"***	***Reinforced Concrete Pipe***	***US Highway 101***	
@	0.0		Access Point - Manhole	Upstream MH 14C	0.0
@	66.1		Access Point - Manhole	Downstream MH 13	66.1
14-14B		***15"***	***Reinforced Concrete Pipe***	***US Highway 101***	
@	0.0		Access Point - Manhole	Upstream MH 14	0.0
@	95.6		Access Point - Manhole	Downstream MH 14B	95.6
15A-15		***15"***	***Reinforced Concrete Pipe***	***US Highway 101***	
@	0.0		Access Point - Manhole	Upstream MH 15A	0.0
@	438.0	4"	Tap-Factory Made	Service Left @ 10:00	438.0
@	447.6		Access Point - Manhole	Downstream MH 15	447.6
16-15		***15"***	***Reinforced Concrete Pipe***	***US Highway 101***	
@	0.0		Access Point - Manhole	Upstream MH 16	0.0
@	168.3		Infiltration-Runner	at 6:00	168.3
@	231.1	4"	Tap-Factory Made	Left @ 10:00	231.1
@	395.4		Access Point - Manhole	Downstream MH 15	395.4
17-16		***15"***	***Reinforced Concrete Pipe***	***US Highway 101***	
@	0.0		Access Point - Manhole	Upstream MH 17	0.0
@	435.2		Access Point - Manhole	Downstream MH 16	435.2
18-17		***15"***	***Reinforced Concrete Pipe***	***5th Street***	
@	0.0		Access Point - Manhole	Upstream MH 18	0.0
@	72.6		Infiltration-Runner	at 10:00	72.6
@	94.3		Access Point - Manhole	Downstream MH 17	94.3
21-20		***15"***	***Reinforced Concrete Pipe***	***5th Street***	
@	0.0		Access Point - Manhole	Upstream MH 21	0.0
@	99.8		Tap-Factory Made	Service Left @ 9:00	99.8
@	104.2		Tap-Factory Made	Service Right @ 3:00	104.2
@	162.0		Tap-Factory Made	Service Right @ 3:00	162.0
@	191.0		Tap-Factory Made	Service Left @ 9:00	191.0
@	326.7		Tap-Factory Made	Service Right @ 3:00	326.7
@	347.0		Tap-Factory Made	Service Right @ 3:00	347.0
@	360.5		Tap-Factory Made	Service Left @ 9:00	360.5
@	389.0		Tap-Factory Made	Service Left @ 3:00	389.0
@	447.1		Tap-Factory Made	Service Left @ 9:00	447.1
@	488.0			Downstream MH 20	488.0
20-19		***12"***	***Reinforced Concrete Pipe***	***5th Street***	
@	0.0		Access Point - Manhole	Upstream MH 20*	0.0
@	300.0		Access Point - Manhole	Downstream MH 19*	300.0

* Upstream MH 20 = infront of post office. Downstream HM 19 = bottom of 5th Street

City of Bay City
TV/Cleaning Results
April 2016

Manhole #	Feet	Pipe Size	Description	Comments	Total feet Televised
33-32A		***10"***	***Reinforced Concrete Pipe***	***14th Street***	
	0.0		Access Point-Manhole	Upstream MH 33	0.0
@	32.2	4"	Tap-Factory Made-Capped	Service Right @ 2:00	32.2
@	79.5	4"	Tap-Factory Made-Capped	Service Right @2:00	79.5
@	106.7		Access Point-Manhole	Downstream MH 32A	106.7
40-40A		***8"***	***Reinforced Concrete Pipe***	***Spruce Street***	
	0.0		Access Point-Manhole	Upstream MH 40	0.0
@	74.1	6"	Tap-Factory Made	Service Left @ 9:00	74.1
@	109.3	6"	Tap-Factory Made	Service Right @ 3:00	109.3
@	175.3		Infiltration-Stain	From 10:00 to 7:00	175.3
@	204.7		Access Point-Manhole	Downstream MH 40A	204.7
40A-33		***8"***	***Reinforced Concrete Pipe***	***Spruce Street***	
	0.0		Access Point-Manhole	Upstream MH 40A	0.0
@	52.1		Infiltration - Dripper	at 3:00	52.1
@	92.3	4"	Tap-Factory Made	Service Left @ 9:00	92.3
@	151.9	6"	Tap-Factory Made	Service Right @ 3:00	151.9
@	156.6	6"	Tap, Break-in/Hammer	Service Right @ 3:00 Plugged	156.6
@	199.0		Infiltration - Dripper	at 2:00 Deposits Attached: Encrustation 5% @2:00	199.0
@	220.5		Infiltration - Dripper	at 3:00	220.5
@	220.6		Access Point-Manhole	Downstream MH 33 outside Drop	220.6
41-40		***8"***	***Reinforced Concrete Pipe***	***Spruce Street***	
	0.0		Access Point-Manhole	Upstream MH 41	0.0
@	31.8	6"	Tap, Break-in/Hammer	Service Right @ 3:00	31.8
@	34.4	4"	Tap, Break-in/Hammer	Service Left @ 9:00	34.4
@	66.9	6"	Tap, Factory Made	Service Right @ 2:00	66.9
@	95.4	6"	Tap, Break-in/Hammer	Service Right @ 9:00	95.4
@	98.4	6"	Tap-Factory Made	Service Left @ 9:00	98.4
@	119.3	6"	Tap-Factory Made	Service Right @ 3:00	119.3
@	123.9	6"	Tap, Break-in/Hammer	Service Left @ 9:00	123.9
@	151.3	6"	Tap, Break-in/Hammer	Service Left @ 9:00	151.3
@	220.1	6"	Tap-Factory Made	Service Left @ 9:00	220.1
@	229.6		Access Point-Manhole	Downstream MH 40	229.6
41A-41		***8"***	***Reinforced Concrete Pipe***	***17th Street***	
	45.1		Access Point-Manhole	Upstream MH 41A	45.1
@	0.0		Access Point-Manhole	Downstream MH 41	0.0
42-41		***8"***	***Reinforced Concrete Pipe***	***18th Street***	
	0.0		Access Point-Manhole	Upstream MH 42	0.0
@	41.7	4"	Tap, Break-in/Hammer	at 10:00	41.7
@	43.0	4"	Tap-Factory Made	Service Left @ 10:00	43.0
@	73.0	6"	Tap, Break-in/Hammer	Service Right @ 9:00	73.0
@	86.1	4"	Tap-Factory Made	Service Right @ 3:00	86.1
@	158.6	6"	Tap-Factory Made Infiltration- Gusher	Service Right @ 2:00 Infiltration in the Lateral @6:00 Gusher	158.6
@	185.0		Access Point-Manhole	Downstream MH 41	185.0

City of Bay City
TV/Cleaning Results
April 2016

43-42		***8"***	***Reinforced Concrete Pipe***	***19th Street***	
@	261.6		Access Point-Manhole	Upstream MH 43	261.2
@	182.2	4"	Tap, Break-in/Hammer	Service Right @ 2:00	182.2
@	158.0	6"	Tap-Factory Made	Service Left @ 10:00	158.0
@	124.3	4"	Tap, Break-in/Hammer	Service Right @ 2:00 Pipe Broken @ 4:00	124.3
@	99.2	6"	Tap-Factory Made	at 10:00	99.2
@	44.0	4"	Tap, Break-in/Hammer	at 2:00	44.0
@	36.0		Infiltration - Stain	at 2:00	36.0
@	20.9		Infiltration - Stain	at 3:00	20.9
@	19.4		Infiltration - Stain	at 2:00	19.4
@	0.4	2"	Tap, Break-in/Hammer	Service Right @ 2:00 pipe Intruding 2"	0.4
@	0.0		Access Point-Manhole	Downstream MH 42	0.0
52-79		***8"***	***Reinforced Concrete Pipe***	***Tillamook Ave***	
@	0.0		Access Point-Manhole	Upstream MH 52	0.0
@	92.7	6"	Tap-Factory Made	Service Left @ 9:00	92.7
@	225.1		Access Point-Manhole	Downstream MH 79	225.1
53-52		***8"***	***Reinforced Concrete Pipe***	***15th Street***	
	0.0		Access Point-Manhole	Upstream MH 53	0.0
@	82.4	8"	Tap-Factory Made	at 9:00	82.4
@	166.1	8"	Tap-Factory Made	Service Right @ 3:00	166.1
@	284.9		Access Point-Manhole	Downstream MH 52	284.9
54-53		***8"***	***Reinforced Concrete Pipe***	***15th Street***	
	0.0		Access Point-Manhole	Upstream MH54	0.0
@	8.9	6"	Tap-Factory Made	Service Right @ 3:00	8.9
@	38.7	4"	Tap, Break-in/Hammer	Service Right @ 2:00 Capped	38.7
@	134.4	6"	Tap-Factory Made	Service Right @ 3:00 Capped	138.4
@	184.3		Access Point-Manhole	Downstream MH 53	184.3
55A-54		***8"***	***Reinforced Concrete Pipe***	***15th Street***	
	0.0		Access Point-Manhole	Upstream MH 55A	0.0
@	84.7		Access Point-Manhole	Downstream MH 54	84.7
55-54		***8"***	***Reinforced Concrete Pipe***	***Seattle Ave***	
	0.0		Access Point-Manhole	Upstream MH 55	0.0
@	6.1	6"	Tap-Factory Made	Service Left @ 9:00	6.1
@	16.4	6"	Tap-Factory Made	Service Right @ 3:00	16.4
@	58.4	6"	Tap-Factory Made	Service Left @ 9:00	58.4
@	166.5	4"	Tap, Break-in/Hammer	Service Right @ 1:00	166.5
@	290.5		Access Point-Manhole	Downstream MH 54	290.5
56-55		***8"***	***Reinforced Concrete Pipe***	***Seattle Ave***	
	0.0		Access Point-Manhole	Upstream MH 56	0.0
@	3.2		Water Mark 40% (diameter)		3.2
@	15.4		Infiltration - Stain	at 10:00	15.4
@	100.5		Access Point-Manhole	Downstream MH 55	100.5
57-56		***8"***	***Reinforced Concrete Pipe***	***Seattle Ave***	
	0.0		Access Point-Manhole	Upstream MH 57	0.0
@	72.7		Access Point-Manhole	Downstream MH 56	72.7

City of Bay City
TV/Cleaning Results
April 2016

58-57		***8"***	***Reinforced Concrete Pipe***	***Seattle Ave***	
	0.0		Access Point-Manhole	Upstream MH 58	0.0
@	44.7		Infiltration - Stain	at 2:00	44.7
@	113.5	6"	Tap, Break-in/Hammer	Service Right @ 3:00	113.5
@	236.8	6"	Tap, Break-in/Hammer	Service Right @ 3:00	236.8
@	270.6		Access Point-Manhole	Downstream MH 57	270.6
59-58		***8"***	***Reinforced Concrete Pipe***	***Seattle Ave***	
	0.0		Access Point-Manhole	Upstream MH 59	0.0
@	92.3	6"	Tap-Factory Made	Service Right @ 3:00 Infiltration Stain in Lateral on right side	92.3
@	96.7		Infiltration - Stain	from 6:00 to 11:00	96.7
@	130.8	6"	Tap-Factory Made	Service Left @ 9:00	130.8
@	156.8		Access Point-Manhole	Downstream MH 58	156.8
64-56		***8"***	***Reinforced Concrete Pipe***	***Sunnyside Street***	
	0.0		Access Point-Manhole	Upstream MH 64	0.0
@	67.0	4"	Tap-Factory Made	Service Left @ 10:00	67.0
@	105.4	6"	Tap-Factory Made	Service Right @ 2:00	105.4
@	163.5		Infiltration - Stain	at 9:00	163.5
@	168.1	4"	Tap-Factory Made	Service Right @ 3:00	168.1
@	218.4		Infiltration - Runner	at 10:00	218.4
@	220.1		Access Point-Manhole	Downstream MH 56	220.1
65-64		***8"***	***Reinforced Concrete Pipe***	***Sunnyside Street***	
	127.2		Access Point-Manhole	Upstream MH 65	127.2
@	108.7	4"	Tap-Factory Made	Service Left @ 9:00	108.7
@	0.0		Access Point-Manhole	Downstream MH 64	0.0
66-65		***8"***	***Reinforced Concrete Pipe***	***Portland Ave***	
	0.0		Access Point-Manhole	Upstream MH 66	0.0
@	74.6	6"	Tap, Break-in/Hammer	Service Right @ 2:00	74.6
@	86.0		Access Point-Manhole	Downstream MH 65	86.0
153-145		***8"***	***Reinforced Concrete Pipe***	***7th Street***	
	0.0		Access Point-Manhole	Upstream MH 153	0.0
@	6.2		Deposits Settled: Compactated from 5:00 to 7:00		6.2
@	45.5	6"	Tap-Factory Made	Service Right @ 3:00	45.5
@	49.0	6"	Tap-Factory Made	Service Left @ 9:00	49.0
@	115.5	6"	Tap-Factory Made	Service Left @ 9:00	115.5
@	213.2	6"	Tap-Factory Made	Service Right @ 3:00	213.2
@	221.1		Water Level: Sag	10% (diameter)	221.1
@	312.4		Surface: Aggregate Projecting from 7:00 to 4:00		312.4
@	328.1	4"	Tap, Break-in/Hammer	Service Left @ 10:00 Pipe Intruding 2"	328.1
@	405.4	4"	Tap-Factory Made	Service Left @ 9:00	405.4
@	412.3	6"	Tap-Factory Made	Service Right @ 3:00	412.3
@	478.9		Point Repair - Pipe Replaced	Pipe Replaced	478.9
@	508.7		Infiltration - Runner	at 10:00	508.7
@	510.6		Access Point-Manhole	Downstream MH 145 Outside drop	510.6

City of Bay City
TV/Cleaning Results
April 2016

154-153		***8"***	***Reinforced Concrete Pipe***	***7th Street***	
	0.0		Access Point-Manhole	Upstream MH 154	0.0
@	76.6	6"	Tap-Factory Made	Service Right @ 3:00	76.6
@	85.1		Point Repair - Pipe Replaced	Pipe Replaced Settled to cause offset joint	85.1
@	87.1	4"	Tap-Factory Made	Service Right @ 9:00	87.1
@	118.7	6"	Tap-Factory Made	Service Left @ 9:00-Capped	118.7
@	160.7	8"	Tap-Factory Made	Service Right @ 3:00	160.7
@	185.3	6"	Tap-Factory Made	Service Left @ 9:00-Capped	185.3
@	188.3		Surface: Missing Aggregate at 6:00		188.3
@	201.1		Point Repair - Pipe Replaced	Pipe Replaced Settled to cause offset joint	201.1
@	202.7	4"	Tap-Factory Made	at 9:00	202.7
@	204.5		Infiltration - Dripper	at 2:00	204.5
@	208.8		Hole in pipe: soil visible	at 12:00	208.8
@	220.1	6"	Tap-Factory Made	Service Left @ 9:00-Capped	220.1
@	325.1	6"	Tap-Factory Made	at 9:00	325.1
@	328.5	4"	Tap-Factory Made	at 3:00	328.5
@	330.3		Point Repair - Pipe Replaced	Pipe repair settled	330.3
@	332.0	4"	Tap-Factory Made	Service Left @ 9:00. Heavy infiltration in the Lateral	332.0
@	405.6	6"	Tap-Factory Made	Service Left @ 9:00-Capped	405.6
@	417.8		Point Repair - Pipe Replaced	Pipe Replaced Settled to cause offset joint	417.8
@	419.9	4"	Tap-Factory Made	Service Left @ 10:00	419.9
@	423.4	6"	Tap, Break-in/Hammer	Service Left @ 9:00	423.4
@	447.2	4"	Tap-Factory Made	Service Right @ 3:00	447.2
@	501.4		Point Repair - Localized Lining	Local Lining	501.4
@	505.1		Access Point-Manhole	Downstream MH 153	505.1
155-154		***8"***	***Reinforced Concrete Pipe***	***7th Street***	
	0.0		Access Point-Manhole	Upstream MH 155	0.0
@	80.3	6"	Tap, Break-in/Hammer	Service Right @ 3:00	80.3
@	119.0		Roots, Tap: Barrel Crack Circumferential	at 8:00 from 7-4	119.0
@	119.7	6"	Tap, Break-in/Hammer	Service Right @ 3:00	119.7
@	120.6		Roots, Fine: Barrel	From 8:00-4:00	120.6
@	140.1	4"	Tap, Break-in/Hammer	Service Right @ 10:00	140.1
@	216.7	8"	Tap-Factory Made	Service Right @ 3:00	216.7
@	266.8	6"	Tap, Break-in/Hammer	Service Right @ 10:00	266.8
@	313.3		Crack Circumferential Infiltration - Stain	From 7:00-11:00 From 7:00-11:00	313.3
@	315.1		Access Point-Manhole	Downstream MH 154	315.1

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Mixing Zone Report - Draft

3

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Mixing Zone Report

City of Bay City
PO Box 3309
Bay City, OR 97107

Prepared for:

City of Bay City

Engineers & Geologists

September 2018

611013.151

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Reference: 611013.151

Mixing Zone Report

Prepared for:

City of Bay City

PO Box 3309

Bay City, OR 97107

Prepared by:

SHN Engineers & Geologists

275 Mark Avenue

Coos Bay, OR 97420

541-266-9890

August 2018

QA/QC:SKD___

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Table of Contents

Appendices

List of Illustrations

Abbreviations and Acronyms

m/s	
mg/L	
pH	
ppt	parts per thousand
ADWF	Average Dry Weather Flow
AOU	Apparent Oxygen Utilization
AWWF	Average Wet Weather Flow
BOD	Biological Oxygen Demand
CCC	Criteria Chronic Concentration
CMC	Criteria Maximum Concentration
DEQ	Oregon Department of Environmental Quality
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FONSI	Finding of No Significant Impact
NPDES	National Pollutant Discharge Elimination System
SBR	Sequential Batch Reactor
SHN	SHN Engineers & Geologists
TDZ	Toxic Dilution Zone
US EPA	United States Environmental Protection Agency
ZID	Zone of Immediate Dilution

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1.0 Introduction

1.1 Purpose

The City of Bay City is required by NPDES permit 101025 to conduct a periodic review of its outfall and conduct a mixing zone analysis based on current information. During the course of this work, it was determined that the City's existing outfall was failing and becoming inundated by bay sediments. A new outfall and mixing zone was determined necessary. The study was modified to evaluate new outfall locations and to evaluate and optimize an outfall design configuration for the City of Bay City's Wastewater Treatment Plant effluent disposal system. Based on the study results, an outfall design and mixing zone located lower in the estuary system are recommended to provide the City with a long-term effluent disposal system that is both environmentally and financially acceptable. The proposed project site, shown in Figure 1 is located the North Coast Basin of Western Oregon west of the City of Bay City in Tillamook Bay.

1.2 Objective

This study applied research on ambient conditions and a computer model to simulate discharge scenarios and predict how much dilution will occur in an area defined as the "mixing zone". The results of the study are intended to demonstrate that, outside of the mixing zone, the recommended outfall design will meet all regulatory criteria under all foreseeable ambient conditions and foreseeable future uses.

Predictions of dilution consider two critical regulatory areas within the mixing zone:

The zone of initial dilution where acute criteria (Criteria Maximum Concentration) must be achieved and

The fringe of the mixing zone where all water quality criteria including chronic criteria (Criteria Continuous Concentration) must be achieved.

Criteria, which define adequate mixing in these two locations and an analysis of the dilution of the parameters of concern for each criterion, are considered in this study.

1.3 Scope of Work

This report includes the following items:

- Field reconnaissance and an evaluation of the existing outfall.
- A summary of past studies and data collected to characterize ambient conditions that affect the discharge and effluent disposal system design.
- Conducting an analysis of outfall designs using the Environmental Protection Agency's (EPA) CORMIX, version GI mixing zone model.
- Modeling different outfall diffuser configurations to optimize the mixing achieved from the disposal system.

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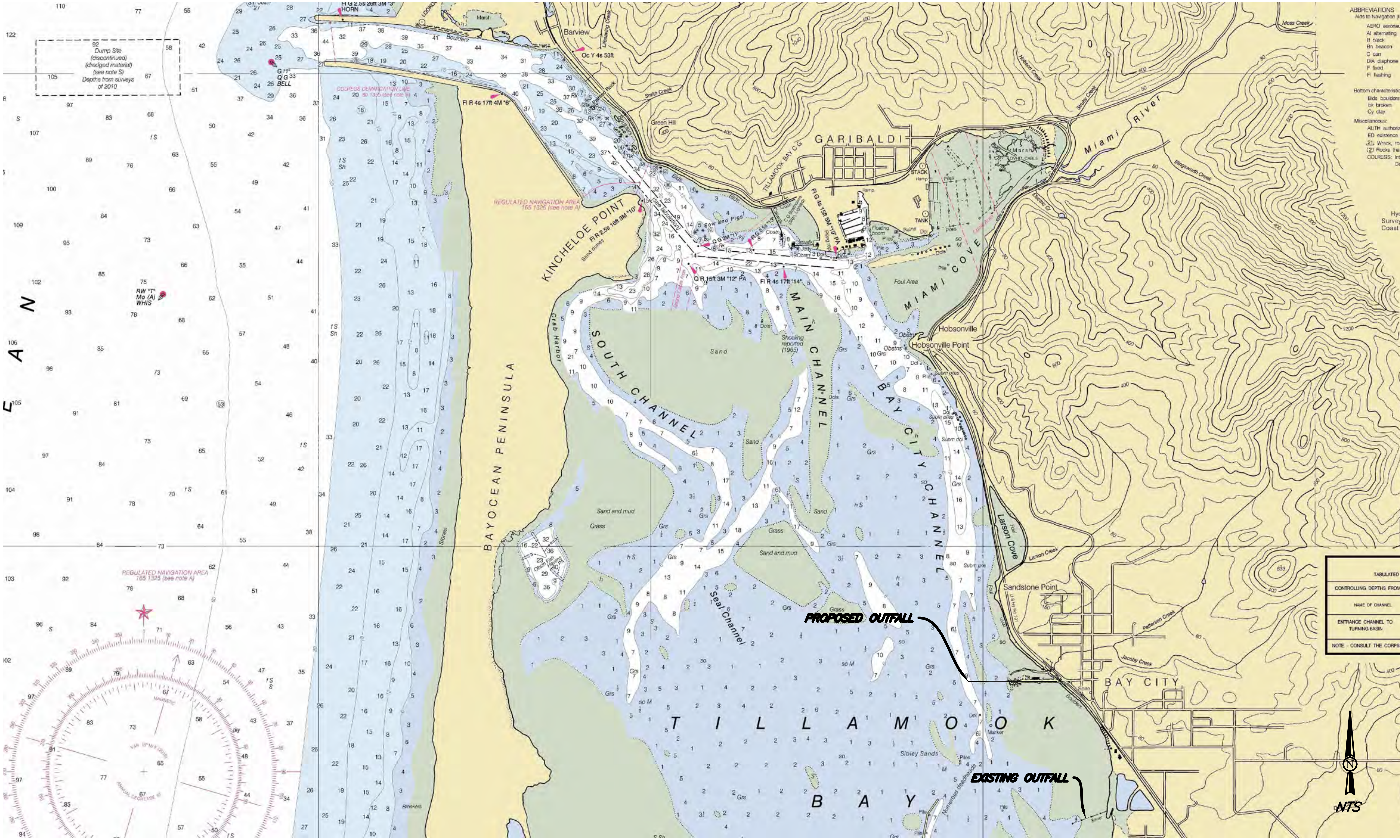

SHN Consulting Engineers & Geologists, Inc.	CITY OF BAY CITY WASTEWATER FACILITIES PLAN Bay City, Oregon	BAY CITY PROPOSED WW OUTFALL SITE PLAN SHN 010000	
	January 2010	611013-OFALL	Figure 1

\\COOSBAYSVRNEW\Projects\2011\611013-Bay City EOR -Wastewater\151-WWFP\Dwgs, SAVED: 9/13/2018 3:16 PM RSTILLMAKER, PLOTTED: 9/13/2018 3:21 PM, RON STILLMAKER

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- Preparing a mixing zone study report that presents the background data, mixing zone modeling results, and recommendations for the design of a diffuser structure.]

The City's mixing zone study should identify an optimum diffuser design, demonstrate that dilution effect in the ambient water mitigate effluent pollutants, and support a finding of no significant impact (FONSI), concerning continued disposal of the City of Bay City's wastewater effluent to the Tillamook estuary.

2.0 Principal Rules and Regulations

Water Quality Standards for the North Coast basin are set forth in OAR 340-041-0230 and are enforced by the Oregon Department of Environmental Quality (DEQ). Specific water quality standards not to be exceeded for wastewater discharge are determined for marine waters. Primary regulations of concern are provided below:

OAR **340-041-0230**
Basin-Specific Criteria (North Coast): Beneficial Uses to Be Protected in the North Coast Basin
(1) Water quality in the North Coast Basin must be managed to protect the designated beneficial uses shown in Table 230A (November 2003). (see Appendix 1)
(2) Designated fish uses to be protected in the North Coast Basin are shown in Figures 230A and 230B (November 2003). (see Appendix 1)
(3) Coastal water contact recreation use is to be protected in all North Coast Basin marine waters and in coastal waters designated in Figures 230C through 230H (August 2016). (see Appendix 1)
(4) Shellfish harvesting use is to be protected in all North Coast Basin marine waters and in coastal waters as designated in Figures 230Cthrough 230H (August 2016). (see Appendix 1)
[ED. NOTE: To view tables referenced in rule text, click here to view rule.]
Statutory/Other Authority: ORS 468.020, 468B.030, 468B.035 & 468B.048
Statutes/Other Implemented: ORS 468B.030, 468B.035 & 468B.048
History:
DEQ 9-2016, f. & cert. ef. 8-18-16
DEQ 17-2003, f. & cert. ef. 12-9-03

OAR **340-041-0234**
Basin-Specific Criteria (North Coast): Approved TMDLs in the Basin:
The following TMDLs have been approved by EPA, and appear on the Department's web site:
Nestucca Bay Drainage — Temperature, Bacteria and Sediment — May 13, 2002
Tillamook Bay Drainage — Temperature and Bacteria — July 31, 2001
North Coast — Temperature and Bacteria — August 20, 2003
Statutory/Other Authority: ORS 468.020, 468B.030, 468B.035 & 468B.048
Statutes/Other Implemented: ORS 468B.030, 468B.035 & 468B.048
History:
DEQ 17-2003, f. & cert. ef. 12-9-03

OAR **340-041-0235**
Basin-Specific Criteria (North Coast): Water Quality Standards and Policies for this Basin
(1) pH (hydrogen ion concentration). pH values may not fall outside the following ranges:

(a) Marine waters: 7.0–8.5;
(b) Estuarine and fresh waters: 6.5–8.5.
(2) Total Dissolved Solids. Guide concentrations may not be exceeded unless otherwise specifically authorized by DEQ upon such conditions as it may deem necessary to carry out the general intent of this plan and to protect the beneficial uses set forth in OAR 340-04l-0230: All Fresh Water Streams and Tributaries (other than the main stem Columbia River) — 100.0 mg/l.
(3) Minimum Design Criteria for Treatment and control of Sewage Wastes in this Basin:
(a) During periods of low stream flows (approximately April 1 to October 31): Treatment resulting in monthly average effluent concentrations not to exceed 20 mg/l of BOD and 20 mg/l of SS or equivalent control;
(b) During the period of high stream flows (approximately November 1 to April 30): A minimum of secondary treatment or equivalent control and unless otherwise specifically authorized by the Department, operation of all waste treatment and control facilities at maximum practicable efficiency and effectiveness so as to minimize waste discharges to public waters.
Statutory/Other Authority: ORS 468.020, 468B.030, 468B.035 & 468B.048
Statutes/Other Implemented: ORS 468B.030, 468B.035 & 468B.048
History:
DEQ 2-2007, f. & cert. ef. 3-15-07
DEQ 17-2003, f. & cert. ef. 12-9-03

2.1 Application of Regulatory Criteria

North coast basin rules pertaining to the City of Bay City discharge are within the design capabilities of the wastewater treatment plant. Effluent quality requirements can be met provided the City achieves adequate secondary treatment at the facility. Some allowances for toxic pollutants may be necessary to account for a toxic dilution zone for ammonia. Chlorine discharge will not be considered since the City will be utilizes a UV disinfection system.

2.2 Pollutants of Concern

The significant pollutants of concern, reasons for concern, and probable concentration limits are summarized in the Table 1 below. Ammonia represents the toxic substance that must be addressed in a toxic dilution zone.

Table 1 Summary of Significant Pollutants of Concern

Pollutant of Concern	Reason for Concern	Water Quality Criteria
Ammonia at end of toxic dilution zone	Acute Toxicity	Temp & pH dependent
Ammonia at Fringe of Mixing Zone	Chronic Toxicity	Temp & pH dependent
Chlorine at end of toxic dilution zone	Acute Toxicity	0.013 mg/L (not)[1]
Chlorine at Fringe of Mixing Zone	Chronic Toxicity	0.0075 mg/L (not)[1]
Temperature at Fringe of Mixing Zone	Biological Life	+/- 0.2°C
Turbidity at Fringe of Mixing Zone	Aesthetics	< 10% Increase
DO at Fringe of Mixing Zone	Biological Life	+/- 0.1 mg/L
Geometric Mean of Bacteria at End of Pipe	Human exposure	126 E. coli org./100 ml
Geometric Mean of Bacteria at Fringe of Mixing Zone	Human exposure	14 E. coli org./100 ml
1. Not present in effluent discharge.		

Ammonia concentrations for chronic and acute toxicity limits at the anticipated range of temperatures and pH for a salinity of 30 kg/L as defined by EPA's Ambient Water Quality Criteria for Ammonia (Saltwater) - 1989 are summarized in Table 2 below.

Table 2 Water Quality Criteria for Saltwater Aquatic Life Based on Total Ammonia Concentration as N, (mg/L)

Temperature	11.8°C		14.4°C		17.0°C	
	Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**
pH 7.6	25.38	3.81	21.31	3.20	17.65	2.65
pH 8.2	6.52	0.98	5.50	0.83	4.58	0.69
pH 8.9	1.45	0.22	1.25	0.19	1.04	0.16
Data developed from DEQ Ammonia Calculator Based on EPA 440/5-88-004 April 1989						

2.3 Mixing Zones

A mixing zone is an established area where water quality standards may be exceeded as long as acute toxic conditions are prevented and the states designated beneficial uses are protected. Generally, regulatory criteria apply at the fringe of the mixing zone.

2.3.1 Regulatory Mixing Zone

The RMZ at the Bay City outfall must be redefined. Currently the outfall provides no mixing during events.

2.3.2 Zone of Immediate Dilution (ZID)

In accordance with OAR 340-041-0325.4.b, allowances for exceeding acute criteria may be necessary in a zone of immediate dilution (ZID) in order to allow dilution of toxic constituents to below acute criteria(in other words, the CMC). The EPA in Technical Support Document for Water quality-Based Toxics Control provides guidance for setting stringent criteria that can be used to limit the ZID (referenced by EPA as a toxic dilution zone or TDZ) based on probable exposure with no impact from short-term contact with toxic constituents. Three criteria are provided, the more stringent of which should govern the limit of the ZID.

1. The CMC should be met at a distance of 10 percent of the distance from the edge of the outfall structure to the edge of the regulatory mixing zone.
2. The CMC should be met within a distance of 50 times the discharge length scale in any special direction. (The discharge length scale is calculated as the square root of the discharge port area).
3. The CMC should be met within a distance of five times the local water depth in any horizontal direction from any discharge outlet.

Each of these criteria should be considered in defining the mixing zone and ZID for the Bay City outfall.

3.0 Ambient Conditions of Tillamook Bay

Tillamook Bay is a small, shallow estuary about 60 miles west of Portland on the Oregon Coast. Tillamook Bay, along with other Oregon estuaries, is a truly a unique environments. This environment is influenced by numerous and complex estuarine factors that affect the mixing process. Approximately 6.2 miles long and 2.1 miles wide, the Bay averages only 6.6 feet depth. At low tide, about 50% of the bottom is exposed as intertidal mud flats.

In addition to ambient forces, the design of the outfall diffuser will have an initial influence on the transport and spreading of effluent. Design criteria are discussed later in this report and are based on an understanding of how ambient conditions, primary currents, and turbulence control the transport and mixing phenomenon farther from the discharge. This section describes the research, analytical tools, and background data gathered to describe ambient conditions.

3.1 Physical Setting

The proposed outfall site, shown in Figure 1, is to be located approximately 4,500 feet northwest of the existing outfall, in the upper reach of the Bay City channel, on the eastern side of mid bay, between Sandstone point and Goose Point. This area of the bay was selected as a probable outfall location due to the proximity of a main channel (that holds water during low tide), proximity to the WWTP, and the location's distance from environmental receptors.

3.2 Environmental Mapping

"Environmental mapping" has been prepared to identify the areas in and around the proposed outfall area that may be sensitive to the impact of the discharge on beneficial uses within the bay. Habitats, critical resources areas, and other beneficial uses are mapped within the segment of the water body receiving the discharge.

Established water quality standards require management of water quality to protect beneficial uses, which fall into the following categories:

- Designated fish uses to be protected in the Bay
- Shellfish harvesting
- Coastal water contact recreation

3.2.1 Fish Use

The bay provides habitat for numerous fish, shellfish, crabs, birds, seals and sea grasses. Multiple species of fish have been identified in the bay at various times of the year. Five species of anadromous salmon use the bay at some point in their life cycle. The Tillamook Watershed is home to Summer and Winter Steelhead, Coho, Chum, Spring and Fall Chinook and sea-run Cutthroat Trout. The following fish species resident in the bay are federally listed as "Threatened" under the Endangered Species Act:

- Coho salmon
- Green sturgeon

- Eulachon (commonly called smelt, candlefish, or hooligan)

None of these species spawn in the bay, but use the bay for rearing and migration. Water quality is to be managed in order to accommodate salmon and trout rearing and migration within the waters of the Bay. In addition to threatened species, Oregon also lists the Pacific lamprey as a State Species of Concern and Steelhead are listed as a federal Species of Concern. Figure 2 depicts fish use areas in the Bay (http://www.oregonfishinginfo.com/Tillamook%20Bay.html).

3.2.3 Shellfish Harvesting Use

Clam digging and crabbing are important for the economy and lifestyle within the Tillamook watershed. Oysters have been grown commercially in Tillamook Bay since the 1930's. Tillamook Bay has been one of the leading oyster producing bays in Oregon, with an average annual production of about 21,200 shucked gallons during the 1970s and 1980s. Beginning in 1990, the level of production dropped off sharply and has remained low due to reduced production by several Oyster Companies. Figure 3 depicts the oyster growing lease areas in the Bay. 2016 shellfish plat production was 5,926.69 gallons of shucked oysters in Tillamook Bay, (Source: Oregon Department of Agriculture, Natural Resources Program). Figure 4 depicts clamming and crabbing use areas in the Bay.

3.2.2 Recreational Use

Water contact recreational use of the estuary is typically limited to activities associated with sport fishing and shellfish harvesting. Figure 4 generally depicts the location of public boating access points and recreational shellfish harvesting areas within the bay.

3.3 Existing Outfall Site

The existing outfall is located approximately 2,000 feet north of Goose Point on the east side of the Bay. The outfall pipe extends approximately 1,250 feet from the eastern shoreline into the Bay, situated in what was once a shallow channel, serving Doty Creek. The Doty Creek channel, when the outfall was planned and installed, was approximately 2-3 deep at Mean Low Water. Storm events within the area have relocated that channel closer to the shore line and the outfall diffuser is currently inundated with sediment and discharges in a "bubble-up" fashion into adjacent mud-flats. When exposed at lower tides, effluent flows across the mud flats as it makes its way back to the channel.

3.4 Proposed Outfall Site

Due to the location of the existing outfall site being in the mud flats and observed channel migration, a new outfall will need to be located in the Tillamook estuary. The proposed outfall site, (Figure 1), is to be located approximately 4,500 feet northwest of the existing outfall, in the upper reach of the Bay City channel, on the eastern side of mid bay, between Sandstone point and Goose Point. This location is intended to situate the

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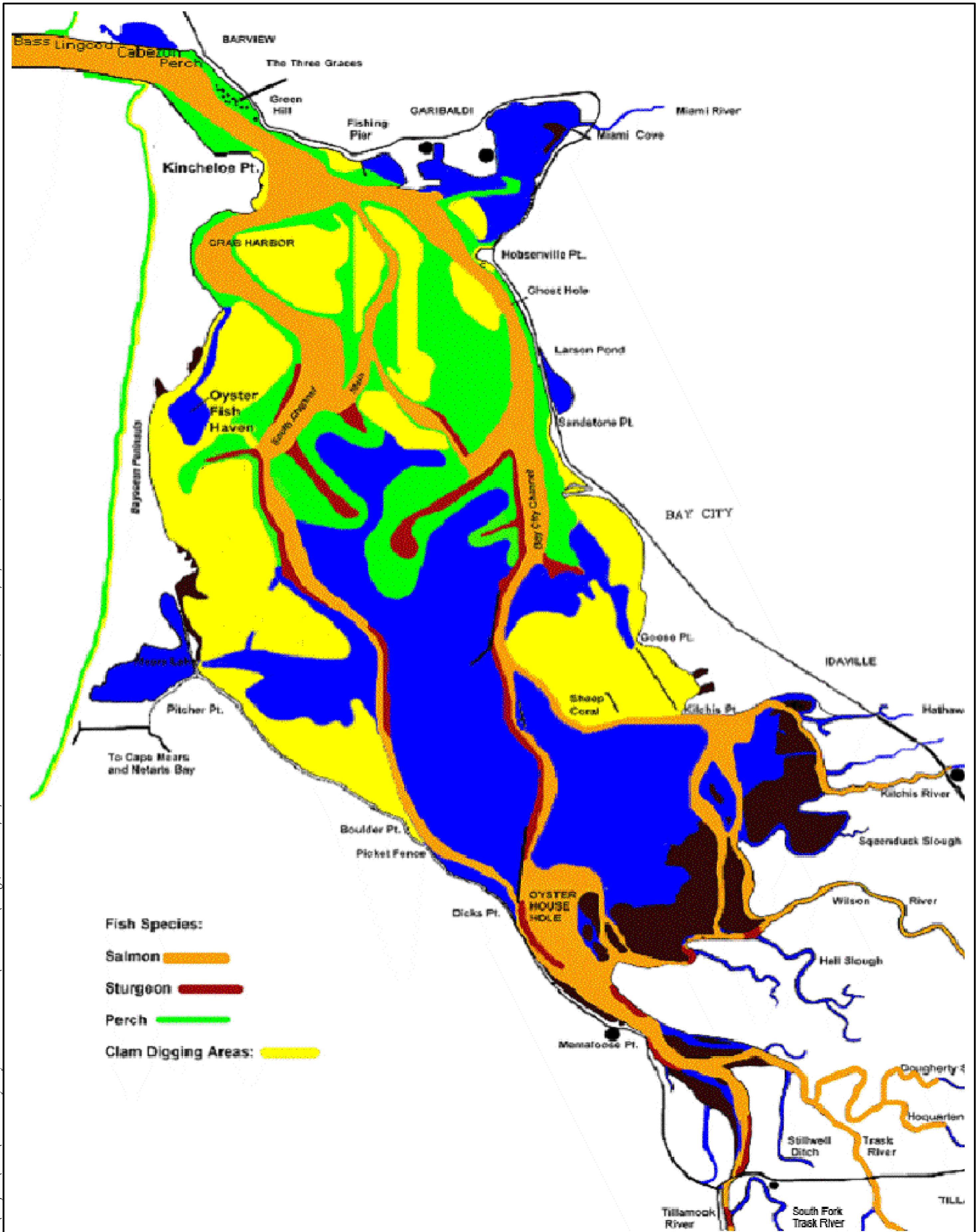

Consulting Engineers & Geologists, Inc.

City of Bay City Wastewater Facilities Plan Bay City, Oregon	ENVIRONMENTAL MAPPING FISH USE AREAS SHN 611013.151
September 2018 · 611013-OFALL	Figure 2

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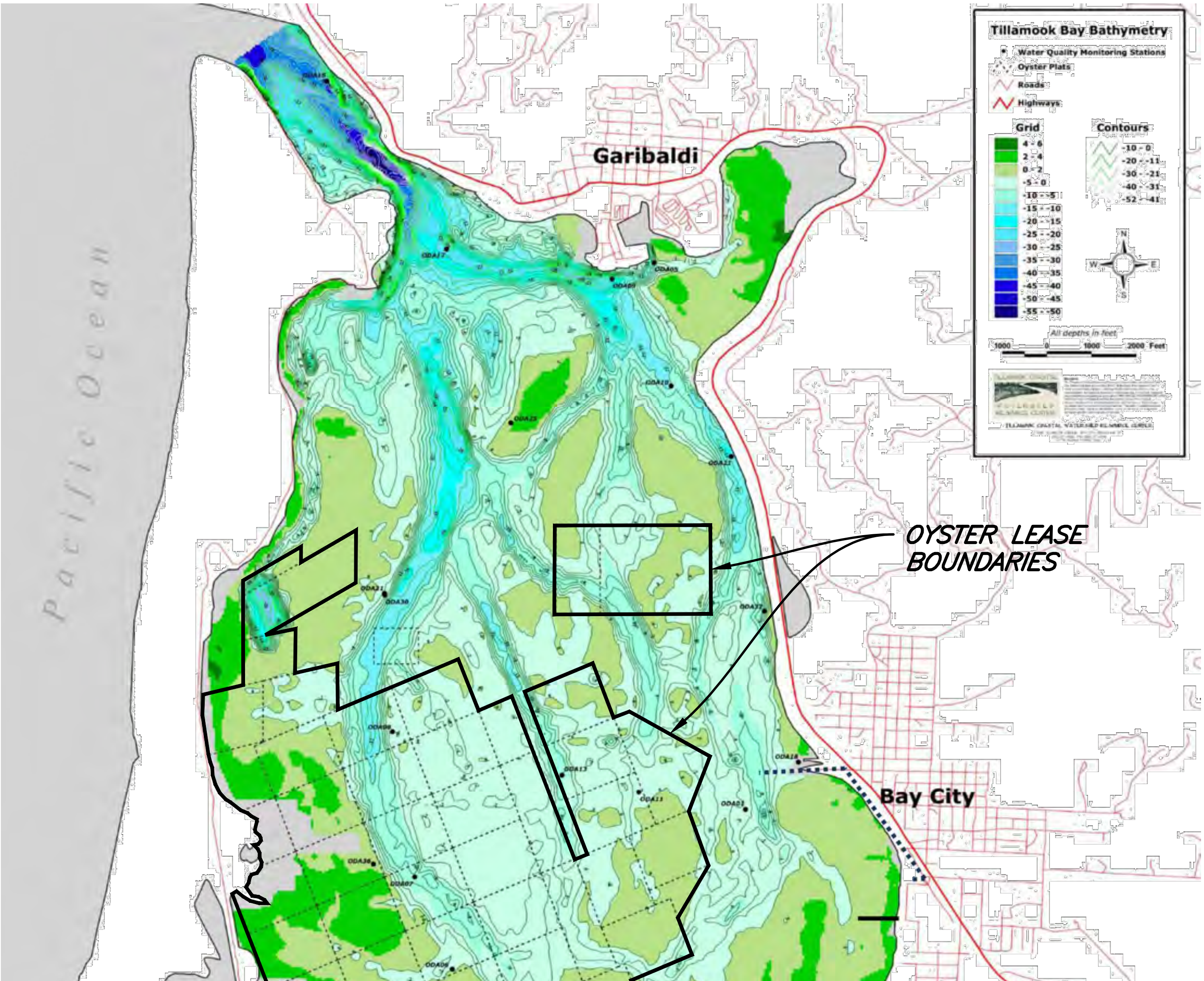

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SHN Consulting Engineers & Geologists, Inc.	City of Bay City Wastewater Facilities Plan Bay City, Oregon	ENVIRONMENTAL MAPPING OYSTER LEASE AREAS SHN 611013.151
	September 2018 / 611013-OFALL	Figure 3

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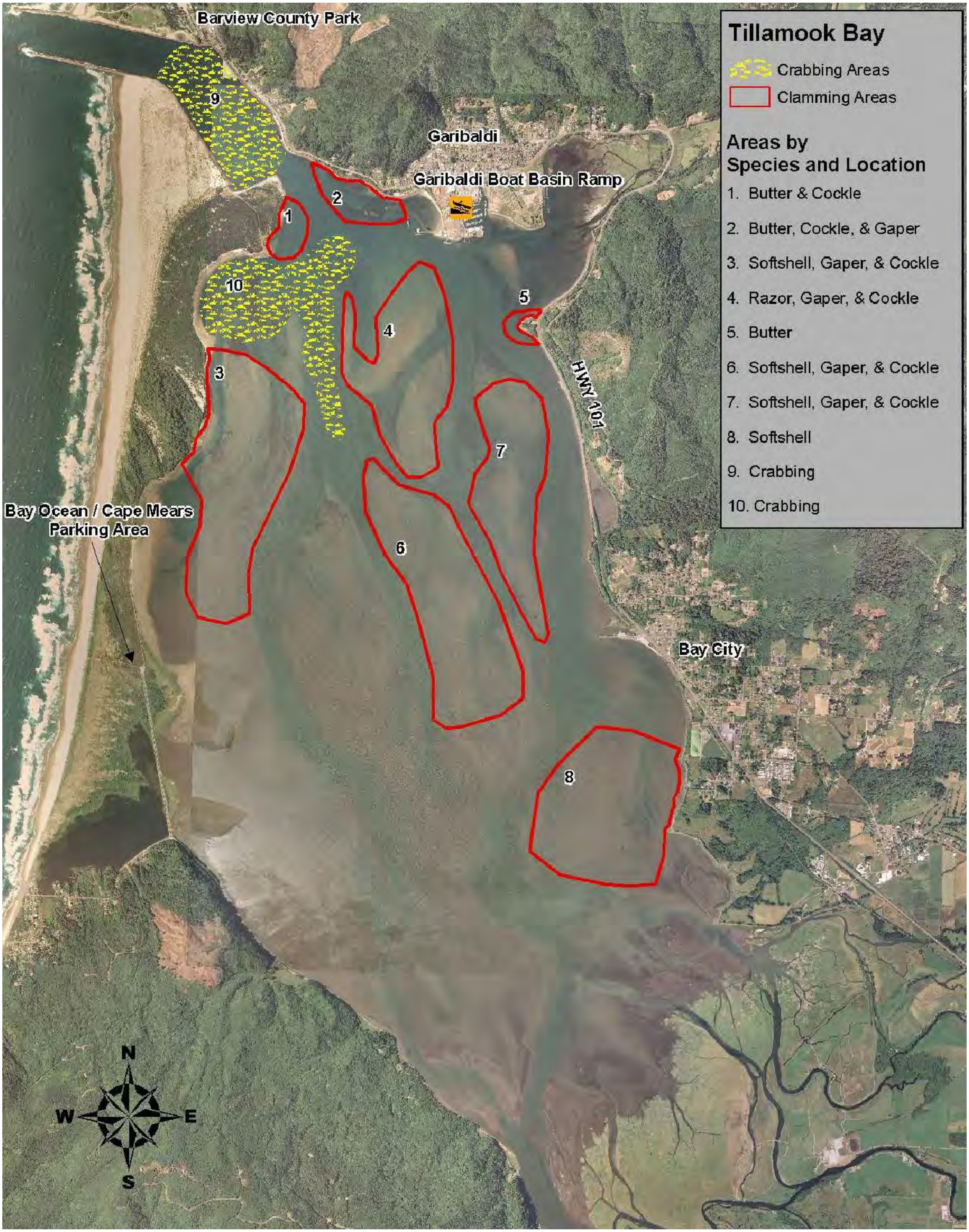

SHN Consulting Engineers & Geologists, Inc.	City of Bay City Wastewater Facilities Plan Bay City, Oregon		ENVIRONMENTAL MAPPING CLAM/CRAB USE AREAS SHN 611013.151
	September 2018	611013-OFALL	Figure 4

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outfall diffuser in a deeper, more stable channel within the Bay. Historical NOAA navigation charts indicate this channel has been present at this location and has maintained mean low water depths of seven to nine feet for at least the past 90 years (1926 chart attached). Selection of the proposed outfall site considered the following:

- Water Depth
- Outgoing Tidal Currents
- Channel Stability
- Proximity to existing wastewater facilities
- Distance from designated shellfish reserve areas

Based on these criteria, the outfall site proposed will be located at Latitude N. 45.5237^{o} and Longitude -123.9005^{o}.

Plan and profile views of the proposed outfall are presented in Figure 5.

4.0 Background Water Quality Data

Background water quality data for Tillamook Bay and the Bay City wastewater treatment plant effluent are discussed in the following section. The data are utilized to model ambient conditions assuming the worst case (1 in 10 year flow and treatment performance) discharge scenario.

4.1 Ambient Water Quality Data

The majority of information derived for the study of outfall impact on Tillamook Bay was obtained from various published studies and papers, which have been previously performed in association with some aspect of the Bay or its associated water shed.

4.1.1 Salinity and Temperature

Past studies of the Bay have classified the estuary as a two-layered stratified system during the high run-off periods (November through March) and well-mixed, vertically homogeneous during low flow periods (April through October). The studies suggest that due to the large tidal amplitude, shallow depth and moderate freshwater inflow, stratification is not sustained for extended periods of time.

Salinity and temperature conditions were derived from two previous studies associated with Tillamook Bay. Overall, it appears that salinity and temperature conditions were similar between the two studies. In both studies, mean temperatures in the mid-region of the Bay varied over a wider range than in the lower Bay due to shallow depths and the strong influence of air temperature. Mean temperature associated with measurements taken in April through July, in the midregion of the Bay was 14.4^{o} C and ranged from 9 to 17^{o} C, dependent upon the season.

Mean salinity associated with measurements taken in April through July, in the midregion of the Bay was 22.8 ppt and ranged from 18.3 to 31 ppt, dependent upon the season. In comparison, the Pacific Ocean has an average salinity of 35 ppt.

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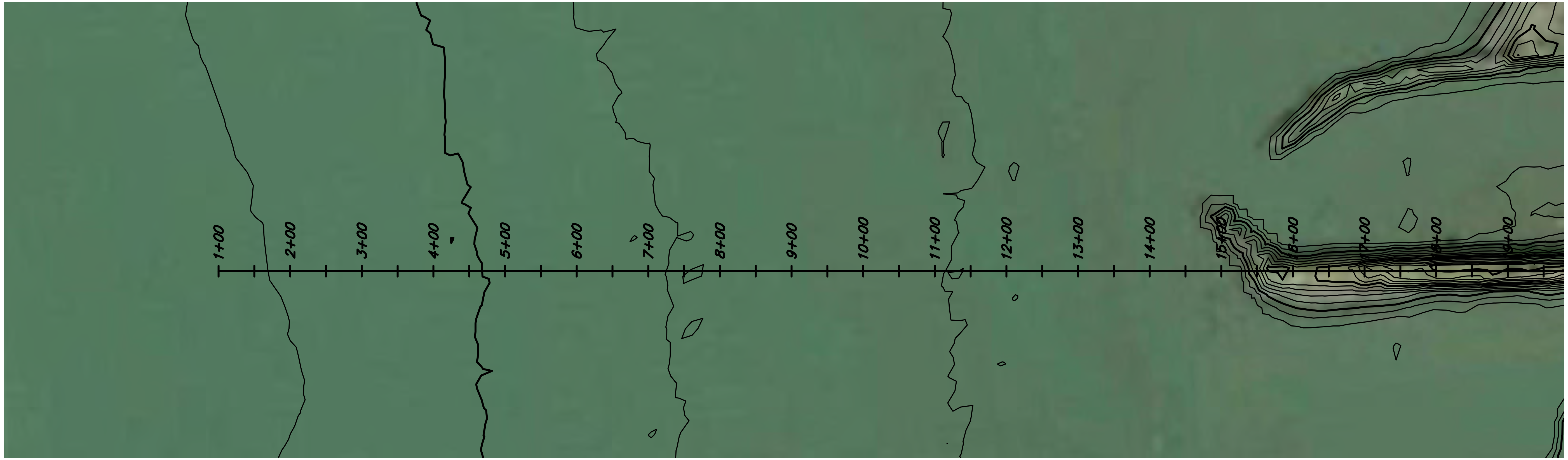

PLAN
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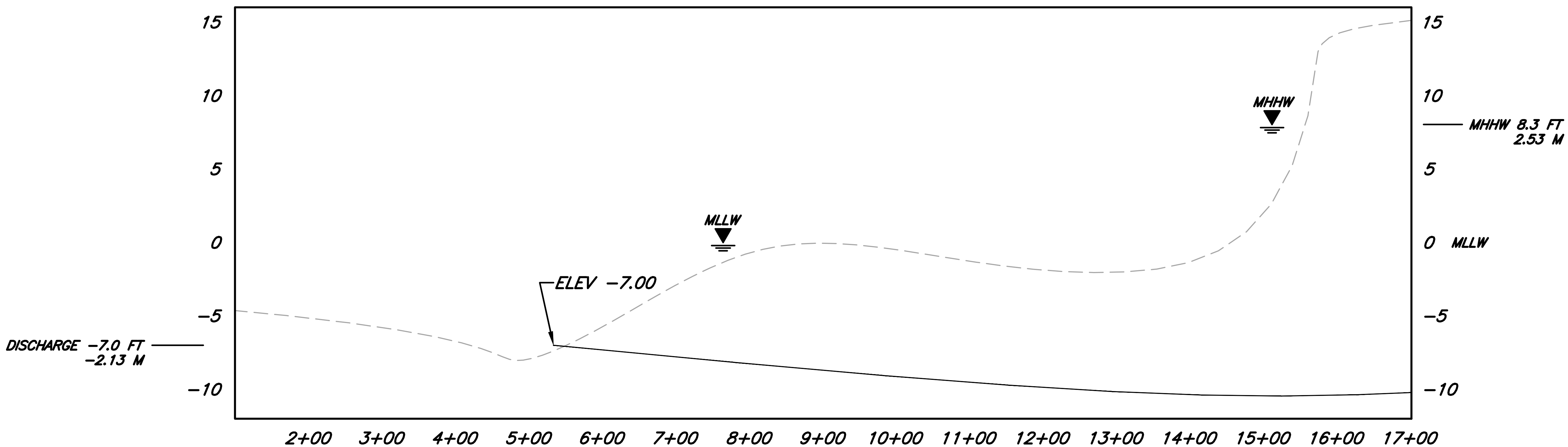

PROFILE
SCALE: 1"=150' H
1"=2' V

SHN Consulting Engineers & Geologists, Inc.	CITY OF BAY CITY WASTEWATER FACILITIES PLAN Bay City, Oregon	PROPOSED WW OUTFALL PLAN/PROFILE SHN 010000
	January 2010 / 611013-OFALL	Figure 5

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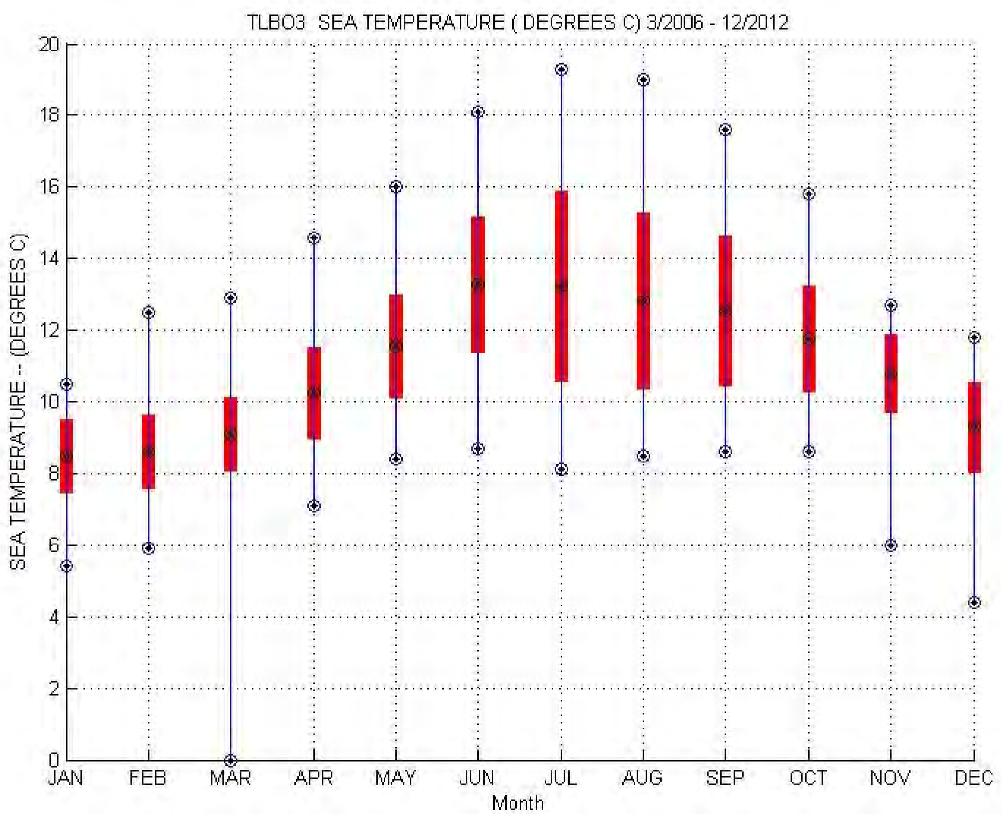
The following graph, downloaded from NOAA, National Buoy Data Center, for readings made at the Garibaldi station (located on the Bay approximately 12,000 ft north of the proposed outfall sit), depicts a recent history of lower bay temperatures:

Figure 6
Station TLBO3 - Climatic Summary Plots for Sea Temperature
Mean and Standard Deviation Plot



4.1.2 Water Depth

Water depth at the proposed outfall location is affected by tidal forces, storm surges and hydrologic inputs from the upstream drainage basins . . For modeling purposes, the average tidal forces will be assumed to control water levels elevations. The National Oceanographic and Atmospheric Ocean Administration collect data on water elevations. The nearest tidal data station closest to the outfall site is the Garibaldi Station (9437540). The elevations for this station are as follows:

Highest Observed Water (12/31/2005)	15.91 feet
Mean Higher High Water	12.3 feet
Mean High Water	11.59 feet
Station Datum (NAVD88)	0.00 feet
Mean Tide Level (MTL)	8.47 feet
Mean Low Water	5.35 feet
Mean Lower Low Water	3.99 feet
Lowest Observed Water (11/26/2007)	-0.52 feet

Under Mean Lower Low Water elevation, the estuary floor at the proposed outfall site will have 9 feet of water above it. In comparison, the existing disposal site will be completely exposed mud flats.

4.1.2 Density

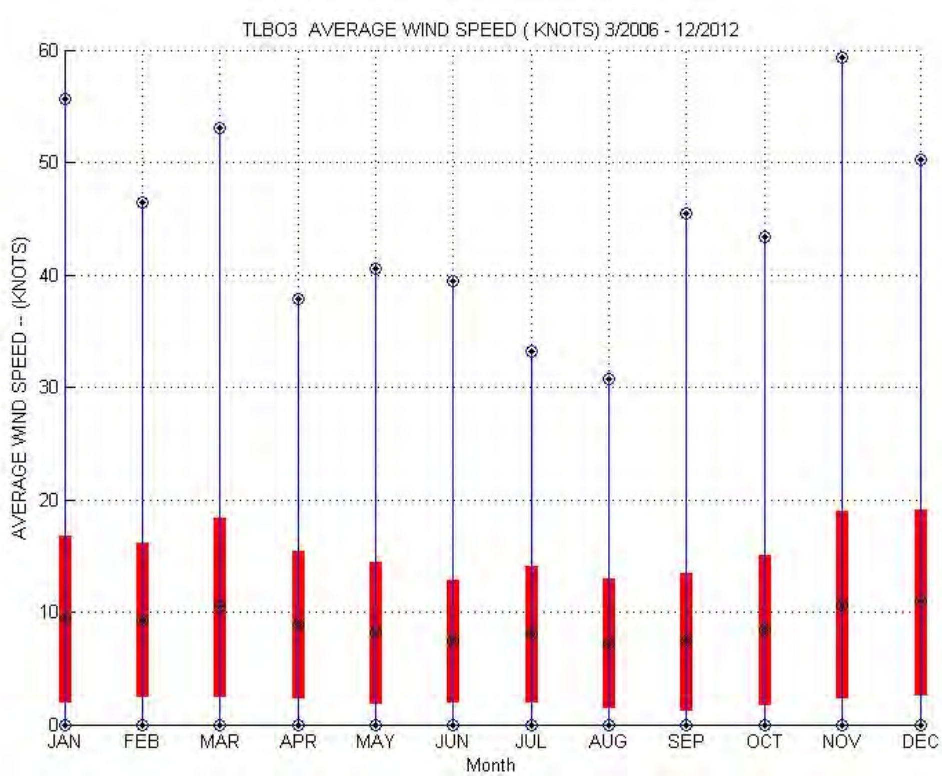
Density profiles for the outfall site were derived by correlating the density of seawater to the associated temperature and salinity. The range in density from 1,013 kg/m^3 to 1252 kg/m^3, depending on salinity and temperature. An average density of 1,136 kg/m^3 will also be used for modeling purposes based on an average temperature of 14.4°C and a salinity of 22.8 ppt.

4.1.3 Winds

Mixing zone modeling will also consider the influence of wind speed on mixing once the discharge floats to the surface. Winds along the Tillamook estuary can be characterized as strong with predominate directions from either the northwest in the winter and southwest or southeast in the summer. Average wind speeds for the Garibaldi weather station, located on the north shores of the Tillamook Bay are shown in Figure 7 below. Based on the data provided from this weather station, wind speeds for modeling purposes will be based on an 11-knot wind (5.7 m/s).

Figure 7
Average Wind Speed at Garibaldi, OR

Station TLBO3 - Climatic Summary Plots for wind speed
Mean and Standard Deviation Plot



The strong winds occurring along the Estuary will generally enhance mixing at the surface layer but may also tend to push the effluent shoreward. Modeling of the diffuser structure should target identifying a design that creates a well-mixed plume at the surface layer to reduce the significance and risk of the strong winds pushing the effluent shoreward

4.1.4 pH

Data for water pH in Tillamook Bay is limited. The water quality data collected with the 1998 fish sampling in the Bay indicates a pH of 9.92 in the vicinity of the proposed outfall site, taken on July 15, 1998. Considering the tidal influence in the mid Bay location of the proposed outfall site, the pH of the ocean will be used for data representing the lower values of the Bay.

The ocean pH is maintained by the net charge balance of positive ions (Na^+, K^+, Mg^{++}, and Ca^{++}) and negative ions (Cl^-, $SO_4^=$, and Br^-). Whenever there is a slight charge imbalance, the ocean buffering capacity neutralizes the additional acid or base. This buffering ability is controlled by the carbonate system that balances the ocean pH in a narrow range between 7.6 and 8.1.

4.1.5 Summary of Ambient Properties

Ambient properties proposed as representative of the Tillamook Bay at the outfall site are provided in Table 3 below.

Table 3 Summary of Tillamook Bay Ambient Properties

Ambient Property	Lowest	Average	Highest
Water Temperature	11.8°C	14.4°C	17°C
Density, kg/m^3	1,013	1,136	1,252
Density Gradient, kg/m^3	none	none	none
pH	7.6	8.2	8.9
Ammonia as N μg/L	0.10	1.0	3.4
Wind speed, knots	0	11	60

4.2 Effluent Quality Characteristics

Effluent characteristics for parameters of concern will be controlled by the efficiency of the wastewater treatment plant. Based on the NPDES permit, the discharge of secondary effluent should meet a 30 mg/L BOD and 30 mg/L TSS criteria. A summary of the NPDES effluent limitations for the WWTP is provided in Table 4 below.

Table 4 NPDES Permit Limits

May 15 – Oct 30		
BOD	30	45
TSS	30	45
Nov 1 – May 14		
BOD	30	45
TSS	30	45

Table 4, Continued NPDES Permit Limits

Year-round	Year-round Limitations
E. coli bacteria:	Shall not exceed 126 organisms per 100 ml monthly geometric mean. No single sample shall exceed 406 organisms per 100 ml.
pH:	Shall be within the range of 6.0 to 9.0
BOD_5 and TSS Removal Efficiency:	Shall not be less than 85% monthly average based on ADWF and AWWF for the facility.
Total Chlorine Residual:	No chlorine or chlorine products shall be allowed.
* Based on average dry weather flow (ADWF) to the facility of 0.132 mgd and average wet weather flow (AWWF) of 0.248 mgd.	

4.2.1 Ammonia

The ammonia concentrations in the discharge is not an NPDES parameter of concern. However, ammonia testing has been performed on plant effluent once a week since 2009. Effluent ammonia ranged from 0.0016 mg/L to 13.93 mg/L, with an average of 1.37 mg/L over the past 8 years.

Variations in effluent ammonia will depend on operational modes of the Sequencing Batch Reactor (SBR) process. During the summer, the treatment plant will be operated to promote nitrification resulting in lower effluent NH_3-N concentrations. Average summer time ammonia concentrations over the past 8 years have been 1.77 mg/L.

During the winter, higher flows may require the plant to operate in a high rate batching process that does not allow nitrification. It is reasonable to expect ammonia removal to be limited by the rapid process time and lower temperatures. Average winter time ammonia concentrations over the past 8 years has been 1.09 mg/L.

The 90th percentile of exceedence (1 in 10 year) ammonia level over the past 8 years is 6.79 mg/L and will be used as the upper limit of ammonia concentration in the discharge for modeling purposes

Ammonia toxicity criteria that determine mixing requirements are defined in Table 2. Worst case scenario for toxicity criteria are encountered with ambient properties of 17 ^oC, a pH of 8.9 and salinity of 18.2 ppt. These conditions represent ambient conditions in the highest range of temperature and pH along with the lowest range of salinity found in previous documentation of estuary conditions.

4.2.2 Effluent Temperature

Wastewater temperature is known to vary seasonally and generally parallels climatic temperatures. Data evaluated from the Bay City Wastewater Treatment Plant Discharge Monitoring Report (DMR) for effluent temperature suggests winter temperature ranges between 7 ^oC and 21 ^oC and during the summer ranging between 11 ^oC and 21 ^oC. The maximum thermal discharge that could influence the Bay temperature for the winter and summer seasonal average is 21 ^oC. Temperature standards for the protection of fish relate to the mid bay region, that is associated with rearing and migration is a maximum of 17.8^oC.

4.3 Constituents of Concern

Summaries of effluent properties of concern are provided in Table 5 below.

Table 5 Summary of Effluent Properties and Required Standards

Ambient Property	Lowest	Average	Highest	Standards
Biochemical Oxygen Demand, mg/L	1	2.9	12	30
Total Suspended Solids, mg/L[1]	1	6.3	22	30
E coli bacteria, #/100ml[2]	2	6.7	38	End of Pipe
Summer Temperature, °C Winter Temperature, °C	11 7	16.5 13.1	21 21	17.5
Density, kg/m[3]	998	998.8	1000	N/A
pH	6.0	6.9	7.3	6-9
Summer Ammonia as N, mg/L Winter Ammonia as N, mg/L[5]	0.004 0.0016	1.77 1.09	13.93 8.80	1.04 CMC[4] Acute 0.16 CCC[6] Chronic

1. mg/L – milligrams per liter
2. ml - millileter
3. kg/m – kilograms per meter
4. CMC – Criteria Maximum Concentration
5. Wastewater Treatment Plant Design, WPCF MOP 8
6. CCC – Criteria Chronic Concentration

4.4 Hydraulic Loadings

The effluent discharge rate can have a significant impact on the receiving water because the loading of pollutants is based on the discharge rate but also because the comparison to receiving water velocities (estimated flow rate for ambient with assumed boundary conditions) and the effluent momentum affect the mixing phenomenon. Effluent will be discharged from the City's Wastewater Treatment Plant through the proposed installation of a new discharge pumping system. Pump discharge rates are dictated by the process of the existing Sequential Batch Reactor (SBR) treatment system used by the City. The SBRs are typically operated in 6-hour cycles producing a total of eight batches per day. However, during high flows, cycle times can be decreased to as low as 3-hour intervals.

Treated supernatant is withdrawn from the SBR basins utilizing a floating 10-inch diameter decanter mechanism and discharged for disinfection. Effluent from the SBR is disinfected using a single-channel with two UV disinfection systems. The UV system is designed to disinfect a peak decant flow rate of 2.8 MGD, assuming a tranmissivity of 65%.

After UV disinfection, treated effluent will be discharged via effluent pump station to Tillamook Bay through the proposed 12 inch discharge pipeline and 8 inch discharge port outfall. The effluent pump station will be sized to accommodate the SBR decant rate of approximately 1,700 gallons per minute.

4.5 Discharge Velocities

Effluent discharge velocities will be controlled by the design of the diffuser port. According to the CORMIX model design recommendations, effluent discharge velocities should be high, ranging between 3 m/s to 8 m/s. Lower velocities may be allowed, but discharge velocities less than 0.5 m/s are not recommended.

It is important to note that the discharge port size will affect the analysis of the toxic dilution zone (by reducing the discharge length scale) described in the regulatory review section of this report. In general, smaller discharge ports will decrease the length scale, which in turn reduces the ZID. In some cases, it could become necessary to reduce the length of the mixing zone and install more, smaller area, diffusers to achieve toxic dilution criteria.

5.0 Effluent Modeling

A variety of models exist for evaluating effluent dilution. The primary mixing zone models currently in common use include simple dilution equations, DYNTOX, CORMIX, UM, RSB, UDKHDEN, PDS, and PDSM. The structure, applicability, assumptions, and complexity of each model are summarized in Table 6 below.

Table 6 Summary of Available Mixing Zone Model

Model	Discharge Depth	Receiving Water Depth	# Ports	Dimensions	Complexity
Jet-Momentum Eq.	submerged	any	single	one	low
River Initial Mixing Eq.	any	shallow	single	one	low
Ambient Dilution Eq.	any	shallow	any	one	low
CYNTOX	any	shallow	single	one	moderate
CORMIX	any	any	any	three	moderate
UM	submerged	any	any	three	moderate
RSB	submerged	deep	multiple	three	moderate
PDS	surface	deep	single	three	high
PDSM	surface	deep	single	three	high
UDKHDEN	submerged	deep	multiple	three	high

Model selection for this study was based on the objectives of the study, availability and quality of input data, and the specific conditions of the perceived discharge scenario proposed to be modeled. The following selection criteria were applied to select the model used in this study:

- Input data was limited; therefore the model should not require extensive input data
- The results of the model should be reproducible by others, therefore the model should be readily available, well-documented, and relatively easy to use
- Schedule and budgetary limits were critical to the project, therefore model input parameters should be easy to adjust, enabling relatively rapid analysis of various outfall configurations
- The results of the study are subject to DEQ examination; therefore the model should be recognized and accepted by regulators

Based on these criteria, CORMIX was selected for use in this study. CORMIX satisfies the criteria listed above as follows:

- CORMIX is a length scale analytical model. As such, it does not require extensive input data, as might be required for multi-dimensional numerical models.
- CORMIX engine is a public domain model; readily available and well documented.
- The CORMIX interface allows input parameters to be adjusted relatively quickly, permitting sensitivity analyses to be conducted expeditiously
- CORMIX has been accepted and endorsed by the USEPA and Oregon DEQ
- As an expert system, CORMIX provides design recommendations, which can enhance the design process and lead to an improved diffuser system

5.1 Mixing Zone Modeling Parameters

EPA's *Technical Support Document for Water Quality-based Toxics Control* (*TSD)* describes the critical design flows that should be used when performing mixing zone analyses for the various waterbodies. EPA's *TSD* defines estuaries as having a main channel reversing flow and coastal bays as having significant two-dimensional flow in the horizontal directions. For both water bodies, the critical design conditions recommended by EPA are based on a combination of the tides and the river conditions. Because plume dynamics within an estuarine environment are so complex, discharge dilution cannot be calculated simply based on the receiving stream critical low flow and the effluent discharge rate. Effluent mixing within an estuary is complicated by density stratification, tidal variation, wind effects, riverine inputs, and complex circulation patterns.

In addition to evaluation of the above critical design conditions, an off-design condition was evaluated as well. The recommended off-design condition for both stratified and unstratified conditions is that of maximum velocity during a tidal cycle. It was assumed the off-design condition would likely result in greater dilution but it could carry the plume further downstream. An evaluation of this condition was made to assure toxic conditions are not carried downstream into critical resource areas such as shellfish habitat.

For application of acute criteria, the 10th % velocity over one tidal cycle was used for critical slack conditions and 90th % for the off-design condition. For chronic and human health criteria the 50th% velocity was used.

5.1.1 Detailed Tidal Simulations

A high variation in both ambient velocity and tidal elevation occurs during the tidal episode shown in Figure 8. In such highly time-variant ambient conditions, CORMIX recommends predictions are performed at critical tidal conditions throughout a reversal episode. These critical tidal conditions are identified as:

1. Shortly after slack tide: Effects of re-entrainment of discharge from the previous half-cycle are greatest. However, the flow is evolving rapidly in time, causing CORMIX tidal predictions to be limited in spatial extent. Several predictions should be made at hourly or half hourly intervals following the reversal.
2. Maximum flood and ebb currents: These represent extremes of along-shore extent and shoreline interaction. Re-entrainment will be less important at these times.

Per CORMIX guidance, seven simulations were performed at the times indicated on Figure 8 by the letters a-g. In the following section, a detailed simulation is performed corresponding to time b, one hour after slack tide. The results are contrasted for that case to the steady-state assumption simulated in the preceding.

Along with the recommended CORMIX tidal simulations, four simulations were performed to correlate with the prescribed conditions by the EPA's TSD.

Figure 8 represents the ambient water conditions associated with each simulation.

Minimal initial dilution generally will not occur at slack tide, but shortly after slack tide when the plum re-entrains material remaining from the previous tidal cycle In tidal mode, CORMIX considers the reduction in initial dilution due to renentrainment of material remaining from the previous cycle.

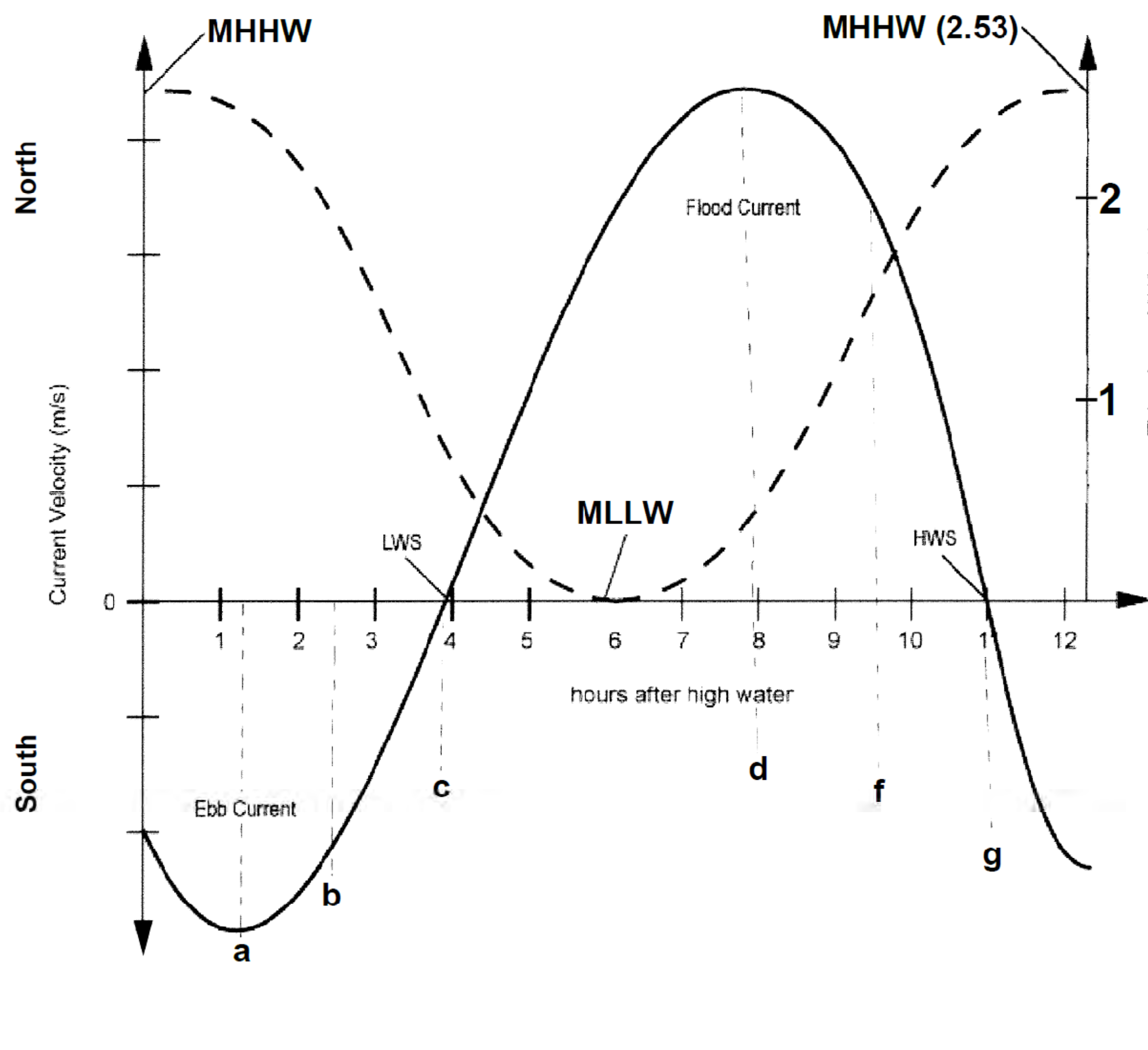


Figure 8.

Table 7 Detailed Tidal Simulations

Flow Scenario		Tidal Elevation (ft)	Tidal Elevation (m)	Average Depth (m) 4.11 Water Depth to Bottom (m)	Average Depth (ft) 13.5 Water Depth to Bottom (ft)	Maximum Velocity (m/s) 1.0 Current Velocity (m/s)	distance to left bank (m)
Ebb Current	a	7.9	2.4	5.14	16.9	0.75	unbounded
	b	4.5	1.37	4.11	13.5	0.5	unbounded
Low Water Slack	c	1.3	0.4	3.14	10.3	0.01	unbounded
Flood Current	d	0.0	0	2.74	9.0	0.8	560
	e	8.3	2.53	5.27	17.3	1	unbounded
	f	5.9	1.8	4.54	14.9	0.75	unbounded
High Water Slack	g	7.4	2.25	4.99	16.4	0.01	unbounded
Acute Criteria	10th % velocity over one tidal cycle	0.7	0.2	2.94	9.7	0.1	unbounded
	90th % for off-design (impacts on shellfish habitat)	0.0	0	2.74	9.0	0.9	560
Chronic and human health criteria	50% velocity (Ebb)	0.7	0.2	2.94	9.7	0.5	unbounded
	50% velocity (Flood)	6.6	2	4.74	15.6	0.5	unbounded

5.2 Mixing Zone Modeling Results

Several simulations were run with various discharge port sizes and at various directional configurations to determine the most effective combination for mixing. For simplicity and cost effectiveness, a mixing zone based upon a single port discharge was evaluated. An eight inch diameter port, discharging perpendicular to the tidal flow directions (Sigma = 90^o) with an upward angle (Theta) of 10^o, was found to provide adequate mixing for all discharge scenarios under consideration. The eight inch diameter port discharges the effluent at an initial velocity of approximately 3.3 meters/sec. Due to the buoyant nature of the discharge (lower density than ambient receiving stream) the plume will eventually make its way to the surface. However, with the proposed discharge velocities and the modeled scenarios, the Zone of Immediate Dilution is achieved prior to plume surfacing.

A summary of the results from mixing zone analyses in which the distance from the port where the CMC and CCC are met are provided in Table 8 presented below:

Table 8 Mixing Zone Analyses

Flow Scenario		CMC (ZID) Dist. (m)	CCC Dist. (m)
a.	Ebb Current	2.37	25.4
b.		2.85	18.26
c.	Low Water Slack	6.93	
d.	Flood Current	2.35	19.63
e.		2.28	32.75
f.		2.38	25.36
g.	High Water Slack	6.64	
Acute Criteria	10th % velocity over one tidal cycle	5.86	
	90th % for off-design (impacts on shellfish habitat)	2.31	22.88
Chronic and human health criteria	50% velocity (Ebb)	2.81	14.3
	50% velocity (Flood)	2.84	19.05

5.3 Summary of Mixing Zone Modeling Results

Under all conditions, modeling predicts that the single-port diffuser will meet acute and chronic criteria and achieve all water quality objectives for pollutants of concern. The mixing zone length of 70 meters (30 m upstream and 40 m downstream from each of discharge nozzle) is shown by the model to provide adequate protection for water quality. Based on the limiting criterion of the discharge length scale, a minimum toxic dilution zone of 7 meters, each direction, should be permitted to achieve the CMC criteria.

DEQ Basin-Specific Criteria

1

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DEQ Basin-Specific Criteria

1

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State of Oregon Department of Environmental Quality

Basin-Specific Criteria (North Coast)

340-041-0230

Beneficial Uses to Be Protected in the North Coast Basin

Figure 1: Oregon Basin Index Map

Basin Name	Basin #	OAR #
DESCHUTES	25	340-41-0130
GOOSE & SUMMER LKS	42	340-41-0140
GRANDE RONDE	31	340-41-0151
HOOD	24	340-41-0160
JOHN DAY	26	340-41-0170
KLAMATH	43	340-41-0180
MALHEUR LAKE	41	340-41-0190
MALHEUR RIVER	33	340-41-0201
MID COAST	12	340-41-0220
NORTH CST-LWR COL	11-21	340-41-0230
OWYHEE	34	340-41-0250
POWDER	32	340-41-0260
ROGUE	15	340-41-0271
SANDY	23	340-41-0286
SOUTH COAST	14	340-41-0300
UMATILLA	27	340-41-0310
UMPQUA	13	340-41-0320
WALLA WALLA	28	340-41-0330
WILLAMETTE	22	340-41-0340

Table 230A
Designated Beneficial Uses
North Coast Basin
(OAR 340-041-0230)
(November 2003)

DEQ
State of Oregon Department of Environmental Quality

Beneficial Uses	Estuaries & Adjacent Marine Waters	All Streams & Tributaries Thereto
Public Domestic Water Supply[1]		X
Private Domestic Water Supply[1]		X
Industrial Water Supply	X	X
Irrigation		X
Livestock Watering		X
Fish & Aquatic Life[2]	X	X
Wildlife & Hunting	X	X
Fishing[3]	X	X
Boating	X	X
Water Contact Recreation[3]	X	X
Aesthetic Quality	X	X
Hydro Power		
Commercial Navigation & Transportation	X	

[1] With adequate pretreatment (filtration & disinfection) and natural quality to meet drinking water standards.

[2] See also Figures 230A and 230B for fish use designations for this basin.

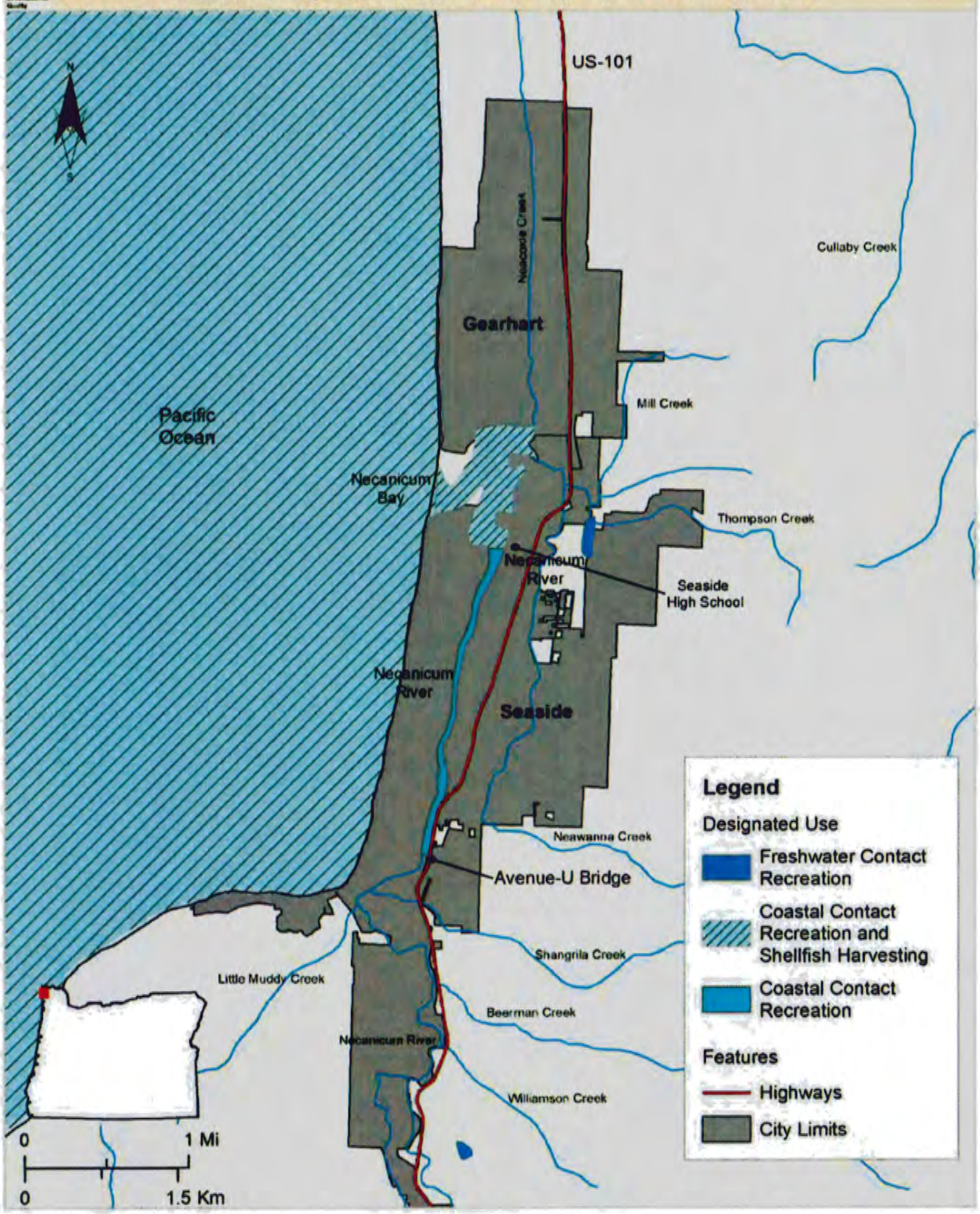
[3] For coastal water contact recreation and shellfish harvesting uses, see also Figures 230C (Necanicum River Estuary), 230D (Nehalem Bay), 230E (Tillamook Bay), 230F (Netarts Bay), 230G (Sand Lake), and 230H (Nestucca Bay)

*Figure 230A: Fish Use Designations**
North Coast Basin, Oregon

*Figure 230B: Salmon and Steelhead Spawning Use Designations**
North Coast Basin, Oregon

OAR 340-041-0230

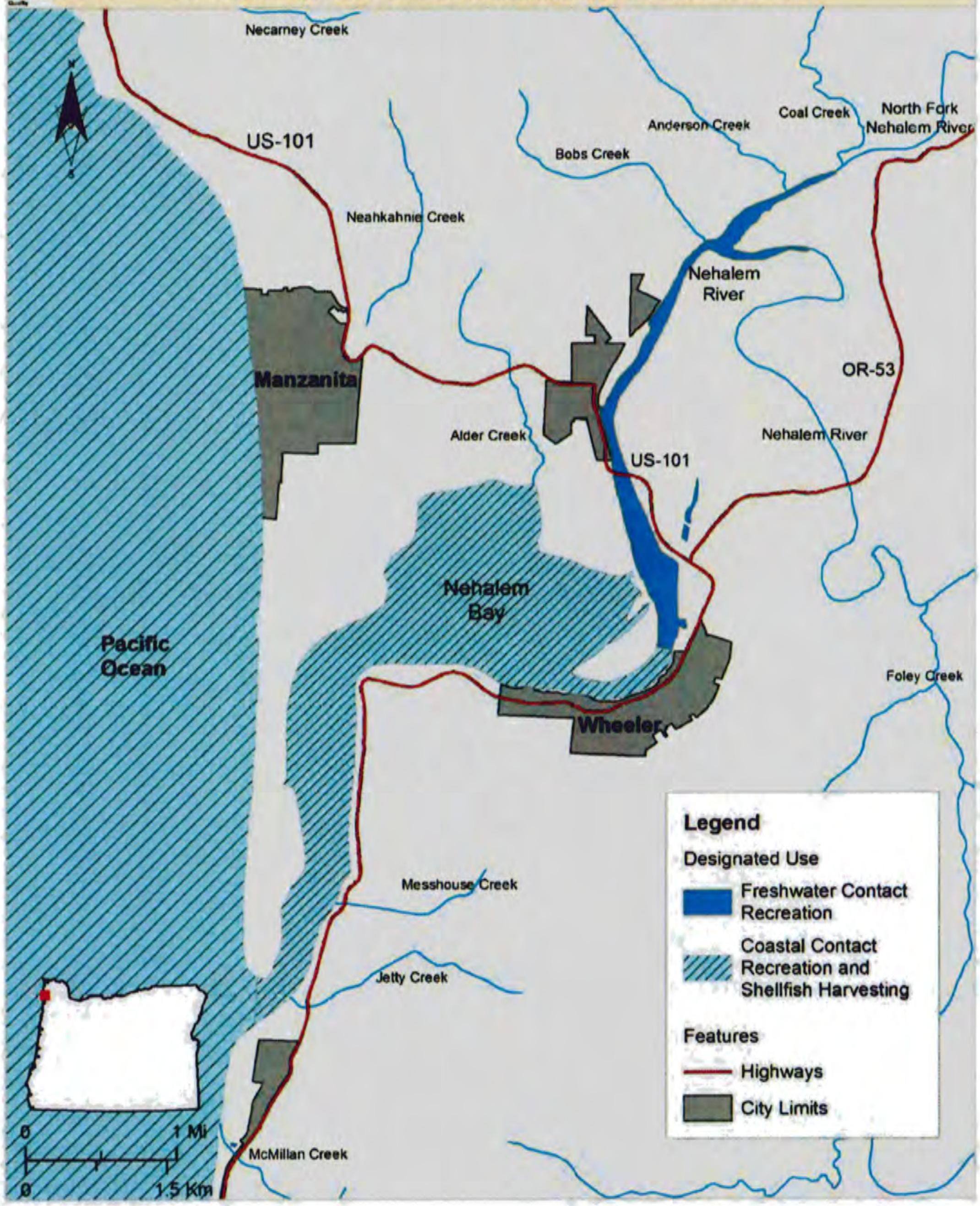
Figure 230C: Water Contact Recreation and Shellfish Harvesting Designated Uses
Necanicum Bay, North Coast Basin, Oregon (Draft February, 2016)



OAR 340-041-0230

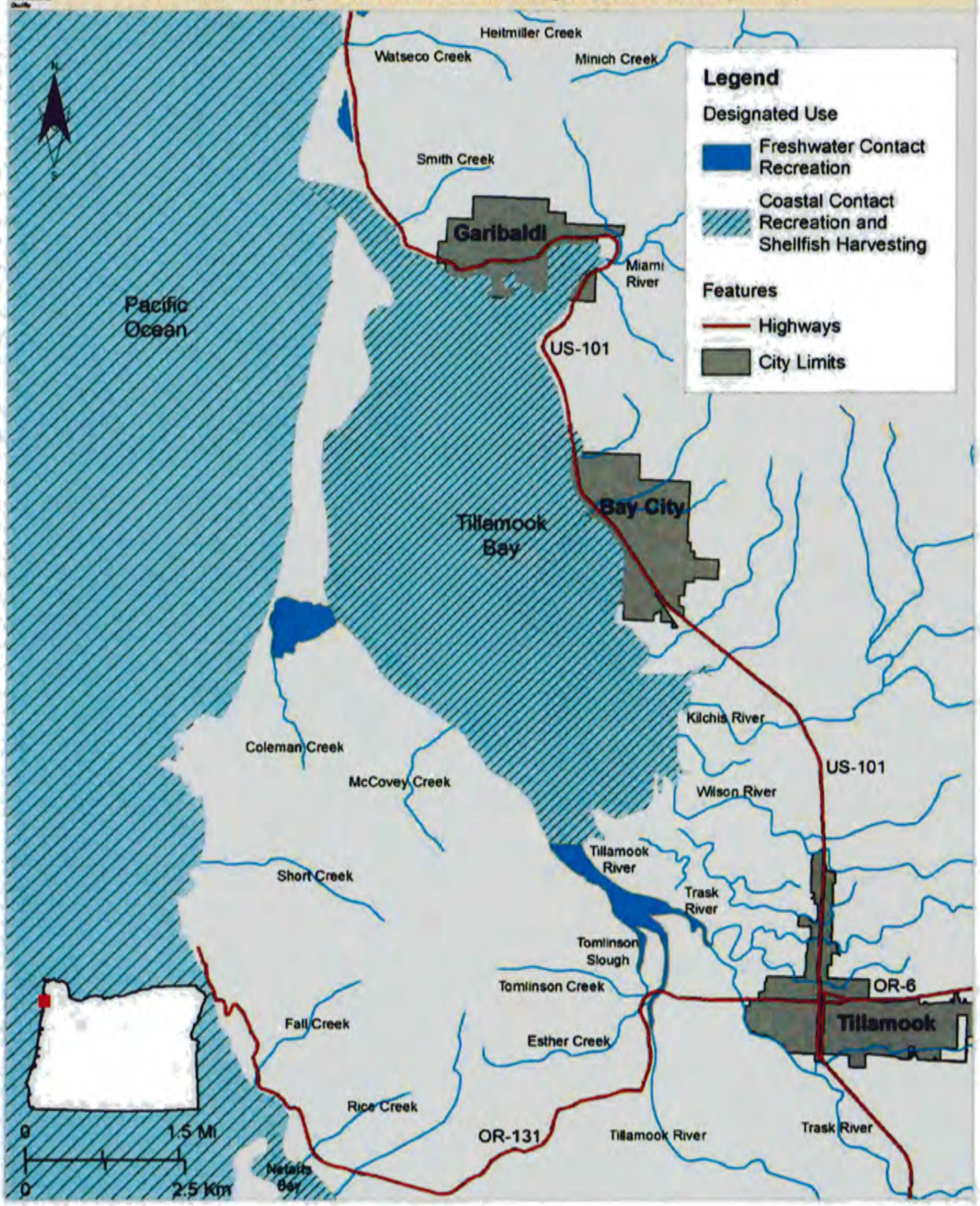
Figure 230D: Water Contact Recreation and Shellfish Harvesting Designated Uses

Nehalem Bay, North Coast Basin, Oregon (Draft February, 2016)



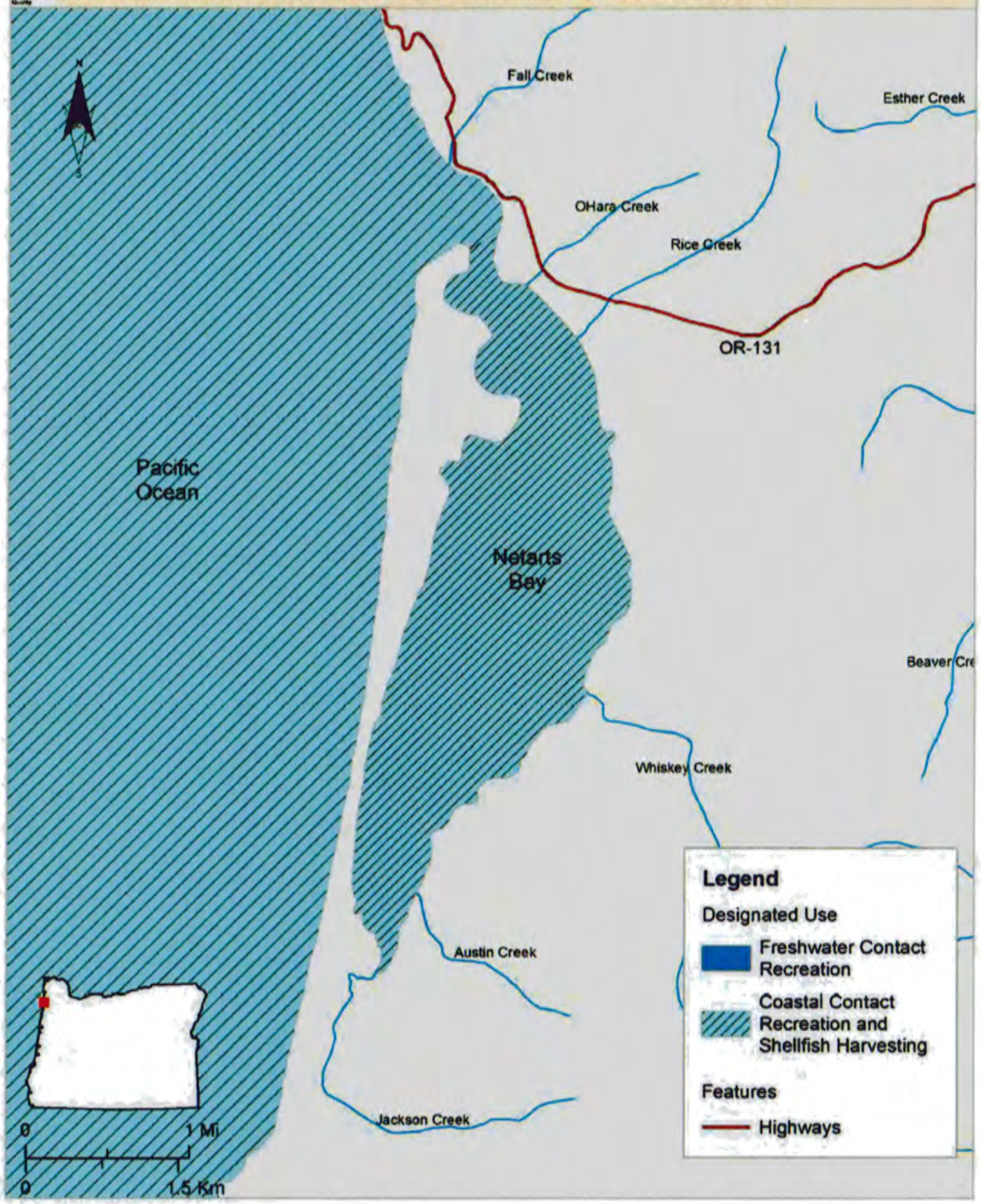
OAR 340-041-0230

Figure 230E: Water Contact Recreation and Shellfish Harvesting Designated Uses
Tillamook Bay, North Coast Basin, Oregon (Draft February, 2016)



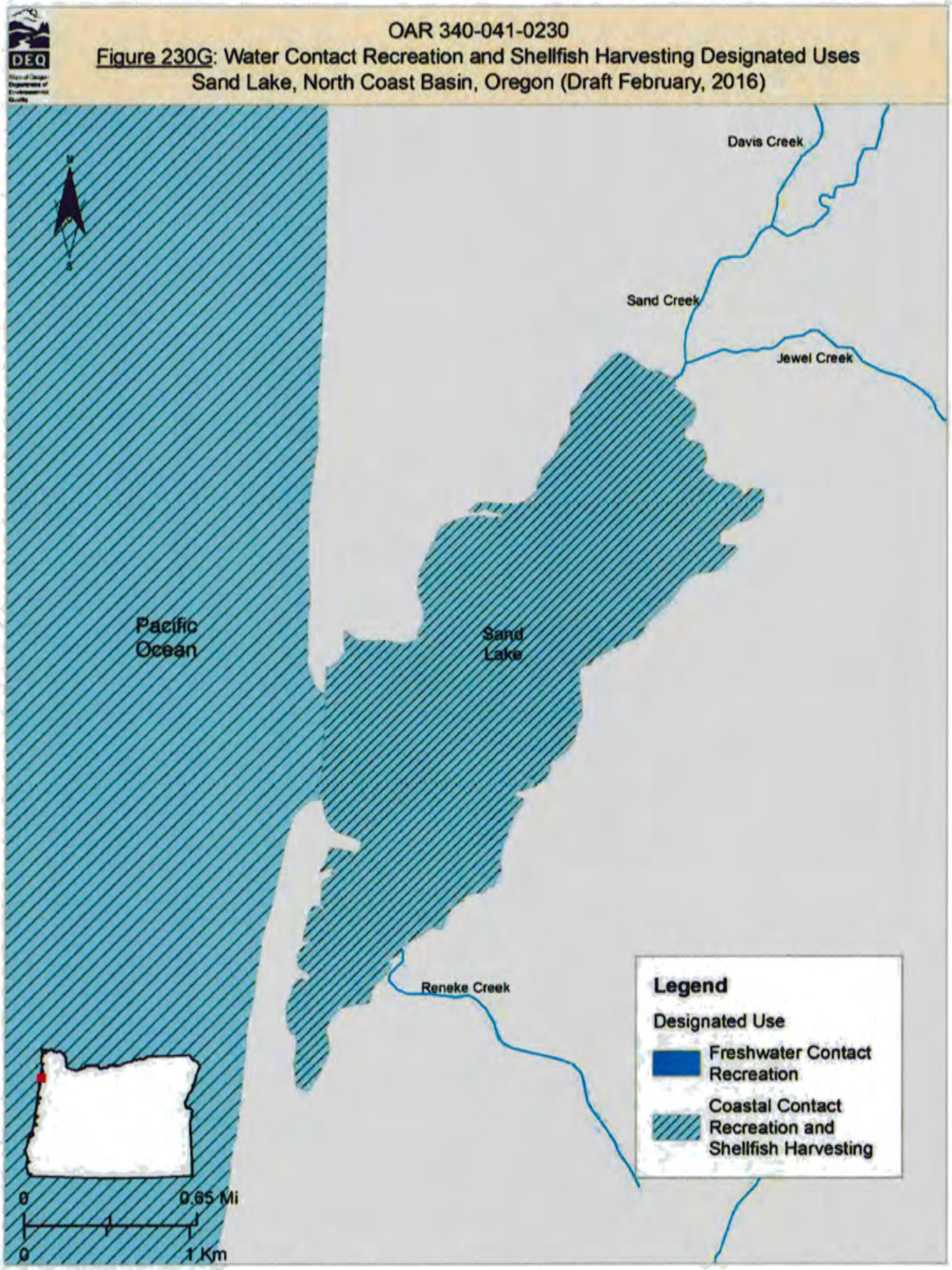
OAR 340-041-0230

Figure 230F: Water Contact Recreation and Shellfish Harvesting Designated Uses
Netarts Bay, North Coast Basin, Oregon (Draft February, 2016)



OAR 340-041-0230

Figure 230G: Water Contact Recreation and Shellfish Harvesting Designated Uses Sand Lake, North Coast Basin, Oregon (Draft February, 2016)



Effluent Characteristics 2

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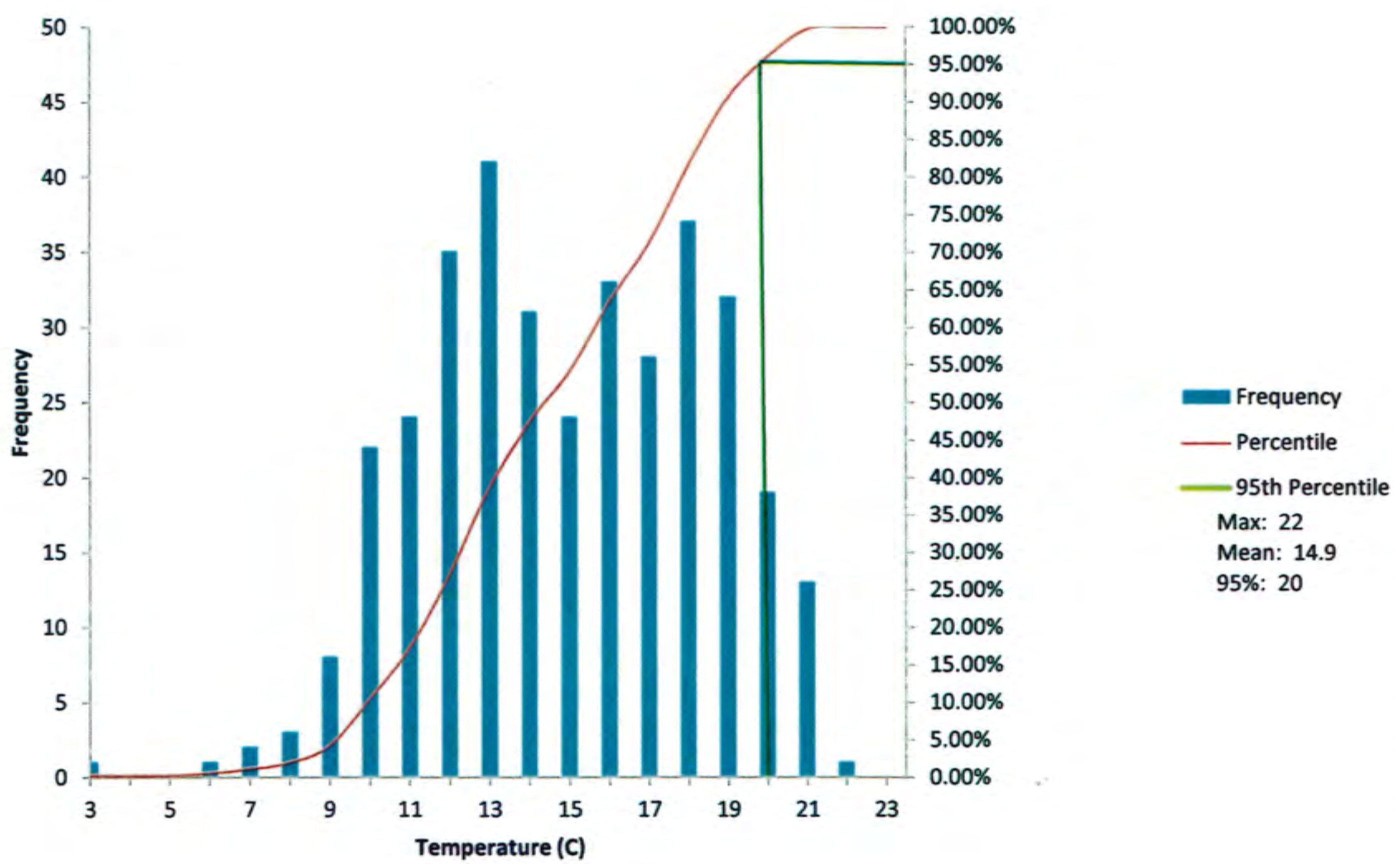
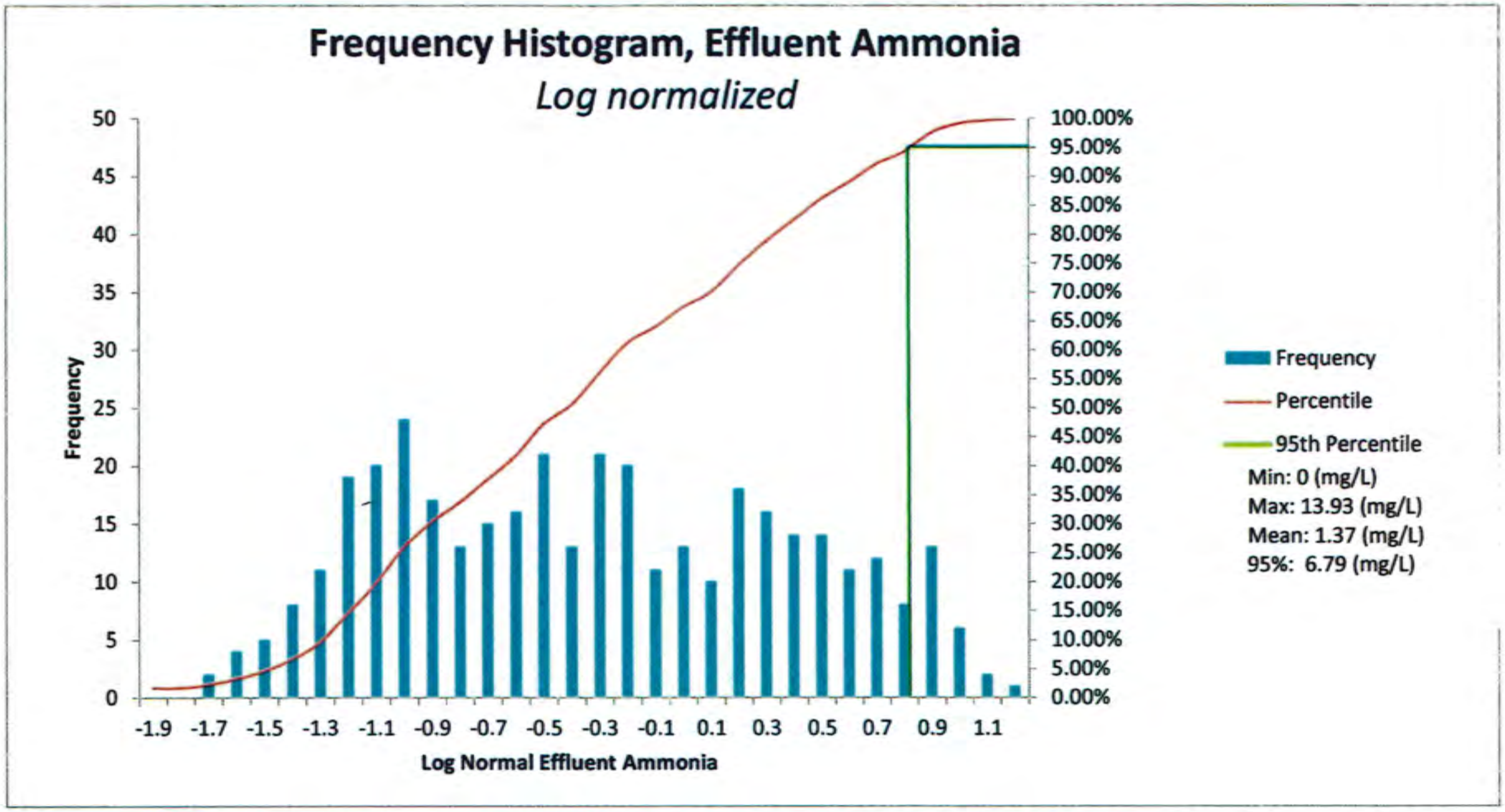
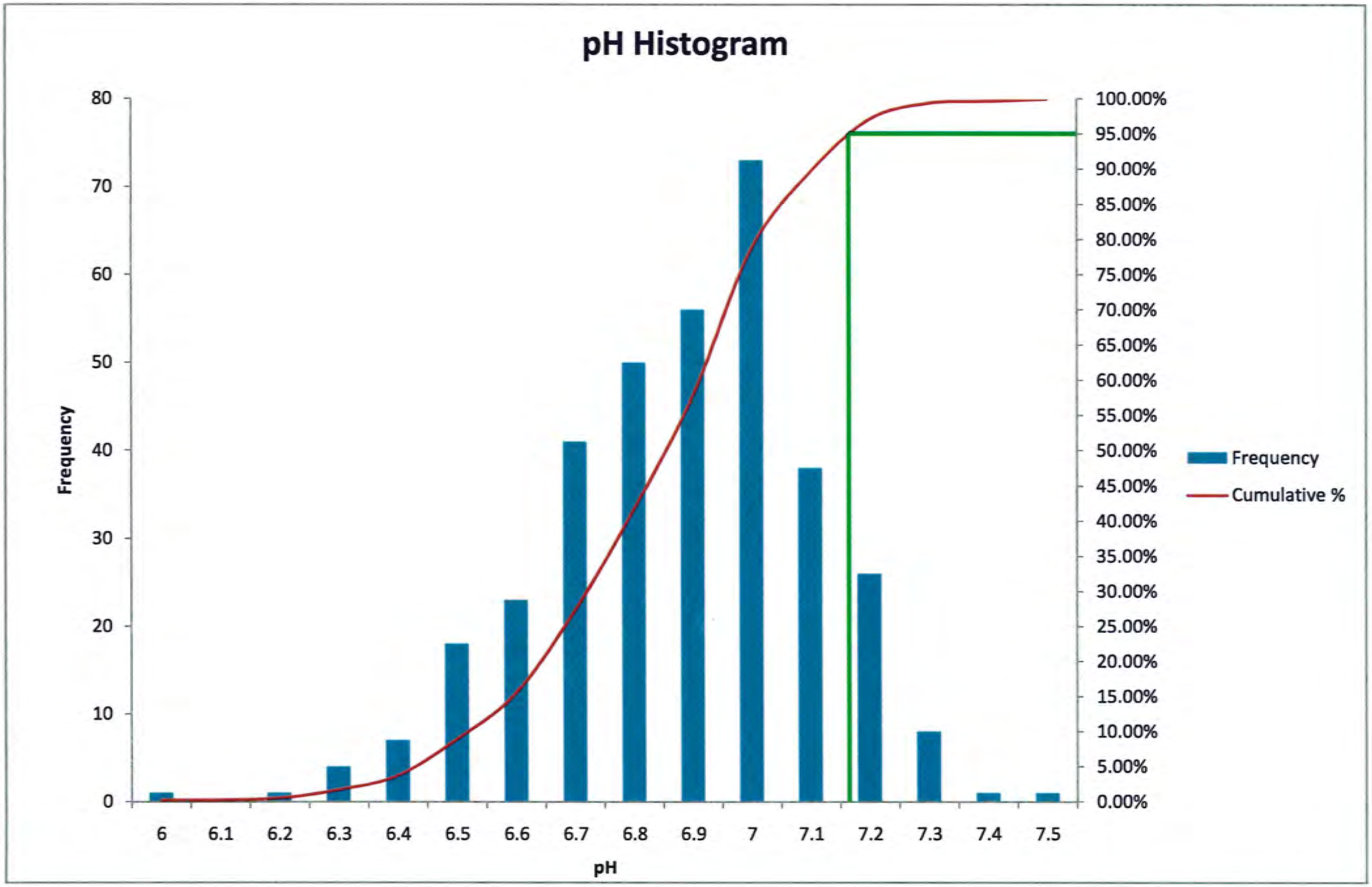
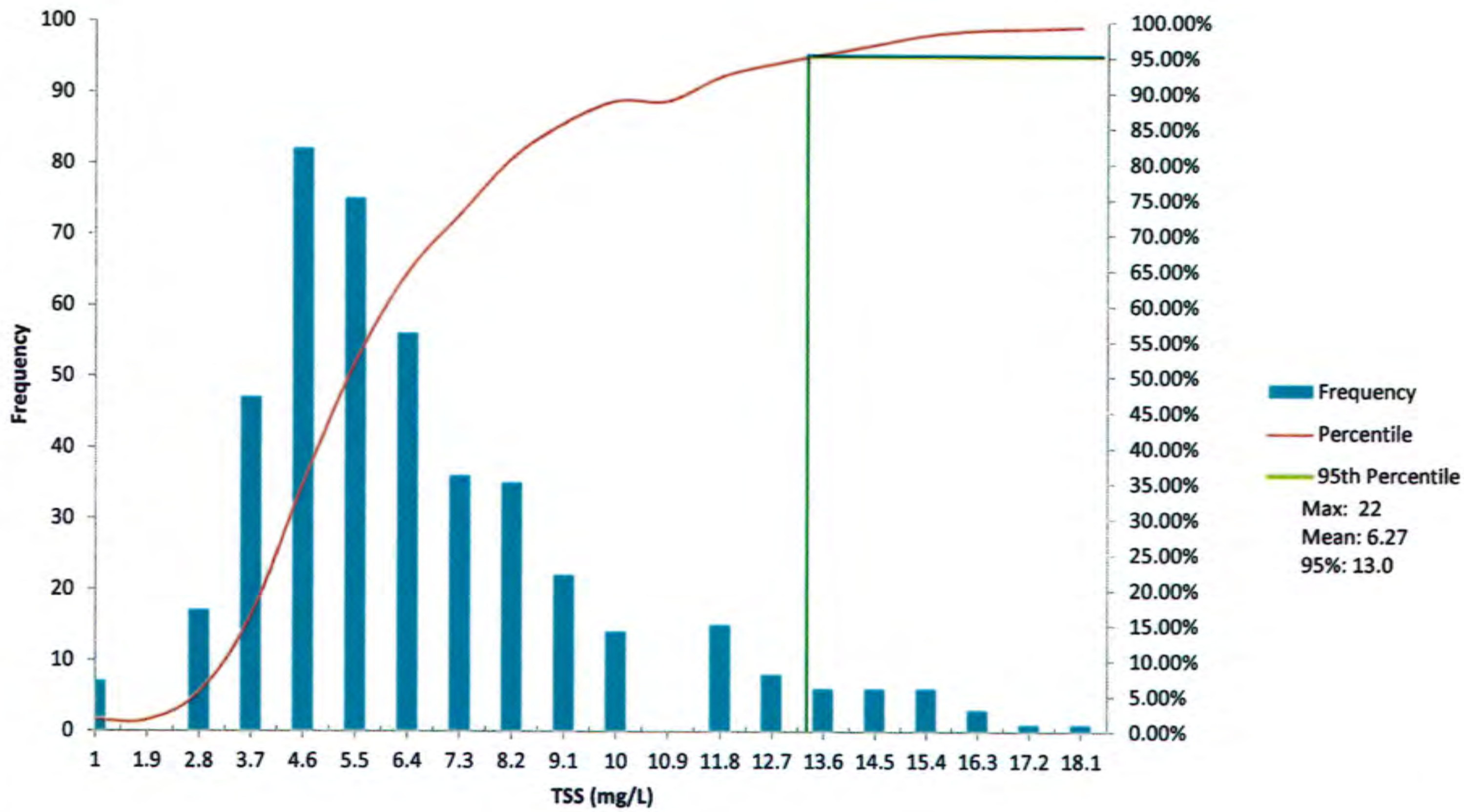
Temperature Frequency Histogram



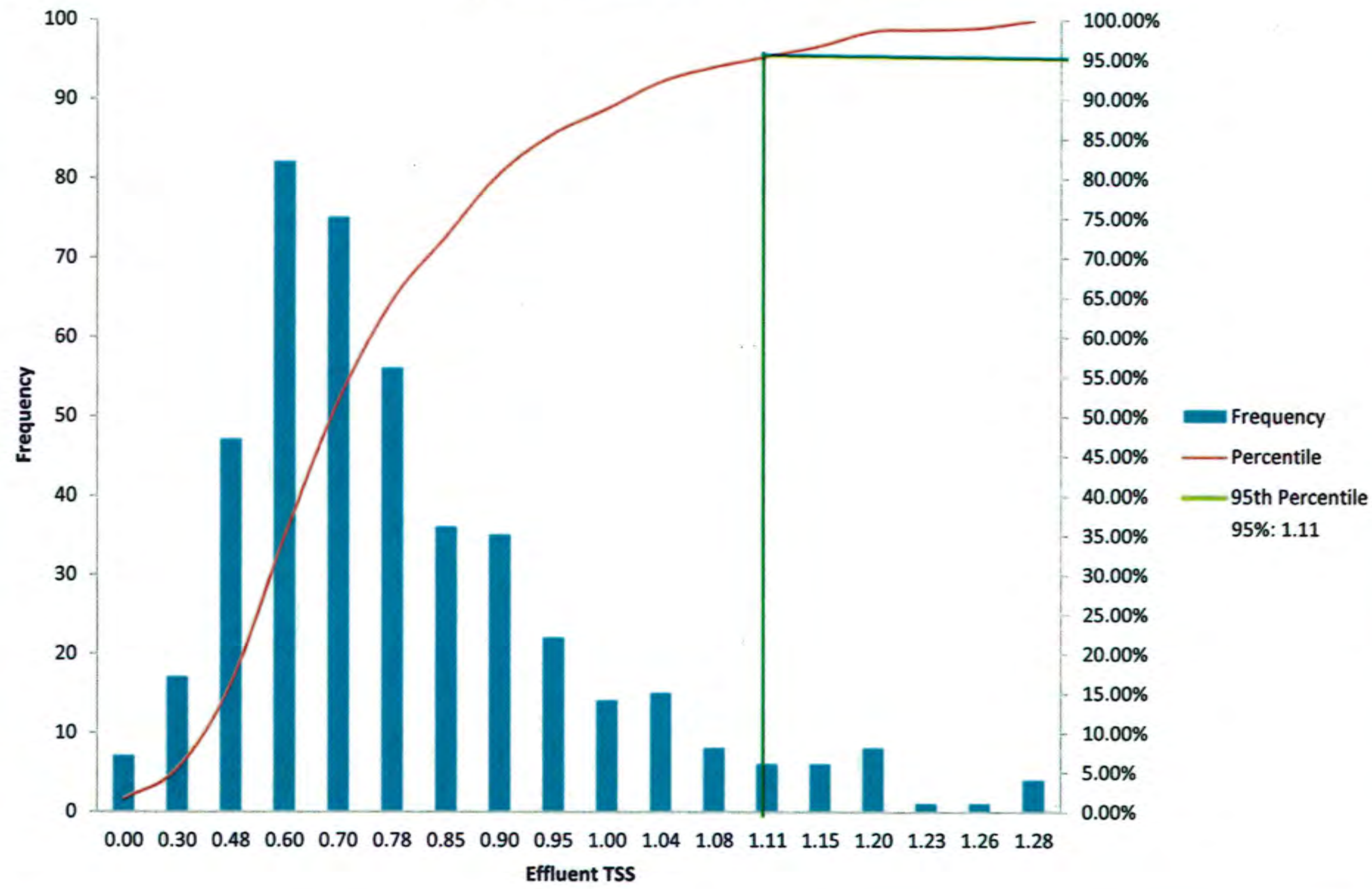

Frequency Histogram, Effluent Ammonia
Log normalized
Frequency
50
45
40
35
30
25
20
15
10
5
0
100.00%
95.00%
90.00%
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
55.00%
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
-1.9 -1.7 -1.5 -1.3 -1.1 -0.9 -0.7 -0.5 -0.3 -0.1 0.1 0.3 0.5 0.7 0.9 1.1
Log Normal Effluent Ammonia
Frequency
Percentile
95th Percentile
Min: 0 (mg/L)
Max: 13.93 (mg/L)
Mean: 1.37 (mg/L)
95%: 6.79 (mg/L)

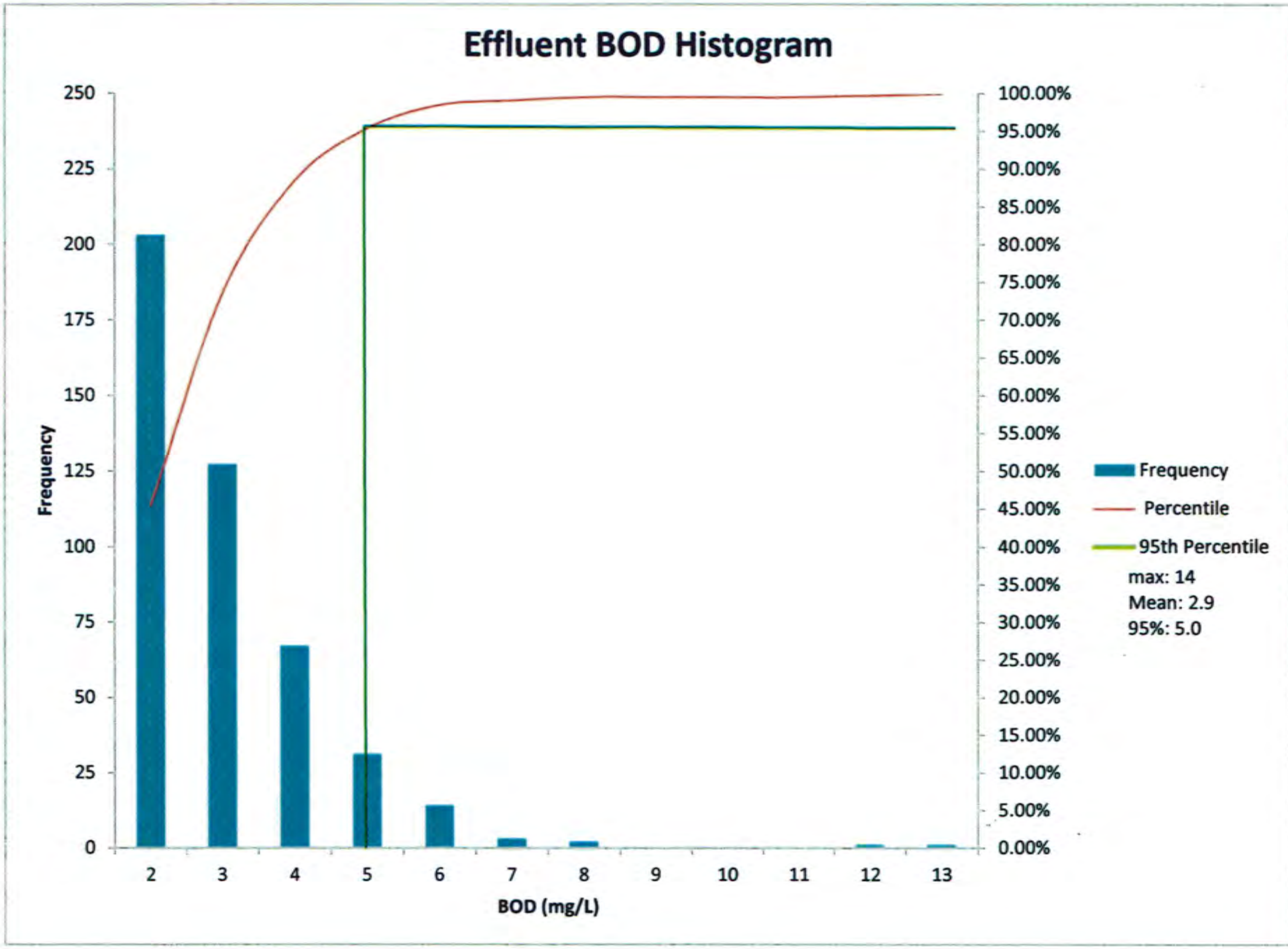

pH Histogram
Frequency
pH
Frequency
Cumulative %
0
10
20
30
40
50
60
70
80
6
6.1
6.2
6.3
6.4
6.5
6.6
6.7
6.8
6.9
7
7.1
7.2
7.3
7.4
7.5
0.00%
5.00%
10.00%
15.00%
20.00%
25.00%
30.00%
35.00%
40.00%
45.00%
50.00%
55.00%
60.00%
65.00%
70.00%
75.00%
80.00%
85.00%
90.00%
95.00%
100.00%

Effluent TSS Histogram

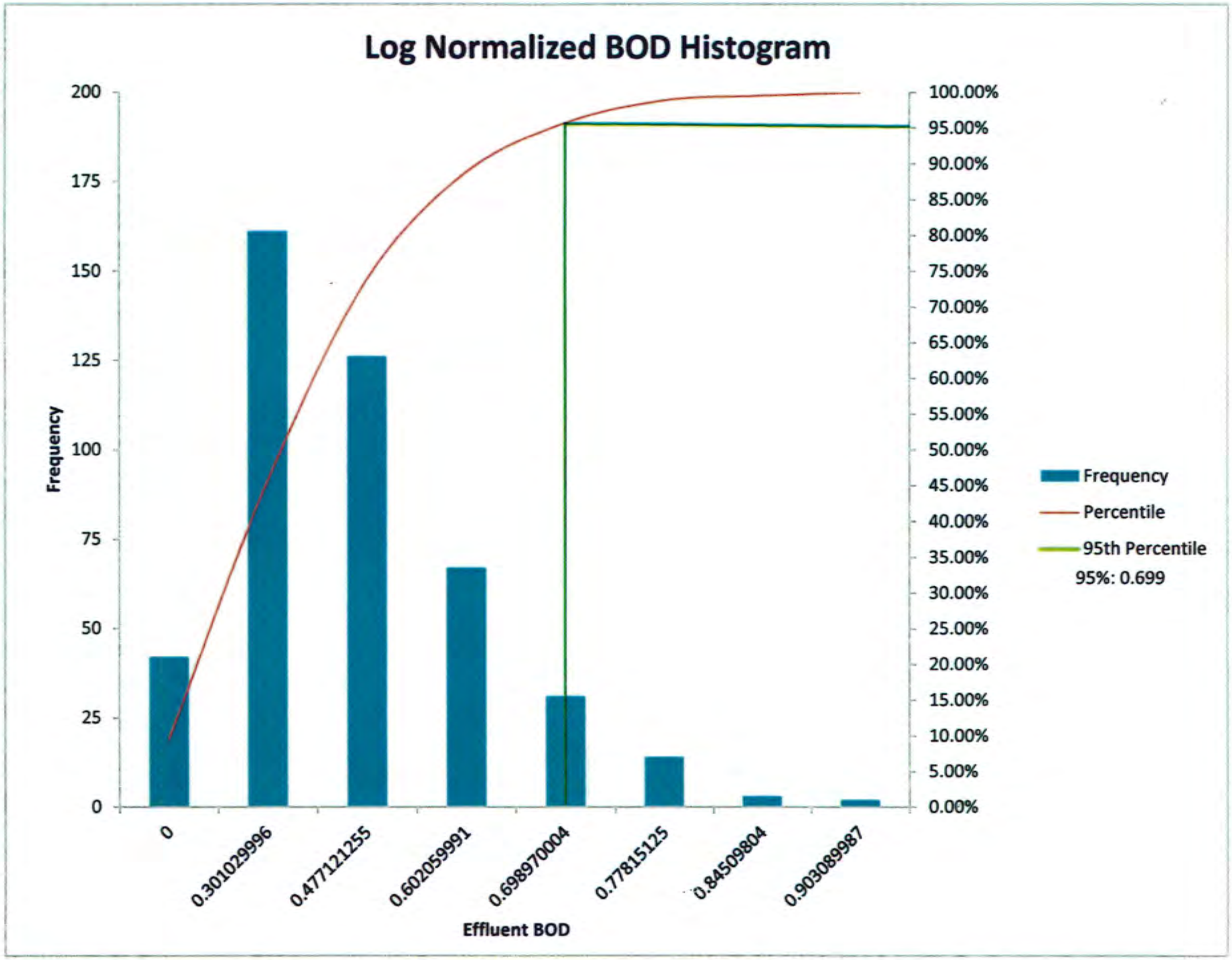


Log Normalized TSS Histogram





Effluent BOD Histogram
Frequency
250
225
200
175
150
125
100
75
50
25
0
2
3
4
5
6
7
8
9
10
11
12
13
BOD (mg/L)
100.00%
95.00%
90.00%
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
55.00%
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Frequency
Percentile
95th Percentile
max: 14
Mean: 2.9
95%: 5.0



Log Normalized BOD Histogram
Frequency
200
175
150
125
100
75
50
25
0
100.00%
95.00%
90.00%
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
55.00%
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
0
0.301029996
0.477121255
0.602059991
0.698970004
0.77815125
0.84509804
0.903089987
Effluent BOD
Frequency
Percentile
95th Percentile
95%: 0.699

CORMIX Model Results 3

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```
CORMIX1 PREDICTION FILE:
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                    CORMIX MIXING ZONE EXPERT SYSTEM
                  Subsystem CORMIX1: Single Port Discharges
                          CORMIX Version 11.0GTH
                     HYDRO1 Version 11.0.0.0 April 2018
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       a.  Max Ebb Current, MHHW
 FILE NAME:         U:\...ixZn\Output\a MHHW max eb current 8 inch port.prd
 Time stamp:        09/06/2018--16:18:57

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     4.11  HD    =      5.14
 Tidal Simulation at TIME =     -2.600 h
 PERIOD=    12.40 h UAmax =      1.000 dUa/dt=      0.288 (m/s)/h
 UA    =     0.750 F     =      0.020 USTAR =0.3712E-01
 UW    =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U         RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT     DISTB =      1.00
 D0    =     0.203 A0    =      0.032 H0    =      0.31  SUB0  =      4.84
 THETA =     10.00  SIGMA =     90.00
 U0    =     3.258 Q0    =      0.106       =0.1056E+00
 RHO0  =  998.0000  DRHO0 =0.1474E+02  GP0   =0.1427E+00
 C0    =0.6790E+01  CUNITS= mg/l
 IPOLL = 1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00  M0    =0.3441E+00  J0    =0.1508E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =      3.66  Lm    =      0.78  Lb    =      0.04
                                        Lmp   =  99999.00  Lbp   =  99999.00
 Tidal:             Tu    =   0.1251 h Lu    =     16.254 Lmin  =      0.180
 Tidal Cutoffs (m): lmax  =  2941.769  xmax  =  8370.000  ymax  =   219.432

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.13  R     =      4.34

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    H2    1
 1  Applicable layer depth HS =    5.14  1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS= mg/l
 NTOX  = 1         CMC   =0.1040E+01  CCC   = CSTD
 NSTD  = 1         CSTD  =0.1600E+00
 REGMZ = 0
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X         Y        Z         S       C         B        Uc        TT
      0.00      0.00     0.31      1.0 0.679E+01   0.10     3.258   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:            THETAE=      9.95  SIGMAE=     84.47
  LE    =      0.26  XE    =      0.01  YE    =      0.26  ZE    =      0.35

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X         Y        Z         S       C         B        Uc        TT
      0.00      0.00     0.31      1.0 0.679E+01   0.10     3.258   .00000E+00
      0.01      0.26     0.35      1.0 0.679E+01   0.11     3.258   .12117E-01
** CMC HAS BEEN FOUND **
```

The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

3.49	1.95	0.78	10.0	0.678E+00	0.54	0.134	.37366E+01
7.67	2.39	1.09	16.4	0.414E+00	0.70	0.078	.87385E+01
11.87	2.63	1.41	22.3	0.304E+00	0.82	0.060	.13915E+02
16.07	2.80	1.74	28.4	0.239E+00	0.93	0.049	.19177E+02
20.21	2.92	2.07	34.6	0.196E+00	1.03	0.043	.24427E+02
24.42	3.01	2.40	41.3	0.164E+00	1.13	0.038	.29779E+02

WATER QUALITY STANDARD OR CCC HAS BEEN FOUND
The pollutant concentration in the plume falls below water quality standard
or CCC value of 0.160E+00 in the current prediction interval.
This is the spatial extent of concentrations exceeding the water quality
standard or CCC value.

28.62	3.09	2.73	48.2	0.141E+00	1.22	0.034	.35161E+02
32.82	3.14	3.04	55.4	0.123E+00	1.31	0.031	.40566E+02
37.02	3.19	3.36	62.8	0.108E+00	1.40	0.028	.45990E+02
41.17	3.23	3.66	70.3	0.965E-01	1.48	0.026	.51353E+02

Cumulative travel time = 51.3532 sec (0.01 hrs)

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	TT
41.17	3.23	3.66	69.4	0.978E-01	1.48	.51353E+02

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)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
39.69	3.22	5.14	70.4	0.965E-01	0.00	0.00	5.14	5.14	.51353E+02
40.14	3.22	5.14	70.4	0.965E-01	1.84	0.92	5.14	3.30	.51353E+02
40.58	3.23	5.14	70.4	0.965E-01	2.18	1.31	5.14	2.96	.51353E+02
41.03	3.23	5.14	70.3	0.965E-01	2.40	1.60	5.14	2.74	.51353E+02
41.47	3.23	5.14	72.3	0.940E-01	2.56	1.85	5.14	2.58	.51748E+02
41.92	3.23	5.14	81.2	0.836E-01	2.68	2.07	5.14	2.46	.52341E+02
42.36	3.23	5.14	93.6	0.726E-01	2.77	2.26	5.14	2.37	.52933E+02
42.80	3.24	5.14	104.8	0.648E-01	2.84	2.44	5.14	2.30	.53525E+02
43.25	3.24	5.14	112.6	0.603E-01	2.88	2.61	5.14	2.26	.54118E+02
43.69	3.24	5.14	116.8	0.582E-01	2.91	2.77	5.14	2.23	.54710E+02
44.14	3.24	5.14	119.5	0.568E-01	2.92	2.92	5.14	2.22	.55302E+02

Cumulative travel time = 55.3025 sec (0.02 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** 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)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
44.14	3.24	5.14	119.5	0.568E-01	2.92	2.92	5.14	2.22	.55302E+02
46.78	3.24	5.14	121.4	0.559E-01	2.83	3.07	5.14	2.31	.58831E+02
49.43	3.24	5.14	123.2	0.551E-01	2.75	3.21	5.14	2.39	.62360E+02
52.08	3.24	5.14	125.0	0.543E-01	2.68	3.34	5.14	2.46	.65888E+02
54.72	3.24	5.14	126.9	0.535E-01	2.61	3.48	5.14	2.53	.69417E+02
57.37	3.24	5.14	128.7	0.528E-01	2.55	3.61	5.14	2.59	.72945E+02
60.02	3.24	5.14	130.5	0.520E-01	2.50	3.74	5.14	2.64	.76474E+02
62.66	3.24	5.14	132.4	0.513E-01	2.46	3.87	5.14	2.68	.80003E+02
65.31	3.24	5.14	134.2	0.506E-01	2.41	4.00	5.14	2.73	.83531E+02
67.95	3.24	5.14	136.1	0.499E-01	2.38	4.12	5.14	2.76	.87060E+02
70.60	3.24	5.14	138.0	0.492E-01	2.34	4.24	5.14	2.80	.90588E+02

Cumulative travel time = 90.5885 sec (0.03 hrs)

Plume is ATTACHED to RIGHT bank/shore.
Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
70.60	-1.00	5.14	138.0	0.492E-01	2.34	8.49	5.14	2.80	.90588E+02
87.88	-1.00	5.14	147.9	0.459E-01	2.31	9.26	5.14	2.83	.11362E+03

105.15	-1.00	5.14	158.8	0.428E-01	2.31	10.01	5.14	2.83	.13666E+03
122.43	-1.00	5.14	170.9	0.397E-01	2.33	10.72	5.14	2.81	.15970E+03
139.71	-1.00	5.14	184.2	0.369E-01	2.37	11.41	5.14	2.77	.18273E+03
156.99	-1.00	5.14	198.9	0.341E-01	2.42	12.09	5.14	2.72	.20577E+03
174.26	-1.00	5.14	214.9	0.316E-01	2.50	12.74	5.14	2.64	.22880E+03
191.54	-1.00	5.14	232.3	0.292E-01	2.58	13.38	5.14	2.56	.25184E+03
208.82	-1.00	5.14	251.1	0.270E-01	2.68	14.00	5.14	2.46	.27487E+03
226.09	-1.00	5.14	271.5	0.250E-01	2.78	14.61	5.14	2.36	.29791E+03
243.37	-1.00	5.14	293.3	0.232E-01	2.90	15.21	5.14	2.24	.32095E+03

Cumulative travel time = 320.9453 sec (0.09 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING

Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = 1.03m

---

BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = 0.383E-01 m^2/s
Horizontal diffusivity (initial value) = 0.565E-01 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)
TT = Cumulative travel time

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
243.37	-1.00	5.14	293.3	0.232E-01	2.90	15.21	5.14	2.24	.32095E+03

Plume interacts with BOTTOM.
The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
prediction interval.

419.03	-1.00	5.14	437.9	0.155E-01	4.11	16.60	5.14	1.03	.55516E+03
594.70	-1.00	5.14	462.9	0.147E-01	4.11	18.02	5.14	1.03	.78938E+03
770.36	-1.00	5.14	490.3	0.138E-01	4.11	19.49	5.14	1.03	.10236E+04
946.02	-1.00	5.14	520.1	0.131E-01	4.11	20.99	5.14	1.03	.12578E+04
1121.68	-1.00	5.14	552.2	0.123E-01	4.11	22.54	5.14	1.03	.14920E+04
1297.35	-1.00	5.14	586.3	0.116E-01	4.11	24.11	5.14	1.03	.17262E+04
1473.01	-1.00	5.14	622.6	0.109E-01	4.11	25.72	5.14	1.03	.19605E+04
1648.67	-1.00	5.14	660.9	0.103E-01	4.11	27.37	5.14	1.03	.21947E+04
1824.34	-1.00	5.14	701.2	0.968E-02	4.11	29.05	5.14	1.03	.24289E+04
2000.00	-1.00	5.14	743.5	0.913E-02	4.11	30.76	5.14	1.03	.26631E+04

Cumulative travel time = 2663.1201 sec (0.74 hrs)

Simulation limit based on maximum specified distance = 2000.00 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
1111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  a.  Max Ebb Current, MHHW
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\a MHHW max eb current 8 inch port.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:18:57
***************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                 HA      = 4.11 m
  Depth at discharge            HD      = 5.14 m
  Darcy-Weisbach friction factor F      = 0.0196
    Calculated from Manning's n         = 0.02
  Wind velocity                 UW      = 5.7 m/s
TIDAL SIMULATION at time        Tsim    = -2.6 hours
  Instantaneous ambient velocity UA     = 0.75 m/s
  Maximum tidal velocity        UaMAX   = 1 m/s
Rate of tidal reversal         dUA/dt = 0.2885 (m/s)/hour
  Period of reversal            T       = 12.4 hours
  Stratification Type           STRCND = U
  Surface density               RHOAS  = 1012.74 kg/m^3
  Bottom density                RHOAB  = 1012.74 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Single Port Discharge
  Nearest bank                           = right
  Distance to bank              DISTB  = 1 m
  Port diameter                 D0      = 0.2032 m
  Port cross-sectional area     A0      = 0.0324 m^2
  Discharge velocity            U0      = 3.26 m/s
  Discharge flowrate            Q0      = 0.10564 m^3/s
  Discharge port height         H0      = 0.31 m
  Vertical discharge angle      THETA  = 10 deg
  Horizontal discharge angle    SIGMA  = 90 deg
  Discharge density             RHO0   = 998 kg/m^3
  Density difference            DRHO   = 14.7400 kg/m^3
  Buoyant acceleration          GP0    = 0.1427 m/s^2
  Discharge concentration       C0      = 6.79 mg/l
  Surface heat exchange coeff.  KS      = 0 m/s
  Coefficient of decay          KD      = 0 /s
---------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m         Lm  = 0.78 m          Lb  = 0.04 m
  LM  = 3.66 m         Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.1251 hours     Lu  = 16.25 m         Lmin= 0.18 m
---------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.13
  Velocity ratio                  R      = 4.34
---------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration             CMC     = 1.04 mg/l
  CCC concentration             CCC     = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 2000 m downstream
***************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 5.14 m
***************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

---------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.0568 mg/l
  Dilution at edge of NFR              s = 119.5
  NFR Location:                        x = 44.14 m
    (centerline coordinates)           y = 3.24 m
                                       z = 5.14 m
```

```
  NFR plume dimensions:  half-width (bh) = 2.92 m
                          thickness (bv) = 2.92 m
Cumulative travel time:       55.3024 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 419.03 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 70.60 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
  Within the region of interest (ROI), the location and trajectory of flow
  are well represented using steady-state analysis and are not limited by
  any tidal restrictions.
  For this condition BEFORE TIDAL REVERSAL, extensive re-entrainment
  of previously discharged is unlikely.
  To determine the minimum dilution, perform additional simulations
  after slack tide.
*********************** TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                      x = 1.71 m
    (centerline coordinates)           y = 1.61 m
                                       z = 0.64 m
  Plume dimension:        half-width (bh) = 0.06 m
                           thickness (bv) = 0.06 m

 Computed distance from port opening to CMC location = 2.37 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.35 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 5.14 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************* REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                    = 0.16  mg/l
Corresponding dilution                   = 42.4
  Plume location:                      x = 25.13 m
    (centerline coordinates)           y = 3.03 m
                                       z = 2.46 m
 Computed horizontal distance from port opening to CCC location = 25.40
  Plume dimension:        half-width (bh) = 1.14 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:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                    CORMIX MIXING ZONE EXPERT SYSTEM
                 Subsystem CORMIX1: Single Port Discharges
                         CORMIX Version 11.0GTH
                  HYDRO1 Version 11.0.0.0 April 2018
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       b. mid High and Low Slack
 FILE NAME:         U:\...mid High and Low Slack single diff 8inch port.prd
 Time stamp:        09/06/2018--16:21:12

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    116.00 AS    =    476.76 QA    =    238.38  ICHREG= 1
 HA    =      4.11 HD    =      4.11
 Tidal Simulation at TIME =    -1.100 h
 PERIOD=    12.40 h UAmax =     1.000 dUa/dt=      0.455 (m/s)/h
 UA    =     0.500 F     =     0.020 USTAR =0.2475E-01
 UW    =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U         RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT     DISTB =      1.00
 D0    =     0.203 A0    =     0.032 H0    =      0.30  SUB0  =       3.81
 THETA =     10.00  SIGMA =     90.00
 U0    =     3.257 Q0    =     0.106       =0.1056E+00
 RHO0  =  998.0000  DRHO0 =0.1474E+02 GP0   =0.1427E+00
 C0    =0.6790E+01  CUNITS= mg/l
 IPOLL =  1         KS    =0.0000E+00 KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00 M0    =0.3440E+00 J0    =0.1507E-01 SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18 LM    =      3.66 Lm    =       1.17 Lb    =       0.12
                                     Lmp   =  99999.00 Lbp   =  99999.00
 Tidal:             Tu    =   0.0924 h Lu    =     13.966 Lmin  =      0.180
 Tidal Cutoffs (m): lmax  =   869.798 xmax  =  5580.000 ymax  =**********

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12 R     =      6.51

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =     H2     1
 1  Applicable layer depth HS =     4.11   1
 1  Limiting Dilution S =QA/Q0=  2258.11   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS= mg/l
 NTOX  =  1         CMC   =0.1040E+01  CCC   = CSTD
 NSTD  =  1         CSTD  =0.1600E+00
 REGMZ =  0
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X         Y        Z         S        C        B        Uc        TT
      0.00      0.00     0.30      1.0 0.679E+01   0.10    3.257   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:            THETAE=       9.98  SIGMAE=      86.31
  LE    =      0.51 XE    =      0.02 YE    =       0.51 ZE    =       0.39

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X         Y        Z         S        C        B        Uc        TT
      0.00      0.00     0.30      1.0 0.679E+01   0.10    3.257   .00000E+00
```

0.02	0.51	0.39	1.0	0.679E+01	0.11	3.257	.94232E-02
0.86	2.00	0.71	4.4	0.154E+01	0.40	0.599	.10613E+01

** CMC HAS BEEN FOUND **
The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

2.50	2.70	0.95	9.2	0.739E+00	0.62	0.217	.33516E+01
4.29	3.09	1.17	13.3	0.512E+00	0.75	0.140	.61743E+01
6.07	3.35	1.39	16.9	0.402E+00	0.86	0.110	.91208E+01
7.89	3.55	1.62	20.5	0.331E+00	0.95	0.092	.12239E+02
9.68	3.71	1.85	24.0	0.282E+00	1.03	0.081	.15355E+02
11.51	3.84	2.08	27.7	0.245E+00	1.11	0.073	.18591E+02
13.30	3.94	2.31	31.4	0.216E+00	1.19	0.067	.21794E+02
15.13	4.03	2.55	35.3	0.193E+00	1.26	0.062	.25100E+02
16.93	4.11	2.78	39.1	0.174E+00	1.33	0.057	.28346E+02

Cumulative travel time = 28.3460 sec (0.01 hrs)

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	TT
16.93	4.11	2.78	39.0	0.174E+00	1.33	.28346E+02

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)
- TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
15.60	4.08	4.11	39.1	0.174E+00	0.00	0.00	4.11	4.11	.28346E+02
16.00	4.09	4.11	39.1	0.174E+00	1.67	0.84	4.11	2.44	.28346E+02
16.39	4.10	4.11	39.1	0.174E+00	1.98	1.19	4.11	2.13	.28346E+02
16.79	4.10	4.11	39.1	0.174E+00	2.18	1.45	4.11	1.93	.28346E+02
17.19	4.11	4.11	40.2	0.169E+00	2.32	1.68	4.11	1.79	.28879E+02

WATER QUALITY STANDARD OR CCC HAS BEEN FOUND
The pollutant concentration in the plume falls below water quality standard
or CCC value of 0.160E+00 in the current prediction interval.
This is the spatial extent of concentrations exceeding the water quality
standard or CCC value.

17.59	4.12	4.11	45.2	0.150E+00	2.43	1.88	4.11	1.68	.29676E+02
17.99	4.13	4.11	52.1	0.130E+00	2.52	2.06	4.11	1.59	.30473E+02
18.39	4.13	4.11	58.3	0.116E+00	2.58	2.22	4.11	1.53	.31269E+02
18.79	4.14	4.11	62.6	0.108E+00	2.62	2.37	4.11	1.49	.32066E+02
19.18	4.15	4.11	65.0	0.105E+00	2.65	2.52	4.11	1.46	.32863E+02
19.58	4.16	4.11	66.5	0.102E+00	2.65	2.65	4.11	1.46	.33660E+02

Cumulative travel time = 33.6603 sec (0.01 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** 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)
- TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
19.58	4.16	4.11	66.5	0.102E+00	2.65	2.65	4.11	1.46	.33660E+02
22.43	4.16	4.11	68.3	0.994E-01	2.46	2.95	4.11	1.65	.39344E+02
25.27	4.16	4.11	70.0	0.970E-01	2.30	3.23	4.11	1.81	.45028E+02
28.11	4.16	4.11	71.5	0.950E-01	2.17	3.50	4.11	1.94	.50712E+02
30.96	4.16	4.11	72.9	0.931E-01	2.06	3.76	4.11	2.05	.56396E+02
33.80	4.16	4.11	74.3	0.914E-01	1.97	4.01	4.11	2.14	.62079E+02
36.64	4.16	4.11	75.5	0.899E-01	1.89	4.25	4.11	2.22	.67763E+02
39.48	4.16	4.11	76.8	0.884E-01	1.82	4.49	4.11	2.29	.73447E+02
42.33	4.16	4.11	78.0	0.871E-01	1.76	4.72	4.11	2.35	.79131E+02
45.17	4.16	4.11	79.1	0.858E-01	1.71	4.94	4.11	2.40	.84815E+02
48.01	4.16	4.11	80.3	0.846E-01	1.66	5.16	4.11	2.45	.90498E+02

Cumulative travel time = 90.4984 sec (0.03 hrs)

Plume is ATTACHED to RIGHT bank/shore.
Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT

```
     48.01     -1.00     4.11     80.3 0.846E-01   1.66     10.32     4.11     2.45 .90498E+02
    115.45     -1.00     4.11     99.7 0.681E-01   1.44     14.97     4.11     2.67 .22531E+03
    182.89     -1.00     4.11    126.7 0.536E-01   1.45     18.97     4.11     2.66 .36013E+03
    250.33     -1.00     4.11    163.4 0.416E-01   1.59     22.59     4.11     2.52 .49494E+03
    317.76     -1.00     4.11    211.1 0.322E-01   1.80     25.93     4.11     2.31 .62976E+03
    385.20     -1.00     4.11    270.9 0.251E-01   2.07     29.08     4.11     2.04 .76457E+03
    452.64     -1.00     4.11    343.4 0.198E-01   2.40     32.06     4.11     1.71 .89939E+03
    520.08     -1.00     4.11    429.3 0.158E-01   2.77     34.90     4.11     1.34 .10342E+04
    587.51     -1.00     4.11    529.4 0.128E-01   3.18     37.64     4.11     0.93 .11690E+04
    654.95     -1.00     4.11    644.1 0.105E-01   3.63     40.28     4.11     0.48 .13038E+04
    722.39     -1.00     4.11    774.0 0.877E-02   4.11     42.84     4.11     0.00 .14387E+04
 Cumulative travel time =        1438.6505 sec  (     0.40 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)   = 0.205E-01 m^2/s
  Horizontal diffusivity (initial value) = 0.256E-01 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)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X         Y        Z         S        C         BV        BH        ZU       ZL        TT
    722.39     -1.00     4.11    774.0 0.877E-02   4.11     42.84     4.11     0.00 .14387E+04
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
    850.15     -1.00     4.11    774.8 0.876E-02   4.11     43.08     4.11     0.00 .16941E+04
    869.79     -1.00     4.11    775.1 0.876E-02   4.11     43.12     4.11     0.00 .17333E+04
 Cumulative travel time =        1733.3184 sec  (     0.48 hrs)

 CORMIX simulation has been TERMINATED at last prediction interval.
   Limiting distance (lmax) due to TIDAL REVERSAL has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  b. mid High and Low Slack
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\b mid High and Low Slack single diff 8inch port.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:21:12
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = bounded
  Width                           BS       = 116 m
  Channel regularity              ICHREG = 1
  Ambient flowrate                QA       = 238.38 m^3/s
  Average depth                   HA       = 4.11 m
  Depth at discharge              HD       = 4.11 m
  Darcy-Weisbach friction factor  F        = 0.0196
    Calculated from Manning's n            = 0.02
  Wind velocity                   UW       = 5.7 m/s
TIDAL SIMULATION at time          Tsim     = -1.1 hours
  Instantaneous ambient velocity  UA       = 0.5 m/s
  Maximum tidal velocity          UaMAX  = 1 m/s
Rate of tidal reversal          dUA/dt = 0.4545 (m/s)/hour
  Period of reversal              T        = 12.4 hours
  Stratification Type             STRCND = U
  Surface density                 RHOAS  = 1012.74 kg/m^3
  Bottom density                  RHOAB  = 1012.74 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                             = right
  Distance to bank                DISTB  = 1 m
  Port diameter                   D0       = 0.2032 m
  Port cross-sectional area       A0       = 0.0324 m^2
  Discharge velocity              U0       = 3.26 m/s
  Discharge flowrate              Q0       = 0.105613 m^3/s
  Discharge port height           H0       = 0.30 m
  Vertical discharge angle        THETA  = 10 deg
  Horizontal discharge angle      SIGMA  = 90 deg
  Discharge density               RHO0     = 998 kg/m^3
  Density difference              DRHO     = 14.7400 kg/m^3
  Buoyant acceleration            GP0      = 0.1427 m/s^2
  Discharge concentration         C0       = 6.79 mg/l
  Surface heat exchange coeff.    KS       = 0 m/s
  Coefficient of decay            KD       = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m        Lm  = 1.17 m         Lb  = 0.12 m
  LM  = 3.66 m        Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.0924 hours     Lu  = 13.97 m         Lmin= 0.18 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0      = 19.12
  Velocity ratio                  R        = 6.51
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = yes
  CMC concentration               CMC      = 1.04 mg/l
  CCC concentration               CCC      = 0.16 mg/l
  Water quality standard specified         = given by CCC value
  Regulatory mixing zone                   = no
  Region of interest                       = 2000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 4.11 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 2258.1

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.1021 mg/l
  Dilution at edge of NFR              s = 66.5
  NFR Location:                        x = 19.58 m
    (centerline coordinates)           y = 4.16 m
                                       z = 4.11 m
  NFR plume dimensions:  half-width (bh) = 2.65 m
                          thickness (bv) = 2.65 m
Cumulative travel time:       33.6603 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 850.15 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section contacts one bank only at 48.01 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                       x = 869.79 m
                                       y = -1 m
                                       z = 4.11 m.
  For this condition BEFORE TIDAL REVERSAL, extensive re-entrainment
  of previously discharged is unlikely.
  To determine the minimum dilution, perform additional simulations
  after slack tide.
************************ TOXIC DILUTION ZONE SUMMARY ************************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                      x = 1.51 m
    (centerline coordinates)           y = 2.36 m
                                       z = 0.82 m
  Plume dimension:       half-width (bh) = 0.04 m
                          thickness (bv) = 0.04 m

 Computed distance from port opening to CMC location = 2.85 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.80 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 4.11 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                    = 0.16  mg/l
Corresponding dilution                   = 42.6
  Plume location:                      x = 17.38 m
    (centerline coordinates)           y = 4.12 m
                                       z = 4.11 m
 Computed horizontal distance from port opening to CCC location = 18.26
  Plume dimensions:      half-width (bh) = 1.77 m
                          thickness (bv) = 2.38 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.
```

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CORMIX1 PREDICTION FILE:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                      CORMIX MIXING ZONE EXPERT SYSTEM
                   Subsystem CORMIX1: Single Port Discharges
                            CORMIX Version 11.0GTH
                    HYDRO1 Version 11.0.0.0 April 2018
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:  Bay City Outfall
 Design case:      c. Low Slack
 FILE NAME:        U:\...Zn\Output\c Low Slack single diff 8 inch port.prd
 Time stamp:       09/06/2018--16:25:41

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =      4.11  HD    =      3.14
 UA    =     0.000  F     =     0.020  USTAR =0.0000E+00
 UW    =     5.700  UWSTAR=0.6815E-02
 Uniform density environment
 STRCND=  U         RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  =  RIGHT     DISTB =      1.00
 D0    =     0.203  A0    =     0.032  H0    =      0.60  SUB0  =       2.54
 THETA =     10.00  SIGMA =     90.00
 U0    =     3.257  Q0    =     0.106        =0.1056E+00
 RHO0  =  998.0000  DRHO0 =0.1474E+02  GP0   =0.1427E+00
 C0    =0.6790E+01  CUNITS=  mg/l
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00  M0    =0.3440E+00  J0    =0.1507E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =      3.66  Lm    =  99999.00  Lb    =  99999.00
                                       Lmp   =  99999.00  Lbp   =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12  R     =  99999.00

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =   H4-90  1
 1  Applicable layer depth HS =    3.14   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS=  mg/l
 NTOX  =  1         CMC   =0.1040E+01  CCC   =  CSTD
 NSTD  =  1         CSTD  =0.1600E+00
 REGMZ =  0
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y        Z        S        C         B        Uc        TT
     0.00     0.00     0.60     1.0 0.679E+01   0.10     3.257   .00000E+00

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=     10.00  SIGMAE=     90.00
  LE    =      1.02  XE    =      0.00  YE    =      1.00  ZE    =      0.78

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X        Y        Z        S        C         B        Uc        TT
     0.00     0.00     0.60     1.0 0.679E+01   0.10     3.257   .00000E+00
     0.00     1.00     0.78     1.0 0.679E+01   0.10     3.257   .58365E-02
     0.00     1.49     0.87     1.3 0.519E+01   0.16     2.946   .14714E+00
     0.00     2.00     0.97     1.8 0.380E+01   0.22     2.169   .35806E+00
     0.00     2.51     1.09     2.3 0.300E+01   0.27     1.720   .63221E+00
     0.00     3.04     1.22     2.8 0.245E+01   0.33     1.417   .98723E+00
     0.00     3.54     1.38     3.3 0.208E+01   0.39     1.217   .13881E+01
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      0.00     4.04    1.55      3.8 0.180E+01  0.45    1.071   .18486E+01
      0.00     4.50    1.73      4.3 0.159E+01  0.50    0.965   .23394E+01
      0.00     4.97    1.95      4.8 0.141E+01  0.56    0.877   .29099E+01
      0.00     5.44    2.19      5.4 0.127E+01  0.61    0.808   .35327E+01
      0.00     5.89    2.46      5.9 0.114E+01  0.67    0.753   .42047E+01
 Cumulative travel time =         4.2047 sec  (    0.00 hrs)

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       TT
      0.00     5.89    2.46      5.9 0.114E+01  0.67 .42047E+01

 Profile definitions:
   BV = Gaussian 1/e (37%) vertical thickness
   BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X         Y        Z         S       C        BV       BH       ZU       ZL       TT
     -0.01     5.89    3.14      5.9 0.114E+01  0.00     0.00     3.14     3.14 .42047E+01
     -0.01     6.02    3.14      6.0 0.113E+01  0.60     0.30     3.14     2.54 .45056E+01
     -0.01     6.16    3.14      6.1 0.111E+01  0.71     0.42     3.14     2.43 .48074E+01
     -0.01     6.29    3.14      6.3 0.108E+01  0.78     0.52     3.14     2.36 .51092E+01
     -0.01     6.42    3.14      6.5 0.105E+01  0.83     0.60     3.14     2.31 .54110E+01
** CMC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below CMC value of 0.104E+01
   in the current prediction interval.
 This is the extent of the TOXIC DILUTION ZONE.
     -0.00     6.56    3.14      6.7 0.102E+01  0.87     0.67     3.14     2.27 .57128E+01
     -0.00     6.69    3.14      6.8 0.993E+00  0.90     0.73     3.14     2.24 .60146E+01
     -0.00     6.83    3.14      6.9 0.977E+00  0.92     0.79     3.14     2.22 .63164E+01
     -0.00     6.96    3.14      7.0 0.967E+00  0.94     0.85     3.14     2.20 .66182E+01
     -0.00     7.09    3.14      7.1 0.961E+00  0.95     0.90     3.14     2.19 .69199E+01
      0.00     7.23    3.14      7.1 0.954E+00  0.95     0.95     3.14     2.19 .72217E+01
 Cumulative travel time =         7.2217 sec  (    0.00 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH
----------------------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
 Discharge into STAGNANT AMBIENT environment:
   STEADY-STATE MIXING CONDITION IS NOT POSSIBLE in this zone, even though
   some ADDITIONAL DILUTION MAY OCCUR!
   Also, all far-field processes will be UNSTEADY.
 SIMULATION STOPS because of stagnant ambient conditions.
----------------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  c. Low Slack
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\c Low Slack single diff 8 inch port.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:25:41
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                  HA      = 4.11 m
  Depth at discharge             HD      = 3.14 m
  Ambient velocity               UA      = 0 m/s
  Darcy-Weisbach friction factor F       = 0.0196
    Calculated from Manning's n          = 0.02
  Wind velocity                  UW      = 5.7 m/s
  Stratification Type            STRCND  = U
  Surface density                RHOAS   = 1012.74 kg/m^3
  Bottom density                 RHOAB   = 1012.74 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                           = right
  Distance to bank               DISTB   = 1 m
  Port diameter                  D0      = 0.2032 m
  Port cross-sectional area      A0      = 0.0324 m^2
  Discharge velocity             U0      = 3.26 m/s
  Discharge flowrate             Q0      = 0.105613 m^3/s
  Discharge port height          H0      = 0.6 m
  Vertical discharge angle       THETA   = 10 deg
  Horizontal discharge angle     SIGMA   = 90 deg
  Discharge density              RHO0    = 998 kg/m^3
  Density difference             DRHO    = 14.7400 kg/m^3
  Buoyant acceleration           GP0     = 0.1427 m/s^2
  Discharge concentration        C0      = 6.79 mg/l
  Surface heat exchange coeff.   KS      = 0 m/s
  Coefficient of decay           KD      = 0 /s
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m         Lm  = 99999 m         Lb  = 99999 m
  LM  = 3.66 m         Lm' = 99999 m         Lb' = 99999 m
----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.12
  Velocity ratio                  R      = 99999
----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration              CMC     = 1.04 mg/l
  CCC concentration              CCC     = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 2000 m downstream
****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H4-90 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 3.14 m
****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.9543 mg/l
  Dilution at edge of NFR              s = 7.1
  NFR Location:                        x = 0 m
    (centerline coordinates)           y = 7.23 m
                                       z = 3.14 m
  NFR plume dimensions:  half-width (bh) = 0.95 m
                         thickness (bv) = 0.95 m
Cumulative travel time:       7.2217 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Because of the specified STAGNANT ambient conditions, there exists
  no steady-state far-field for this discharge.
  Unsteady circulations and pollutant buid-up may result in the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                       x = -0.01 m
    (centerline coordinates)            y = 6.45 m
                                        z = 3.14 m
  Plume dimension:       half-width (bh) = 0.61 m
                          thickness (bv) = 0.84 m

 Computed distance from port opening to CMC location = 6.93 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 6.45 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 3.14 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
The CCC for the toxic pollutant was not encountered within the predicted
  plume region.
********************* 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:
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                       CORMIX MIXING ZONE EXPERT SYSTEM
                   Subsystem CORMIX1: Single Port Discharges
                             CORMIX Version 11.0GTH
                     HYDRO1 Version 11.0.0.0 April 2018
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       d. MLLW
 FILE NAME:         U:\...r\2018\BayCityMixZn\Output\d MLLW 8 inch port.prd
 Time stamp:        09/06/2018--16:29:52

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =     3.60  HD     =      2.74
 Tidal Simulation at TIME =      2.000 h
 PERIOD=    12.40 h UAmax =      1.000 dUa/dt=       0.400 (m/s)/h
 UA     =    0.800  F      =     0.020 USTAR =0.4048E-01
 UW     =    5.700  UWSTAR=0.6815E-02
 Uniform density environment
 STRCND=  U         RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  =  RIGHT     DISTB =      1.00
 D0    =    0.203  A0     =     0.032 H0     =       0.31  SUB0  =       2.43
 THETA =    10.00  SIGMA  =     90.00
 U0    =    3.257  Q0     =     0.106        =0.1056E+00
 RHO0  =  998.0000  DRHO0 =0.1474E+02  GP0    =0.1427E+00
 C0    =0.6790E+01  CUNITS=  mg/l
 IPOLL =  1         KS    =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00  M0    =0.3440E+00  J0     =0.1507E-01  SIGNJ0=        1.0
 Associated length scales (meters)
 LQ    =     0.18  LM     =      3.66  Lm     =       0.73  Lb     =       0.03
                                       Lmp    =   99999.00  Lbp    =   99999.00
 Tidal:             Tu    =   0.1006 h Lu     =     14.574 Lmin   =      0.180
 Tidal Cutoffs (m): lmax  =  2246.170  xmax   =    916.732  ymax   =    196.744

NON-DIMENSIONAL PARAMETERS
 FR0   =    19.12  R      =      4.07

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =    H2    1
 1  Applicable layer depth HS =    2.74   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS=  mg/l
 NTOX  =  1         CMC   =0.1040E+01  CCC    =  CSTD
 NSTD  =  1         CSTD  =0.1600E+00
 REGMZ =  0
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y        Z         S       C        B        Uc        TT
     0.00     0.00     0.31      1.0 0.679E+01   0.10    3.257   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:            THETAE=       9.95  SIGMAE=      84.10
  LE    =     0.21  XE     =      0.01  YE     =       0.21  ZE     =       0.34

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X        Y        Z         S       C        B        Uc        TT
     0.00     0.00     0.31      1.0 0.679E+01   0.10    3.257   .00000E+00
     0.01     0.21     0.34      1.0 0.679E+01   0.11    3.257   .62826E-02
     1.33     1.37     0.58      5.5 0.124E+01   0.38    0.288   .12392E+01
```

```
** CMC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below CMC value of 0.104E+01
   in the current prediction interval.
 This is the extent of the TOXIC DILUTION ZONE.
      3.20      1.76     0.72      9.2 0.737E+00   0.51     0.137   .32194E+01
      5.07      2.00     0.85     12.1 0.559E+00   0.58     0.098   .53055E+01
      6.98      2.17     0.98     14.8 0.459E+00   0.65     0.080   .74779E+01
      8.89      2.30     1.11     17.3 0.392E+00   0.70     0.068   .96832E+01
     10.77      2.40     1.25     19.8 0.343E+00   0.75     0.061   .11879E+02
     12.68      2.49     1.38     22.3 0.304E+00   0.80     0.055   .14123E+02
     14.59      2.57     1.52     24.9 0.273E+00   0.85     0.050   .16380E+02
     16.47      2.63     1.66     27.4 0.248E+00   0.89     0.047   .18615E+02
     18.39      2.69     1.80     30.0 0.226E+00   0.93     0.043   .20869E+02
 Cumulative travel time =          20.8685 sec  (     0.01 hrs)

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        TT
     18.39      2.69     1.80     29.5 0.230E+00   0.93 .20869E+02

 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)
   TT = Cumulative travel time

       X         Y         Z         S        C         BV        BH       ZU        ZL        TT
     17.45      2.67     2.74     30.0 0.226E+00   0.00      0.00     2.74      2.74 .20869E+02
     17.73      2.68     2.74     30.0 0.226E+00   1.16      0.59     2.74      1.58 .20869E+02
     18.01      2.68     2.74     30.0 0.226E+00   1.38      0.83     2.74      1.36 .20869E+02
     18.29      2.68     2.74     30.0 0.226E+00   1.52      1.01     2.74      1.22 .20869E+02
     18.57      2.69     2.74     30.8 0.220E+00   1.62      1.17     2.74      1.12 .21103E+02
     18.85      2.69     2.74     34.6 0.196E+00   1.70      1.31     2.74      1.04 .21453E+02
     19.13      2.70     2.74     39.9 0.170E+00   1.76      1.43     2.74      0.98 .21804E+02
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.160E+00 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
     19.42      2.70     2.74     44.7 0.152E+00   1.80      1.55     2.74      0.94 .22154E+02
     19.70      2.70     2.74     48.0 0.142E+00   1.83      1.66     2.74      0.91 .22505E+02
     19.98      2.71     2.74     49.8 0.136E+00   1.85      1.76     2.74      0.89 .22855E+02
     20.26      2.71     2.74     50.9 0.133E+00   1.85      1.85     2.74      0.89 .23206E+02
 Cumulative travel time =          23.2059 sec  (     0.01 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH
-----------------------------------------------------------------------------------------------
** 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)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X         Y         Z         S        C         BV        BH       ZU        ZL        TT
     20.26      2.71     2.74     50.9 0.133E+00   1.85      1.85     2.74      0.89 .23206E+02
     23.86      2.71     2.74     52.6 0.129E+00   1.71      2.07     2.74      1.03 .27709E+02
     27.46      2.71     2.74     54.2 0.125E+00   1.61      2.28     2.74      1.13 .32212E+02
     31.06      2.71     2.74     55.8 0.122E+00   1.53      2.48     2.74      1.21 .36716E+02
     34.67      2.71     2.74     57.4 0.118E+00   1.46      2.67     2.74      1.28 .41219E+02
     38.27      2.71     2.74     59.0 0.115E+00   1.41      2.86     2.74      1.33 .45722E+02
     41.87      2.71     2.74     60.7 0.112E+00   1.37      3.04     2.74      1.37 .50225E+02
     45.47      2.71     2.74     62.4 0.109E+00   1.34      3.21     2.74      1.40 .54729E+02
     49.08      2.71     2.74     64.2 0.106E+00   1.31      3.38     2.74      1.43 .59232E+02
     52.68      2.71     2.74     66.1 0.103E+00   1.29      3.55     2.74      1.45 .63735E+02
     56.28      2.71     2.74     68.0 0.999E-01   1.27      3.71     2.74      1.47 .68238E+02
 Cumulative travel time =          68.2382 sec  (     0.02 hrs)

-----------------------------------------------------------------------------------------------
 Plume is ATTACHED to RIGHT bank/shore.
   Plume width is now determined from RIGHT bank/shore.

 Plume Stage 2 (bank attached):
       X         Y         Z         S        C         BV        BH       ZU        ZL        TT
     56.28     -1.00     2.74     68.0 0.999E-01   1.27      7.42     2.74      1.47 .68238E+02
     67.12     -1.00     2.74     73.1 0.929E-01   1.30      7.90     2.74      1.44 .81789E+02
```

```
     77.96     -1.00     2.74     78.7 0.863E-01   1.33      8.36     2.74      1.41 .95340E+02
     88.80     -1.00     2.74     84.8 0.801E-01   1.37      8.81     2.74      1.37 .10889E+03
     99.65     -1.00     2.74     91.4 0.743E-01   1.42      9.24     2.74      1.32 .12244E+03
    110.49     -1.00     2.74     98.5 0.689E-01   1.48      9.67     2.74      1.26 .13599E+03
    121.33     -1.00     2.74    106.2 0.639E-01   1.54     10.09     2.74      1.20 .14954E+03
    132.17     -1.00     2.74    114.4 0.594E-01   1.61     10.50     2.74      1.13 .16309E+03
    143.01     -1.00     2.74    123.1 0.551E-01   1.68     10.90     2.74      1.06 .17664E+03
    153.85     -1.00     2.74    132.5 0.513E-01   1.75     11.29     2.74      0.99 .19020E+03
    164.69     -1.00     2.74    142.3 0.477E-01   1.84     11.68     2.74      0.90 .20375E+03
 Cumulative travel time =         203.7466 sec  (     0.06 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------------------------
 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -0.86m
-----------------------------------------------------------------------------------------------
BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)    = 0.222E-01 m^2/s
  Horizontal diffusivity (initial value) = 0.397E-01 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)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X         Y        Z         S        C         BV        BH        ZU        ZL        TT
    164.69     -1.00     2.74    142.3 0.477E-01   1.84     11.68     2.74      0.90 .20375E+03
    348.22     -1.00     2.74    220.9 0.307E-01   2.85     12.93     2.74     -0.11 .43316E+03
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
    531.75     -1.00     2.74    287.0 0.237E-01   3.60     14.22     2.74     -0.86 .66257E+03
    715.28     -1.00     2.74    299.8 0.226E-01   3.60     15.55     2.74     -0.86 .89199E+03
    898.81     -1.00     2.74    316.7 0.214E-01   3.60     16.91     2.74     -0.86 .11214E+04
    916.73     -1.00     2.74    318.7 0.213E-01   3.60     17.05     2.74     -0.86 .11438E+04
 Cumulative travel time =        1143.8005 sec  (     0.32 hrs)

 CORMIX simulation has been TERMINATED at last prediction interval.
   Limiting time due to TIDAL REVERSAL as per (xmax) has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  d. MLLW
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\d MLLW 8 inch port.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:29:52
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                 HA       = 3.6 m
  Depth at discharge            HD       = 2.74 m
  Darcy-Weisbach friction factor  F      = 0.0205
    Calculated from Manning's n          = 0.02
  Wind velocity                 UW       = 5.7 m/s
TIDAL SIMULATION at time        Tsim     = 2 hours
  Instantaneous ambient velocity UA      = 0.8 m/s
  Maximum tidal velocity        UaMAX    = 1 m/s
Rate of tidal reversal         dUA/dt = 0.4 (m/s)/hour
  Period of reversal            T        = 12.4 hours
  Stratification Type           STRCND = U
  Surface density               RHOAS  = 1012.74 kg/m^3
  Bottom density                RHOAB  = 1012.74 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Single Port Discharge
  Nearest bank                           = right
  Distance to bank              DISTB  = 1 m
  Port diameter                 D0       = 0.2032 m
  Port cross-sectional area     A0       = 0.0324 m^2
  Discharge velocity            U0       = 3.26 m/s
  Discharge flowrate            Q0       = 0.105613 m^3/s
  Discharge port height         H0       = 0.31 m
  Vertical discharge angle      THETA  = 10 deg
  Horizontal discharge angle    SIGMA  = 90 deg
  Discharge density             RHO0     = 998 kg/m^3
  Density difference            DRHO     = 14.7400 kg/m^3
  Buoyant acceleration          GP0      = 0.1427 m/s^2
  Discharge concentration       C0       = 6.79 mg/l
  Surface heat exchange coeff.  KS       = 0 m/s
  Coefficient of decay          KD       = 0 /s
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m          Lm  = 0.73 m          Lb  = 0.03 m
  LM  = 3.66 m          Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.1006 hours      Lu  = 14.57 m         Lmin= 0.18 m
----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.12
  Velocity ratio                R        = 4.07
----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration             CMC      = 1.04 mg/l
  CCC concentration             CCC      = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 2000 m downstream
****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 2.74 m
****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.1334 mg/l
  Dilution at edge of NFR              s = 50.9
  NFR Location:                        x = 20.26 m
    (centerline coordinates)           y = 2.71 m
                                       z = 2.74 m
```

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  NFR plume dimensions:  half-width (bh) = 1.85 m
                          thickness (bv) = 1.85 m
Cumulative travel time:       23.2059 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 531.75 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 56.28 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                      x = 916.73 m
                                      y = -1 m
                                      z = 2.74 m.
  For this condition AFTER TIDAL REVERSAL, mixed water from the previous
  half-cycle becomes re-entrained into the near field of the discharge,
  increasing pollutant concentrations compared to steady-state predictions.
  A pool of mixed water formed at slack tide will be advected downstream
  in this phase.
************************ TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                     x = 1.79 m
    (centerline coordinates)          y = 1.50 m
                                      z = 0.62 m
  Plume dimension:        half-width (bh) = 0.05 m
                           thickness (bv) = 0.05 m

 Computed distance from port opening to CMC location = 2.35 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.33 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 2.74 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                   = 0.16  mg/l
Corresponding dilution                  = 42.6
  Plume location:                     x = 19.29 m
    (centerline coordinates)          y = 2.70 m
                                      z = 2.74 m
 Computed horizontal distance from port opening to CCC location = 19.63
  Plume dimensions:       half-width (bh) = 1.50 m
                           thickness (bv) = 1.78 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:
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                    CORMIX MIXING ZONE EXPERT SYSTEM
                  Subsystem CORMIX1: Single Port Discharges
                            CORMIX Version 11.0GTH
                     HYDRO1 Version 11.0.0.0 April 2018
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       e. MHHW max flood current 8 inch port
 FILE NAME:         U:\...n\Output\e MHHW max flood current 8 inch port.prd
 Time stamp:        09/06/2018--16:32:02

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =      4.11  HD    =       5.27
 Tidal Simulation at TIME =       3.000 h
 PERIOD=     12.40 h UAmax =      1.000 dUa/dt=       0.333 (m/s)/h
 UA    =      1.000 F     =       0.020 USTAR =0.4950E-01
 UW    =      5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U          RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT      DISTB =       1.00
 D0    =      0.203 A0    =       0.032 H0    =       0.30  SUB0  =       4.97
 THETA =     10.00  SIGMA =      90.00
 U0    =      3.257 Q0    =       0.106       =0.1056E+00
 RHO0  =  998.0000  DRHO0 =0.1474E+02 GP0    =0.1427E+00
 C0    =0.6790E+01  CUNITS= mg/l
 IPOLL = 1          KS    =0.0000E+00 KD     =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00  M0    =0.3440E+00 J0     =0.1507E-01  SIGNJ0=       1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =       3.66  Lm    =       0.59  Lb    =       0.02
                                        Lmp   =  99999.00  Lbp   =   99999.00
 Tidal:             Tu    =    0.1136 h Lu    =      15.487 Lmin  =      0.180
 Tidal Cutoffs (m): lmax  =  4228.169  xmax  =   1718.873  ymax  =    209.072

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12  R     =       3.26

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =    H2     1
 1  Applicable layer depth HS =    5.27    1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS= mg/l
 NTOX  = 1          CMC   =0.1040E+01  CCC   = CSTD
 NSTD  = 1          CSTD  =0.1600E+00
 REGMZ = 0
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X         Y        Z         S       C         B       Uc        TT
     0.00      0.00     0.30      1.0 0.679E+01   0.10    3.257   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:             THETAE=       9.92  SIGMAE=      82.64
  LE    =      0.01  XE    =       0.00  YE    =       0.01  ZE    =       0.31

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X         Y        Z         S       C         B       Uc        TT
     0.00      0.00     0.30      1.0 0.679E+01   0.10    3.257   .00000E+00
     0.00      0.01     0.31      1.0 0.679E+01   0.11    3.257   .12761E-01
** CMC HAS BEEN FOUND **
```

The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

5.91	1.54	0.74	11.9	0.568E+00	0.52	0.069	.53491E+01
12.27	1.88	1.09	18.9	0.359E+00	0.66	0.045	.11414E+02
18.63	2.07	1.45	25.8	0.263E+00	0.78	0.035	.17563E+02
25.05	2.19	1.82	33.2	0.204E+00	0.89	0.029	.23807E+02
31.42	2.28	2.18	40.9	0.166E+00	0.99	0.025	.30029E+02

WATER QUALITY STANDARD OR CCC HAS BEEN FOUND
The pollutant concentration in the plume falls below water quality standard
or CCC value of 0.160E+00 in the current prediction interval.
This is the spatial extent of concentrations exceeding the water quality
standard or CCC value.

37.78	2.35	2.53	49.0	0.138E+00	1.08	0.022	.36271E+02
44.20	2.40	2.87	57.5	0.118E+00	1.18	0.019	.42580E+02
50.57	2.43	3.20	66.2	0.103E+00	1.26	0.018	.48850E+02
56.94	2.47	3.52	75.1	0.904E-01	1.35	0.016	.55129E+02
63.36	2.49	3.83	84.2	0.806E-01	1.43	0.015	.61431E+02

Cumulative travel time = 61.4312 sec (0.02 hrs)

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	TT
63.36	2.49	3.83	80.1	0.848E-01	1.43	.61431E+02

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)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
61.93	2.49	5.27	84.3	0.805E-01	0.00	0.00	5.27	5.27	.61431E+02
62.36	2.49	5.27	84.3	0.805E-01	1.77	0.89	5.27	3.50	.61431E+02
62.79	2.49	5.27	84.3	0.806E-01	2.10	1.26	5.27	3.17	.61431E+02
63.22	2.49	5.27	84.2	0.806E-01	2.31	1.54	5.27	2.96	.61431E+02
63.65	2.49	5.27	86.5	0.785E-01	2.47	1.78	5.27	2.80	.61718E+02
64.08	2.49	5.27	97.2	0.698E-01	2.59	1.99	5.27	2.68	.62148E+02
64.51	2.49	5.27	112.0	0.606E-01	2.67	2.18	5.27	2.60	.62579E+02
64.94	2.49	5.27	125.5	0.541E-01	2.74	2.36	5.27	2.53	.63009E+02
65.37	2.50	5.27	134.7	0.504E-01	2.78	2.52	5.27	2.49	.63440E+02
65.80	2.50	5.27	139.7	0.486E-01	2.81	2.68	5.27	2.46	.63870E+02
66.23	2.50	5.27	142.9	0.475E-01	2.82	2.82	5.27	2.45	.64300E+02

Cumulative travel time = 64.3004 sec (0.02 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** 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)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
66.23	2.50	5.27	142.9	0.475E-01	2.82	2.82	5.27	2.45	.64300E+02
68.19	2.50	5.27	144.7	0.469E-01	2.79	2.89	5.27	2.48	.66261E+02
70.15	2.50	5.27	146.4	0.464E-01	2.76	2.96	5.27	2.51	.68222E+02
72.11	2.50	5.27	148.3	0.458E-01	2.73	3.03	5.27	2.54	.70182E+02
74.07	2.50	5.27	150.1	0.452E-01	2.71	3.10	5.27	2.56	.72143E+02
76.03	2.50	5.27	152.0	0.447E-01	2.69	3.17	5.27	2.58	.74103E+02
77.99	2.50	5.27	153.9	0.441E-01	2.67	3.24	5.27	2.60	.76064E+02
79.95	2.50	5.27	155.9	0.436E-01	2.65	3.30	5.27	2.62	.78025E+02
81.91	2.50	5.27	157.8	0.430E-01	2.64	3.37	5.27	2.63	.79985E+02
83.88	2.50	5.27	159.9	0.425E-01	2.63	3.43	5.27	2.64	.81946E+02
85.84	2.50	5.27	162.0	0.419E-01	2.61	3.50	5.27	2.66	.83907E+02

Cumulative travel time = 83.9066 sec (0.02 hrs)

Plume is ATTACHED to RIGHT bank/shore.
Plume width is now determined from RIGHT bank/shore.

Discharge is non-buoyant or weakly buoyant.
Therefore BUOYANT SPREADING REGIME is ABSENT.

END OF MOD141: BUOYANT AMBIENT SPREADING

Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = 1.16m

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BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = 0.522E-01 m^2/s
Horizontal diffusivity (initial value) = 0.201E-01 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)
TT = Cumulative travel time

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
85.84	-1.00	5.27	162.0	0.419E-01	2.61	6.99	5.27	2.66	.83907E+02

Plume interacts with BOTTOM.
The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
prediction interval.

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
277.25	-1.00	5.27	255.9	0.265E-01	4.11	7.87	5.27	1.16	.27532E+03
468.67	-1.00	5.27	263.9	0.257E-01	4.11	8.79	5.27	1.16	.46674E+03
660.09	-1.00	5.27	276.6	0.245E-01	4.11	9.74	5.27	1.16	.65816E+03
851.50	-1.00	5.27	293.0	0.232E-01	4.11	10.71	5.27	1.16	.84957E+03
1042.92	-1.00	5.27	312.5	0.217E-01	4.11	11.72	5.27	1.16	.10410E+04
1234.33	-1.00	5.27	334.9	0.203E-01	4.11	12.76	5.27	1.16	.12324E+04
1425.75	-1.00	5.27	360.1	0.189E-01	4.11	13.83	5.27	1.16	.14238E+04
1617.17	-1.00	5.27	387.8	0.175E-01	4.11	14.93	5.27	1.16	.16152E+04
1718.87	-1.00	5.27	403.9	0.168E-01	4.11	15.53	5.27	1.16	.17169E+04

Cumulative travel time = 1716.9437 sec (0.48 hrs)

CORMIX simulation has been TERMINATED at last prediction interval.
Limiting time due to TIDAL REVERSAL as per (xmax) has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

CORMIX1: Single Port Discharges End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  e. MHHW max flood current 8 inch port
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\e MHHW max flood current 8 inch port.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:32:02
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                  HA      = 4.11 m
  Depth at discharge             HD      = 5.27 m
  Darcy-Weisbach friction factor  F      = 0.0196
    Calculated from Manning's n          = 0.02
  Wind velocity                  UW      = 5.7 m/s
TIDAL SIMULATION at time         Tsim    = 3 hours
  Instantaneous ambient velocity UA      = 1 m/s
  Maximum tidal velocity         UaMAX   = 1 m/s
Rate of tidal reversal         dUA/dt = 0.3333 (m/s)/hour
  Period of reversal             T       = 12.4 hours
  Stratification Type            STRCND = U
  Surface density                RHOAS  = 1012.74 kg/m^3
  Bottom density                 RHOAB  = 1012.74 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                          = right
  Distance to bank               DISTB  = 1 m
  Port diameter                  D0     = 0.2032 m
  Port cross-sectional area      A0     = 0.0324 m^2
  Discharge velocity             U0     = 3.26 m/s
  Discharge flowrate             Q0     = 0.105613 m^3/s
  Discharge port height          H0     = 0.30 m
  Vertical discharge angle       THETA  = 10 deg
  Horizontal discharge angle     SIGMA  = 90 deg
  Discharge density              RHO0.  = 998 kg/m^3
  Density difference             DRHO   = 14.7400 kg/m^3
  Buoyant acceleration           GP0    = 0.1427 m/s^2
  Discharge concentration        C0     = 6.79 mg/l
  Surface heat exchange coeff.   KS     = 0 m/s
  Coefficient of decay           KD     = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m         Lm  = 0.59 m         Lb  = 0.02 m
  LM  = 3.66 m         Lm' = 99999 m        Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.1136 hours     Lu  = 15.49 m        Lmin= 0.18 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.12
  Velocity ratio                  R      = 3.26
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration              CMC     = 1.04 mg/l
  CCC concentration              CCC     = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 2000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 5.27 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.0475 mg/l
  Dilution at edge of NFR              s = 142.9
  NFR Location:                        x = 66.23 m
    (centerline coordinates)           y = 2.50 m
                                       z = 5.27 m
```

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  NFR plume dimensions:  half-width (bh) = 2.82 m
                          thickness (bv) = 2.82 m
Cumulative travel time:       64.3004 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 277.25 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 85.84 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                    x = 1718.87 m
                                    y = -1 m
                                    z = 5.27 m.
  For this condition AFTER TIDAL REVERSAL, mixed water from the previous
  half-cycle becomes re-entrained into the near field of the discharge,
  increasing pollutant concentrations compared to steady-state predictions.
  A pool of mixed water formed at slack tide will be advected downstream
  in this phase.
************************ TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                   x = 1.98 m
    (centerline coordinates)        y = 1.09 m
                                    z = 0.54 m
  Plume dimension:       half-width (bh) = 0.09 m
                          thickness (bv) = 0.09 m

 Computed distance from port opening to CMC location = 2.28 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.27 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 5.27 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                 = 0.16  mg/l
Corresponding dilution                = 42.4
  Plume location:                   x = 32.62 m
    (centerline coordinates)        y = 2.29 m
                                    z = 2.24 m
 Computed horizontal distance from port opening to CCC location = 32.75
  Plume dimension:       half-width (bh) = 1.00 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:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                        CORMIX MIXING ZONE EXPERT SYSTEM
                   Subsystem CORMIX1: Single Port Discharges
                             CORMIX Version 11.0GTH
                     HYDRO1 Version 11.0.0.0 April 2018
--------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       f. Mid MLLW flood to MHHW
 FILE NAME:         U:\...tyMixZn\Output\f midMLLWfloodtoMHHW8inch port.prd
 Time stamp:        09/06/2018--16:34:06

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =      4.11 HD     =      4.54
 Tidal Simulation at TIME =     -1.200 h
 PERIOD=    12.40 h UAmax =      1.000 dUa/dt=       0.625 (m/s)/h
 UA     =     0.750 F      =     0.020 USTAR =0.3712E-01
 UW     =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U          RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT      DISTB =       1.00
 D0     =     0.203 A0     =     0.032 H0     =      0.30  SUB0  =       4.24
 THETA =     10.00  SIGMA =      90.00
 U0     =     3.257 Q0     =     0.106        =0.1056E+00
 RHO0  = 998.0000  DRHO0 =0.1474E+02  GP0    =0.1427E+00
 C0     =0.6790E+01  CUNITS= mg/l
 IPOLL = 1          KS     =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES (metric units)
 Q0     =0.1056E+00 M0     =0.3440E+00  J0     =0.1507E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ     =      0.18 LM     =       3.66 Lm     =       0.78 Lb     =       0.04
                                        Lmp    =  99999.00 Lbp    =  99999.00
 Tidal:             Tu     =    0.0747 h Lu     =     12.559 Lmin  =       0.180
 Tidal Cutoffs (m): lmax  =  1381.603  xmax  =   8370.000  ymax  =     169.549

NON-DIMENSIONAL PARAMETERS
 FR0    =     19.12 R      =       4.34

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =     H2    1
 1  Applicable layer depth HS =    4.54    1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     =0.6790E+01  CUNITS= mg/l
 NTOX  = 1          CMC    =0.1040E+01  CCC    = CSTD
 NSTD  = 1          CSTD   =0.1600E+00
 REGMZ = 0
 XINT  =    2000.00  XMAX  =    2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
--------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

      X         Y         Z         S        C         B        Uc        TT
     0.00      0.00      0.30      1.0 0.679E+01   0.10     3.257   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:            THETAE=       9.95  SIGMAE=      84.47
  LE    =      0.26  XE     =      0.01  YE     =      0.26  ZE     =       0.35

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

      X         Y         Z         S        C         B        Uc        TT
     0.00      0.00      0.30      1.0 0.679E+01   0.10     3.257   .00000E+00
     0.01      0.26      0.35      1.0 0.679E+01   0.11     3.257   .10622E-01
** CMC HAS BEEN FOUND **
```

The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

2.88	1.86	0.73	8.9	0.762E+00	0.51	0.155	.30218E+01
6.38	2.28	0.99	14.5	0.467E+00	0.66	0.088	.71645E+01
9.95	2.53	1.26	19.6	0.346E+00	0.77	0.067	.11529E+02
13.48	2.71	1.54	24.6	0.276E+00	0.87	0.055	.15917E+02
17.01	2.83	1.82	29.8	0.228E+00	0.95	0.048	.20353E+02
20.58	2.93	2.10	35.2	0.193E+00	1.04	0.042	.24881E+02
24.11	3.01	2.38	40.8	0.166E+00	1.12	0.038	.29379E+02

WATER QUALITY STANDARD OR CCC HAS BEEN FOUND

The pollutant concentration in the plume falls below water quality standard
or CCC value of 0.160E+00 in the current prediction interval.
This is the spatial extent of concentrations exceeding the water quality
standard or CCC value.

27.64	3.07	2.65	46.7	0.146E+00	1.20	0.034	.33898E+02
31.22	3.12	2.92	52.7	0.129E+00	1.28	0.032	.38492E+02
34.75	3.17	3.19	58.9	0.115E+00	1.35	0.029	.43019E+02

Cumulative travel time = 43.0189 sec (0.01 hrs)

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	TT
34.75	3.17	3.19	58.4	0.116E+00	1.35	.43019E+02

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)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
33.40	3.16	4.54	58.9	0.115E+00	0.00	0.00	4.54	4.54	.43019E+02
33.80	3.16	4.54	58.9	0.115E+00	1.68	0.84	4.54	2.86	.43019E+02
34.21	3.16	4.54	58.9	0.115E+00	1.99	1.19	4.54	2.55	.43019E+02
34.61	3.16	4.54	58.9	0.115E+00	2.19	1.46	4.54	2.35	.43019E+02
35.02	3.17	4.54	60.5	0.112E+00	2.33	1.69	4.54	2.21	.43379E+02
35.42	3.17	4.54	68.0	0.999E-01	2.44	1.88	4.54	2.10	.43919E+02
35.83	3.17	4.54	78.3	0.867E-01	2.53	2.06	4.54	2.01	.44459E+02
36.23	3.17	4.54	87.7	0.774E-01	2.59	2.23	4.54	1.95	.45000E+02
36.64	3.18	4.54	94.2	0.721E-01	2.63	2.38	4.54	1.91	.45540E+02
37.04	3.18	4.54	97.7	0.695E-01	2.66	2.53	4.54	1.88	.46080E+02
37.45	3.18	4.54	100.0	0.679E-01	2.67	2.67	4.54	1.87	.46620E+02

Cumulative travel time = 46.6203 sec (0.01 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** 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)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
37.45	3.18	4.54	100.0	0.679E-01	2.67	2.67	4.54	1.87	.46620E+02
40.41	3.18	4.54	102.0	0.666E-01	2.56	2.83	4.54	1.98	.50574E+02
43.38	3.18	4.54	103.9	0.653E-01	2.47	3.00	4.54	2.07	.54527E+02
46.34	3.18	4.54	105.8	0.642E-01	2.39	3.16	4.54	2.15	.58480E+02
49.31	3.18	4.54	107.7	0.630E-01	2.32	3.31	4.54	2.22	.62434E+02
52.27	3.18	4.54	109.6	0.619E-01	2.26	3.47	4.54	2.28	.66387E+02
55.24	3.18	4.54	111.5	0.609E-01	2.20	3.62	4.54	2.34	.70340E+02
58.20	3.18	4.54	113.5	0.598E-01	2.15	3.76	4.54	2.39	.74294E+02
61.17	3.18	4.54	115.4	0.588E-01	2.11	3.90	4.54	2.43	.78247E+02
64.13	3.18	4.54	117.4	0.578E-01	2.08	4.04	4.54	2.46	.82200E+02
67.10	3.18	4.54	119.4	0.569E-01	2.04	4.18	4.54	2.50	.86154E+02

Cumulative travel time = 86.1535 sec (0.02 hrs)

Plume is ATTACHED to RIGHT bank/shore.
Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
67.10	-1.00	4.54	119.4	0.569E-01	2.04	8.37	4.54	2.50	.86154E+02
83.19	-1.00	4.54	128.3	0.529E-01	2.03	9.09	4.54	2.51	.10761E+03

```
     99.29    -1.00    4.54   138.2 0.491E-01   2.03     9.79     4.54     2.51 .12907E+03
    115.38    -1.00    4.54   149.1 0.455E-01   2.06    10.47     4.54     2.48 .15053E+03
    131.48    -1.00    4.54   161.2 0.421E-01   2.10    11.12     4.54     2.44 .17199E+03
    147.57    -1.00    4.54   174.4 0.389E-01   2.16    11.75     4.54     2.38 .19345E+03
    163.67    -1.00    4.54   188.9 0.360E-01   2.23    12.37     4.54     2.31 .21491E+03
    179.76    -1.00    4.54   204.6 0.332E-01   2.31    12.98     4.54     2.23 .23637E+03
    195.86    -1.00    4.54   221.6 0.306E-01   2.40    13.57     4.54     2.14 .25783E+03
    211.95    -1.00    4.54   240.0 0.283E-01   2.49    14.14     4.54     2.05 .27929E+03
    228.05    -1.00    4.54   259.7 0.261E-01   2.60    14.71     4.54     1.94 .30075E+03
 Cumulative travel time =         300.7504 sec  (     0.08 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------------------
 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB =  0.43m
-----------------------------------------------------------------------------------------
BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)    = 0.338E-01 m^2/s
  Horizontal diffusivity (initial value) = 0.541E-01 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)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X         Y        Z         S       C        BV       BH       ZU       ZL        TT
    228.05    -1.00    4.54   259.7 0.261E-01   2.60    14.71     4.54     1.94 .30075E+03
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
    405.24    -1.00    4.54   439.1 0.155E-01   4.11    16.09     4.54     0.43 .53701E+03
    582.44    -1.00    4.54   471.6 0.144E-01   4.11    17.52     4.54     0.43 .77327E+03
    759.63    -1.00    4.54   507.2 0.134E-01   4.11    18.98     4.54     0.43 .10095E+04
    936.83    -1.00    4.54   545.6 0.124E-01   4.11    20.49     4.54     0.43 .12458E+04
   1114.02    -1.00    4.54   586.6 0.116E-01   4.11    22.03     4.54     0.43 .14821E+04
   1291.22    -1.00    4.54   630.0 0.108E-01   4.11    23.61     4.54     0.43 .17183E+04
   1381.60    -1.00    4.54   653.2 0.104E-01   4.11    24.43     4.54     0.43 .18388E+04
 Cumulative travel time =        1838.8179 sec  (     0.51 hrs)

 CORMIX simulation has been TERMINATED at last prediction interval.
   Limiting distance (lmax) due to TIDAL REVERSAL has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges               End of Prediction File
1111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  f. Mid MLLW flood to MHHW
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\f midMLLWfloodtoMHHW8inch port.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:34:06
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                 HA       = 4.11 m
  Depth at discharge            HD       = 4.54 m
  Darcy-Weisbach friction factor F       = 0.0196
    Calculated from Manning's n          = 0.02
  Wind velocity                 UW       = 5.7 m/s
TIDAL SIMULATION at time        Tsim     = -1.2 hours
  Instantaneous ambient velocity UA      = 0.75 m/s
  Maximum tidal velocity        UaMAX    = 1 m/s
Rate of tidal reversal        dUA/dt = 0.625 (m/s)/hour
  Period of reversal            T        = 12.4 hours
  Stratification Type           STRCND = U
  Surface density               RHOAS  = 1012.74 kg/m^3
  Bottom density                RHOAB  = 1012.74 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Single Port Discharge
  Nearest bank                           = right
  Distance to bank              DISTB  = 1 m
  Port diameter                 D0       = 0.2032 m
  Port cross-sectional area     A0       = 0.0324 m^2
  Discharge velocity            U0       = 3.26 m/s
  Discharge flowrate            Q0       = 0.105613 m^3/s
  Discharge port height         H0       = 0.30 m
  Vertical discharge angle      THETA  = 10 deg
  Horizontal discharge angle    SIGMA  = 90 deg
  Discharge density             RHO0     = 998 kg/m^3
  Density difference            DRHO     = 14.7400 kg/m^3
  Buoyant acceleration          GP0      = 0.1427 m/s^2
  Discharge concentration       C0       = 6.79 mg/l
  Surface heat exchange coeff.  KS       = 0 m/s
  Coefficient of decay          KD       = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m          Lm  = 0.78 m          Lb  = 0.04 m
  LM  = 3.66 m          Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.0747 hours      Lu  = 12.56 m          Lmin= 0.18 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.12
  Velocity ratio                R        = 4.34
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration             CMC      = 1.04 mg/l
  CCC concentration             CCC      = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 2000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = H2  |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 4.54 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.0679 mg/l
  Dilution at edge of NFR              s = 100.0
  NFR Location:                        x = 37.45 m
    (centerline coordinates)           y = 3.18 m
                                       z = 4.54 m
```

```
  NFR plume dimensions:  half-width (bh) = 2.67 m
                          thickness (bv) = 2.67 m
Cumulative travel time:       46.6202 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 405.24 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 67.10 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                      x = 1381.60 m
                                      y = -1 m
                                      z = 4.54 m.
  For this condition BEFORE TIDAL REVERSAL, extensive re-entrainment
  of previously discharged is unlikely.
  To determine the minimum dilution, perform additional simulations
  after slack tide.
************************ TOXIC DILUTION ZONE SUMMARY ************************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                     x = 1.72 m
    (centerline coordinates)          y = 1.61 m
                                      z = 0.64 m
  Plume dimension:        half-width (bh) = 0.08 m
                           thickness (bv) = 0.08 m

 Computed distance from port opening to CMC location = 2.38 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.35 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 4.54 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                    = 0.16  mg/l
Corresponding dilution                   = 42.4
  Plume location:                     x = 25.09 m
    (centerline coordinates)          y = 3.03 m
                                      z = 2.45 m
 Computed horizontal distance from port opening to CCC location = 25.36
  Plume dimension:        half-width (bh) = 1.14 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:
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                        CORMIX MIXING ZONE EXPERT SYSTEM
                    Subsystem CORMIX1: Single Port Discharges
                              CORMIX Version 11.0GTH
                     HYDRO1 Version 11.0.0.0 April 2018
------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       f. Mid MLLW flood to MHHW
 FILE NAME:         U:\...tyMixZn\Output\f midMLLWfloodtoMHHW8inch port.prd
 Time stamp:        09/06/2018--16:35:23

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =      4.11  HD    =      4.54
 Tidal Simulation at TIME =     -1.200 h
 PERIOD=    12.40 h UAmax =      1.000 dUa/dt=      0.625 (m/s)/h
 UA    =     0.750  F     =      0.020 USTAR =0.3712E-01
 UW    =     5.700  UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U          RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT      DISTB =      1.00
 D0    =     0.203  A0    =     0.032  H0    =      0.30  SUB0  =      4.24
 THETA =    10.00   SIGMA =     90.00
 U0    =     3.257  Q0    =     0.106        =0.1056E+00
 RHO0  = 998.0000   DRHO0 =0.1474E+02  GP0   =0.1427E+00
 C0    =0.6790E+01  CUNITS= mg/l
 IPOLL = 1          KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00  M0    =0.3440E+00  J0    =0.1507E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =      3.66  Lm    =      0.78  Lb    =      0.04
                                       Lmp   =  99999.00  Lbp   =  99999.00
 Tidal:             Tu    =   0.0747 h Lu    =    12.559  Lmin  =     0.180
 Tidal Cutoffs (m): lmax  =  1381.603  xmax  =  8370.000  ymax  =   169.549

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12  R     =      4.34

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)        =    H2    1
 1  Applicable layer depth HS =    4.54    1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS= mg/l
 NTOX  = 1          CMC   =0.1040E+01  CCC   = CSTD
 NSTD  = 1          CSTD  =0.1600E+00
 REGMZ = 0
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X         Y       Z        S      C         B        Uc        TT
     0.00      0.00    0.30     1.0 0.679E+01   0.10     3.257   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:            THETAE=      9.95  SIGMAE=     84.47
  LE    =     0.26  XE    =      0.01  YE    =      0.26  ZE    =      0.35

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X         Y       Z        S      C         B        Uc        TT
     0.00      0.00    0.30     1.0 0.679E+01   0.10     3.257   .00000E+00
     0.01      0.26    0.35     1.0 0.679E+01   0.11     3.257   .10622E-01
** CMC HAS BEEN FOUND **
```

The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

2.88	1.86	0.73	8.9	0.762E+00	0.51	0.155	.30218E+01
6.38	2.28	0.99	14.5	0.467E+00	0.66	0.088	.71645E+01
9.95	2.53	1.26	19.6	0.346E+00	0.77	0.067	.11529E+02
13.48	2.71	1.54	24.6	0.276E+00	0.87	0.055	.15917E+02
17.01	2.83	1.82	29.8	0.228E+00	0.95	0.048	.20353E+02
20.58	2.93	2.10	35.2	0.193E+00	1.04	0.042	.24881E+02
24.11	3.01	2.38	40.8	0.166E+00	1.12	0.038	.29379E+02

WATER QUALITY STANDARD OR CCC HAS BEEN FOUND
The pollutant concentration in the plume falls below water quality standard
or CCC value of 0.160E+00 in the current prediction interval.
This is the spatial extent of concentrations exceeding the water quality
standard or CCC value.

27.64	3.07	2.65	46.7	0.146E+00	1.20	0.034	.33898E+02
31.22	3.12	2.92	52.7	0.129E+00	1.28	0.032	.38492E+02
34.75	3.17	3.19	58.9	0.115E+00	1.35	0.029	.43019E+02

Cumulative travel time = 43.0189 sec (0.01 hrs)

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	TT
34.75	3.17	3.19	58.4	0.116E+00	1.35	.43019E+02

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)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
33.40	3.16	4.54	58.9	0.115E+00	0.00	0.00	4.54	4.54	.43019E+02
33.80	3.16	4.54	58.9	0.115E+00	1.68	0.84	4.54	2.86	.43019E+02
34.21	3.16	4.54	58.9	0.115E+00	1.99	1.19	4.54	2.55	.43019E+02
34.61	3.16	4.54	58.9	0.115E+00	2.19	1.46	4.54	2.35	.43019E+02
35.02	3.17	4.54	60.5	0.112E+00	2.33	1.69	4.54	2.21	.43379E+02
35.42	3.17	4.54	68.0	0.999E-01	2.44	1.88	4.54	2.10	.43919E+02
35.83	3.17	4.54	78.3	0.867E-01	2.53	2.06	4.54	2.01	.44459E+02
36.23	3.17	4.54	87.7	0.774E-01	2.59	2.23	4.54	1.95	.45000E+02
36.64	3.18	4.54	94.2	0.721E-01	2.63	2.38	4.54	1.91	.45540E+02
37.04	3.18	4.54	97.7	0.695E-01	2.66	2.53	4.54	1.88	.46080E+02
37.45	3.18	4.54	100.0	0.679E-01	2.67	2.67	4.54	1.87	.46620E+02

Cumulative travel time = 46.6203 sec (0.01 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** 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)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
37.45	3.18	4.54	100.0	0.679E-01	2.67	2.67	4.54	1.87	.46620E+02
40.41	3.18	4.54	102.0	0.666E-01	2.56	2.83	4.54	1.98	.50574E+02
43.38	3.18	4.54	103.9	0.653E-01	2.47	3.00	4.54	2.07	.54527E+02
46.34	3.18	4.54	105.8	0.642E-01	2.39	3.16	4.54	2.15	.58480E+02
49.31	3.18	4.54	107.7	0.630E-01	2.32	3.31	4.54	2.22	.62434E+02
52.27	3.18	4.54	109.6	0.619E-01	2.26	3.47	4.54	2.28	.66387E+02
55.24	3.18	4.54	111.5	0.609E-01	2.20	3.62	4.54	2.34	.70340E+02
58.20	3.18	4.54	113.5	0.598E-01	2.15	3.76	4.54	2.39	.74294E+02
61.17	3.18	4.54	115.4	0.588E-01	2.11	3.90	4.54	2.43	.78247E+02
64.13	3.18	4.54	117.4	0.578E-01	2.08	4.04	4.54	2.46	.82200E+02
67.10	3.18	4.54	119.4	0.569E-01	2.04	4.18	4.54	2.50	.86154E+02

Cumulative travel time = 86.1535 sec (0.02 hrs)

Plume is ATTACHED to RIGHT bank/shore.
Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
67.10	-1.00	4.54	119.4	0.569E-01	2.04	8.37	4.54	2.50	.86154E+02
83.19	-1.00	4.54	128.3	0.529E-01	2.03	9.09	4.54	2.51	.10761E+03

99.29	-1.00	4.54	138.2	0.491E-01	2.03	9.79	4.54	2.51	.12907E+03
115.38	-1.00	4.54	149.1	0.455E-01	2.06	10.47	4.54	2.48	.15053E+03
131.48	-1.00	4.54	161.2	0.421E-01	2.10	11.12	4.54	2.44	.17199E+03
147.57	-1.00	4.54	174.4	0.389E-01	2.16	11.75	4.54	2.38	.19345E+03
163.67	-1.00	4.54	188.9	0.360E-01	2.23	12.37	4.54	2.31	.21491E+03
179.76	-1.00	4.54	204.6	0.332E-01	2.31	12.98	4.54	2.23	.23637E+03
195.86	-1.00	4.54	221.6	0.306E-01	2.40	13.57	4.54	2.14	.25783E+03
211.95	-1.00	4.54	240.0	0.283E-01	2.49	14.14	4.54	2.05	.27929E+03
228.05	-1.00	4.54	259.7	0.261E-01	2.60	14.71	4.54	1.94	.30075E+03

Cumulative travel time = 300.7504 sec (0.08 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING

Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = 0.43m

---

BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = 0.338E-01 m^2/s
Horizontal diffusivity (initial value) = 0.541E-01 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)
TT = Cumulative travel time

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
228.05	-1.00	4.54	259.7	0.261E-01	2.60	14.71	4.54	1.94	.30075E+03

Plume interacts with BOTTOM.
The passive diffusion plume becomes VERTICALLY FULLY MIXED within this prediction interval.

405.24	-1.00	4.54	439.1	0.155E-01	4.11	16.09	4.54	0.43	.53701E+03
582.44	-1.00	4.54	471.6	0.144E-01	4.11	17.52	4.54	0.43	.77327E+03
759.63	-1.00	4.54	507.2	0.134E-01	4.11	18.98	4.54	0.43	.10095E+04
936.83	-1.00	4.54	545.6	0.124E-01	4.11	20.49	4.54	0.43	.12458E+04
1114.02	-1.00	4.54	586.6	0.116E-01	4.11	22.03	4.54	0.43	.14821E+04
1291.22	-1.00	4.54	630.0	0.108E-01	4.11	23.61	4.54	0.43	.17183E+04
1381.60	-1.00	4.54	653.2	0.104E-01	4.11	24.43	4.54	0.43	.18388E+04

Cumulative travel time = 1838.8179 sec (0.51 hrs)

CORMIX simulation has been TERMINATED at last prediction interval.
Limiting distance (lmax) due to TIDAL REVERSAL has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

CORMIX1: Single Port Discharges End of Prediction File
1111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  f. Mid MLLW flood to MHHW
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\f midMLLWfloodtoMHHW8inch port.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:35:23
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                   HA     = 4.11 m
  Depth at discharge              HD     = 4.54 m
  Darcy-Weisbach friction factor  F      = 0.0196
    Calculated from Manning's n          = 0.02
  Wind velocity                   UW     = 5.7 m/s
TIDAL SIMULATION at time          Tsim   = -1.2 hours
  Instantaneous ambient velocity  UA     = 0.75 m/s
  Maximum tidal velocity          UaMAX  = 1 m/s
Rate of tidal reversal          dUA/dt = 0.625 (m/s)/hour
  Period of reversal              T      = 12.4 hours
  Stratification Type             STRCND = U
  Surface density                 RHOAS  = 1012.74 kg/m^3
  Bottom density                  RHOAB  = 1012.74 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                           = right
  Distance to bank                DISTB  = 1 m
  Port diameter                   D0     = 0.2032 m
  Port cross-sectional area       A0     = 0.0324 m^2
  Discharge velocity              U0     = 3.26 m/s
  Discharge flowrate              Q0     = 0.105613 m^3/s
  Discharge port height           H0     = 0.30 m
  Vertical discharge angle        THETA  = 10 deg
  Horizontal discharge angle      SIGMA  = 90 deg
  Discharge density               RHO0   = 998 kg/m^3
  Density difference              DRHO   = 14.7400 kg/m^3
  Buoyant acceleration            GP0    = 0.1427 m/s^2
  Discharge concentration         C0     = 6.79 mg/l
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m         Lm  = 0.78 m          Lb  = 0.04 m
  LM  = 3.66 m         Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.0747 hours     Lu  = 12.56 m         Lmin= 0.18 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.12
  Velocity ratio                  R      = 4.34
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration               CMC    = 1.04 mg/l
  CCC concentration               CCC    = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 2000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 4.54 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.0679 mg/l
  Dilution at edge of NFR              s = 100.0
  NFR Location:                        x = 37.45 m
    (centerline coordinates)           y = 3.18 m
                                       z = 4.54 m
```

```
  NFR plume dimensions:  half-width (bh) = 2.67 m
                          thickness (bv) = 2.67 m
Cumulative travel time:       46.6202 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 405.24 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 67.10 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                    x = 1381.60 m
                                    y = -1 m
                                    z = 4.54 m.
  For this condition BEFORE TIDAL REVERSAL, extensive re-entrainment
  of previously discharged is unlikely.
  To determine the minimum dilution, perform additional simulations
  after slack tide.
************************ TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                   x = 1.72 m
    (centerline coordinates)        y = 1.61 m
                                    z = 0.64 m
  Plume dimension:       half-width (bh) = 0.08 m
                          thickness (bv) = 0.08 m

 Computed distance from port opening to CMC location = 2.38 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.35 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 4.54 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                    = 0.16  mg/l
Corresponding dilution                   = 42.4
  Plume location:                   x = 25.09 m
    (centerline coordinates)        y = 3.03 m
                                    z = 2.45 m
 Computed horizontal distance from port opening to CCC location = 25.36
  Plume dimension:       half-width (bh) = 1.14 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:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                        CORMIX MIXING ZONE EXPERT SYSTEM
                  Subsystem CORMIX1: Single Port Discharges
                            CORMIX Version 11.0GTH
                    HYDRO1 Version 11.0.0.0 April 2018
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       g. High Water Slack
 FILE NAME:         U:\...BayCityMixZn\Output\g HighWaterSlack8inchport.prd
 Time stamp:        09/06/2018--16:37:07

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA   =      4.11 HD    =      4.99
 UA   =     0.000 F     =     0.020 USTAR =0.0000E+00
 UW   =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U        RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT    DISTB =      1.00
 D0    =     0.203 A0    =     0.032 H0    =      0.30  SUB0  =      4.69
 THETA =    10.00 SIGMA =     90.00
 U0    =     3.257 Q0    =     0.106        =0.1056E+00
 RHO0  = 998.0000 DRHO0 =0.1474E+02 GP0   =0.1427E+00
 C0    =0.6790E+01 CUNITS= mg/l
 IPOLL = 1        KS    =0.0000E+00 KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00 M0    =0.3440E+00 J0    =0.1507E-01 SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18 LM    =      3.66 Lm    = 99999.00 Lb    = 99999.00
                                     Lmp   = 99999.00 Lbp   = 99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =    19.12 R     = 99999.00

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =   H4-90  1
 1  Applicable layer depth HS =    4.99   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01 CUNITS= mg/l
 NTOX  = 1        CMC   =0.1040E+01 CCC   = CSTD
 NSTD  = 1        CSTD  =0.1600E+00
 REGMZ = 0
 XINT  =  2000.00 XMAX  =  2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y       Z        S       C        B       Uc        TT
     0.00     0.00    0.30     1.0 0.679E+01  0.10    3.257   .00000E+00

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=     10.00  SIGMAE=      90.00
  LE    =      1.02  XE    =     0.00  YE    =     1.00  ZE    =      0.48

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X        Y       Z        S       C        B       Uc        TT
     0.00     0.00    0.30     1.0 0.679E+01  0.10    3.257   .00000E+00
     0.00     1.00    0.48     1.0 0.679E+01  0.11    3.257   .91643E-02
     0.00     1.80    0.63     1.6 0.423E+01  0.19    2.407   .27278E+00
     0.00     2.58    0.81     2.3 0.289E+01  0.28    1.662   .68818E+00
     0.00     3.36    1.02     3.1 0.219E+01  0.37    1.277   .12524E+01
     0.00     4.13    1.29     3.9 0.175E+01  0.46    1.045   .19605E+01
     0.00     4.84    1.59     4.7 0.146E+01  0.54    0.899   .27597E+01
```

0.00	5.55	1.96	5.5	0.123E+01	0.63	0.792	.37246E+01
0.00	6.24	2.39	6.4	0.105E+01	0.72	0.715	.48046E+01

** CMC HAS BEEN FOUND **
The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

0.00	6.88	2.88	7.4	0.913E+00	0.80	0.659	.59867E+01
0.00	7.49	3.41	8.5	0.798E+00	0.89	0.618	.72580E+01
0.00	8.05	3.99	9.6	0.704E+00	0.97	0.585	.86064E+01

Cumulative travel time = 8.6064 sec (0.00 hrs)

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	TT
0.00	8.05	3.99	9.6	0.704E+00	0.97	.86064E+01

Profile definitions:
BV = Gaussian 1/e (37%) vertical thickness
BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
-0.01	8.05	4.99	9.6	0.704E+00	0.00	0.00	4.99	4.99	.86064E+01
-0.01	8.25	4.99	9.8	0.693E+00	0.86	0.43	4.99	4.13	.91653E+01
-0.01	8.44	4.99	10.2	0.666E+00	1.02	0.61	4.99	3.97	.97265E+01
-0.01	8.63	4.99	10.8	0.631E+00	1.12	0.75	4.99	3.87	.10288E+02
-0.01	8.83	4.99	11.4	0.596E+00	1.20	0.87	4.99	3.79	.10849E+02
-0.00	9.02	4.99	12.0	0.567E+00	1.26	0.97	4.99	3.73	.11410E+02
-0.00	9.22	4.99	12.5	0.545E+00	1.30	1.06	4.99	3.69	.11971E+02
-0.00	9.41	4.99	12.8	0.530E+00	1.33	1.15	4.99	3.66	.12532E+02
-0.00	9.60	4.99	13.1	0.520E+00	1.35	1.23	4.99	3.64	.13094E+02
-0.00	9.80	4.99	13.2	0.515E+00	1.37	1.30	4.99	3.62	.13655E+02
0.00	9.99	4.99	13.3	0.509E+00	1.37	1.37	4.99	3.62	.14216E+02

Cumulative travel time = 14.2160 sec (0.00 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** End of NEAR-FIELD REGION (NFR) **
Discharge into STAGNANT AMBIENT environment:
STEADY-STATE MIXING CONDITION IS NOT POSSIBLE in this zone, even though
some ADDITIONAL DILUTION MAY OCCUR!
Also, all far-field processes will be UNSTEADY.
SIMULATION STOPS because of stagnant ambient conditions.

CORMIX1: Single Port Discharges End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  g. High Water Slack
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\g HighWaterSlack8inchport.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:37:07
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                 HA       = 4.11 m
  Depth at discharge            HD       = 4.99 m
  Ambient velocity              UA       = 0 m/s
  Darcy-Weisbach friction factor F       = 0.0196
    Calculated from Manning's n          = 0.02
  Wind velocity                 UW       = 5.7 m/s
  Stratification Type           STRCND   = U
  Surface density               RHOAS    = 1012.74 kg/m^3
  Bottom density                RHOAB    = 1012.74 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                           = right
  Distance to bank              DISTB    = 1 m
  Port diameter                 D0       = 0.2032 m
  Port cross-sectional area     A0       = 0.0324 m^2
  Discharge velocity            U0       = 3.26 m/s
  Discharge flowrate            Q0       = 0.105613 m^3/s
  Discharge port height         H0       = 0.30 m
  Vertical discharge angle      THETA    = 10 deg
  Horizontal discharge angle    SIGMA    = 90 deg
  Discharge density             RHO0     = 998 kg/m^3
  Density difference            DRHO     = 14.7400 kg/m^3
  Buoyant acceleration          GP0      = 0.1427 m/s^2
  Discharge concentration       C0       = 6.79 mg/l
  Surface heat exchange coeff.  KS       = 0 m/s
  Coefficient of decay          KD       = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m          Lm  = 99999 m          Lb  = 99999 m
  LM  = 3.66 m          Lm' = 99999 m          Lb' = 99999 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.12
  Velocity ratio                  R      = 99999
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration             CMC      = 1.04 mg/l
  CCC concentration             CCC      = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 2000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = H4-90 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 4.99 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.5091 mg/l
  Dilution at edge of NFR              s = 13.3
  NFR Location:                        x = 0 m
    (centerline coordinates)           y = 9.99 m
                                       z = 4.99 m
  NFR plume dimensions:  half-width (bh) = 1.37 m
                           thickness (bv) = 1.37 m
Cumulative travel time:       14.2160 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Because of the specified STAGNANT ambient conditions, there exists
  no steady-state far-field for this discharge.
  Unsteady circulations and pollutant buid-up may result in the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
*********************** TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                      x = 0 m
    (centerline coordinates)           y = 6.29 m
                                       z = 2.43 m
  Plume dimension:       half-width (bh) = 0.07 m
                          thickness (bv) = 0.07 m

 Computed distance from port opening to CMC location = 6.64 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
              Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 6.29 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
              HD = 4.99 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
              test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
The CCC for the toxic pollutant was not encountered within the predicted
  plume region.
******************** 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:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                      CORMIX MIXING ZONE EXPERT SYSTEM
                  Subsystem CORMIX1: Single Port Discharges
                         CORMIX Version 11.0GTH
                    HYDRO1 Version 11.0.0.0 April 2018
--------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       DEQ Accute Criteria 10th % Velocity
 FILE NAME:         U:\...r\2018\BayCityMixZn\Output\Accute10thVelocity.prd
 Time stamp:        09/06/2018--16:39:53

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =      4.11  HD    =      2.94
 Tidal Simulation at TIME =      1.000 h
 PERIOD=     12.40 h UAmax =     1.000 dUa/dt=      0.100 (m/s)/h
 UA    =     0.100 F     =       0.020 USTAR =0.4950E-02
 UW    =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U          RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT      DISTB =      1.00
 D0    =     0.203 A0    =       0.032 H0    =      0.30  SUB0  =      2.64
 THETA =     10.00  SIGMA =     90.00
 U0    =     3.257 Q0    =       0.106       =0.1056E+00
 RHO0  =  998.0000  DRHO0 =0.1474E+02 GP0   =0.1427E+00
 C0    =0.6790E+01  CUNITS= mg/l
 IPOLL = 1          KS    =0.0000E+00 KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00 M0    =0.3440E+00 J0    =0.1507E-01 SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =      3.66  Lm    =       5.86  Lb    =     15.07
                                       Lmp   =  99999.00  Lbp   =  99999.00
 Tidal:             Tu    =   0.2535 h Lu    =     23.134 Lmin  =      0.180
 Tidal Cutoffs (m): lmax  =   162.886  xmax  =     57.296 ymax  =    312.311

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12  R     =     32.57

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    H4-90  1
 1  Applicable layer depth HS =    2.94   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS= mg/l
 NTOX  = 1          CMC   =0.1040E+01  CCC   = CSTD
 NSTD  = 1          CSTD  =0.1600E+00
 REGMZ = 0
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
--------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

      X        Y        Z        S     C         B        Uc        TT
     0.00     0.00     0.30     1.0 0.679E+01  0.10     3.257   .00000E+00

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=     10.00  SIGMAE=     89.26
  LE    =      0.92  XE    =      0.01  YE    =      0.90  ZE    =      0.46

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

      X        Y        Z        S     C         B        Uc        TT
     0.00     0.00     0.30     1.0 0.679E+01  0.10     3.257   .00000E+00
     0.01     0.90     0.46     1.0 0.679E+01  0.10     3.257   .59765E-02
     0.02     1.40     0.56     1.3 0.513E+01  0.16     2.908   .15156E+00
```

0.05	1.92	0.66	1.8	0.373E+01	0.22	2.118	.37085E+00
0.10	2.44	0.78	2.3	0.291E+01	0.28	1.659	.65847E+00
0.16	2.96	0.92	2.9	0.236E+01	0.34	1.358	.10152E+01
0.24	3.46	1.07	3.4	0.198E+01	0.41	1.145	.14419E+01
0.34	3.96	1.24	4.0	0.168E+01	0.47	0.986	.19394E+01
0.46	4.44	1.44	4.7	0.145E+01	0.54	0.862	.25084E+01
0.61	4.93	1.67	5.4	0.125E+01	0.61	0.760	.31831E+01
0.77	5.38	1.92	6.2	0.109E+01	0.68	0.681	.38992E+01

** CMC HAS BEEN FOUND **

The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

0.95	5.80	2.19	7.0	0.966E+00	0.75	0.619	.46454E+01

Cumulative travel time = 4.6454 sec (0.00 hrs)

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	TT
0.95	5.80	2.19	7.0	0.969E+00	0.75	.46454E+01

Profile definitions:
BV = Gaussian 1/e (37%) vertical thickness
BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
0.64	5.12	2.94	7.0	0.966E+00	0.02	0.00	2.94	2.92	.46454E+01
0.74	5.32	2.94	7.0	0.966E+00	0.65	0.33	2.94	2.29	.46454E+01
0.83	5.53	2.94	7.0	0.966E+00	0.77	0.46	2.94	2.17	.46454E+01
0.92	5.73	2.94	7.0	0.966E+00	0.85	0.57	2.94	2.09	.46454E+01
1.02	5.94	2.94	7.1	0.959E+00	0.91	0.66	2.94	2.03	.50078E+01
1.11	6.15	2.94	7.3	0.928E+00	0.95	0.73	2.94	1.99	.55514E+01
1.20	6.35	2.94	7.6	0.888E+00	0.98	0.80	2.94	1.96	.60949E+01
1.29	6.56	2.94	7.9	0.854E+00	1.01	0.87	2.94	1.93	.66385E+01
1.39	6.77	2.94	8.2	0.833E+00	1.02	0.93	2.94	1.92	.71821E+01
1.48	6.97	2.94	8.3	0.822E+00	1.03	0.98	2.94	1.91	.77256E+01
1.57	7.18	2.94	8.3	0.814E+00	1.04	1.04	2.94	1.90	.82692E+01

Cumulative travel time = 8.2692 sec (0.00 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

BEGIN MOD155: WEAKLY DEFLECTED SURFACE/BOTTOM PLUME

SURFACE/BOTTOM PLUME into a crossflow

Profile definitions:
BV = Gaussian 1/e (37%) vertical thickness
BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
1.57	7.18	2.94	8.3	0.814E+00	1.04	1.04	2.94	1.90	.82692E+01
2.42	8.03	2.94	12.4	0.547E+00	0.70	2.30	2.94	2.24	.13832E+02
3.31	8.87	2.94	14.9	0.455E+00	0.58	3.33	2.94	2.36	.19807E+02
4.23	9.72	2.94	16.9	0.403E+00	0.51	4.25	2.94	2.43	.26195E+02
5.18	10.57	2.94	18.5	0.367E+00	0.47	5.13	2.94	2.47	.32995E+02
6.17	11.41	2.94	20.0	0.340E+00	0.43	5.97	2.94	2.51	.40208E+02
7.19	12.26	2.94	21.3	0.319E+00	0.41	6.78	2.94	2.53	.47833E+02
8.25	13.11	2.94	22.5	0.302E+00	0.38	7.58	2.94	2.56	.55871E+02
9.34	13.96	2.94	23.6	0.288E+00	0.37	8.37	2.94	2.57	.64321E+02
10.47	14.80	2.94	24.7	0.275E+00	0.35	9.15	2.94	2.59	.73183E+02
11.63	15.65	2.94	25.7	0.264E+00	0.34	9.92	2.94	2.60	.82458E+02

Cumulative travel time = 82.4577 sec (0.02 hrs)

END OF MOD155: WEAKLY DEFLECTED SURFACE/BOTTOM PLUME

BEGIN MOD156: STRONGLY DEFLECTED SURFACE/BOTTOM PLUME

Profile definitions:
BV = top-hat thickness, measured vertically
BH = top-hat half-width, measured horizontally from bank/shoreline
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
11.63	15.65	2.94	25.7	0.264E+00	0.34	9.92	2.94	2.60	.82458E+02
15.02	16.72	2.94	25.8	0.263E+00	0.31	10.92	2.94	2.63	.11630E+03
18.40	17.70	2.94	26.0	0.262E+00	0.30	11.89	2.94	2.64	.15015E+03
21.79	18.61	2.94	26.1	0.260E+00	0.28	12.82	2.94	2.66	.18399E+03
25.17	19.47	2.94	26.2	0.259E+00	0.27	13.73	2.94	2.67	.21784E+03
28.56	20.28	2.94	26.3	0.258E+00	0.26	14.62	2.94	2.68	.25168E+03
31.94	21.04	2.94	26.4	0.257E+00	0.25	15.49	2.94	2.69	.28553E+03
35.32	21.77	2.94	26.5	0.256E+00	0.24	16.34	2.94	2.70	.31937E+03
38.71	22.46	2.94	26.7	0.255E+00	0.24	17.18	2.94	2.70	.35322E+03
42.09	23.13	2.94	26.8	0.254E+00	0.23	18.00	2.94	2.71	.38706E+03
45.48	23.77	2.94	26.9	0.253E+00	0.23	18.81	2.94	2.71	.42091E+03

Cumulative travel time = 420.9065 sec (0.12 hrs)

END OF MOD156: STRONGLY DEFLECTED SURFACE/BOTTOM PLUME

** End of NEAR-FIELD REGION (NFR) **

The initial plume WIDTH values in the next far-field module will be
CORRECTED by a factor 1.84 to conserve the mass flux in the far-field!
The correction factor is quite large because of the small ambient velocity
relative to the strong mixing characteristics of the discharge!
This indicates localized RECIRCULATION REGIONS and INTERNAL HYDRAULIC JUMPS.
Width predictions show discontinuities. Dilution values should be acceptable.

In this design case, the discharge is located CLOSE TO BANK/SHORE.
Some lateral boundary interaction occurs at end of the near-field.
This may be related to a design case with a very LOW AMBIENT VELOCITY.
The dilution values in one or more of the preceding zones may be too high.
Carefully evaluate results in near-field and check degree of interaction.

Consider locating outfall further away from bank or shore.
In the next prediction module, the plume centerline will be set
to follow the bank/shore.

BEGIN MOD141: BUOYANT AMBIENT SPREADING

Plume is ATTACHED to RIGHT bank/shore.
Plume width is now determined from RIGHT bank/shore.

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)
TT = Cumulative travel time

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
45.48	-1.00	2.94	26.9	0.252E+00	0.49	59.29	2.94	2.45	.42091E+03
162.80	-1.00	2.94	34.6	0.204E+00	0.43	91.85	2.94	2.51	.15941E+04

Cumulative travel time = 1594.1165 sec (0.44 hrs)

CORMIX simulation has been TERMINATED at last prediction interval.
Limiting distance (lmax) due to TIDAL REVERSAL has been reached.

END OF MOD141: BUOYANT AMBIENT SPREADING

CORMIX1: Single Port Discharges End of Prediction File
1111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  DEQ Accute Criteria 10th % Velocity
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\Accute10thVelocity.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:39:53
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = unbounded
  Average depth                 HA        = 4.11 m
  Depth at discharge            HD        = 2.94 m
  Darcy-Weisbach friction factor  F       = 0.0196
    Calculated from Manning's n          = 0.02
  Wind velocity                 UW        = 5.7 m/s
TIDAL SIMULATION at time        Tsim      = 1 hours
  Instantaneous ambient velocity  UA      = 0.1 m/s
  Maximum tidal velocity        UaMAX     = 1 m/s
Rate of tidal reversal          dUA/dt = 0.1 (m/s)/hour
  Period of reversal            T         = 12.4 hours
  Stratification Type           STRCND    = U
  Surface density               RHOAS     = 1012.74 kg/m^3
  Bottom density                RHOAB     = 1012.74 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Single Port Discharge
  Nearest bank                            = right
  Distance to bank              DISTB     = 1 m
  Port diameter                 D0        = 0.2032 m
  Port cross-sectional area     A0        = 0.0324 m^2
  Discharge velocity            U0        = 3.26 m/s
  Discharge flowrate            Q0        = 0.105613 m^3/s
  Discharge port height         H0        = 0.30 m
  Vertical discharge angle      THETA     = 10 deg
  Horizontal discharge angle    SIGMA     = 90 deg
  Discharge density             RHO0      = 998 kg/m^3
  Density difference            DRHO      = 14.7400 kg/m^3
  Buoyant acceleration          GP0       = 0.1427 m/s^2
  Discharge concentration       C0        = 6.79 mg/l
  Surface heat exchange coeff.  KS        = 0 m/s
  Coefficient of decay          KD        = 0 /s
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m          Lm  = 5.86 m          Lb  = 15.07 m
  LM  = 3.66 m          Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.2535 hours     Lu  = 23.13 m         Lmin= 0.18 m
----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0     = 19.12
  Velocity ratio                R         = 32.57
----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = yes
  CMC concentration             CMC       = 1.04 mg/l
  CCC concentration             CCC       = 0.16 mg/l
  Water quality standard specified        = given by CCC value
  Regulatory mixing zone                  = no
  Region of interest                      = 2000 m downstream
****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = H4-90 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 2.94 m
****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.2539 mg/l
  Dilution at edge of NFR              s = 26.7
  NFR Location:                        x = 45.48 m
    (centerline coordinates)           y = 23.77 m
                                       z = 2.94 m
```

```
  NFR plume dimensions:  half-width (bh) = 18.81 m
                          thickness (bv) = 0.23 m
Cumulative travel time:       420.9063 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 contacts nearest bank at 45.48 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                      x = 162.80 m
                                      y = -1 m
                                      z = 2.94 m.
  For this condition AFTER TIDAL REVERSAL, mixed water from the previous
  half-cycle becomes re-entrained into the near field of the discharge,
  increasing pollutant concentrations compared to steady-state predictions.
  A pool of mixed water formed at slack tide will be advected downstream
  in this phase.
*********************** TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                     x = 0.84 m
    (centerline coordinates)          y = 5.54 m
                                      z = 2.02 m
  Plume dimension:        half-width (bh) = 0.05 m
                           thickness (bv) = 0.05 m

 Computed distance from port opening to CMC location = 5.86 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 5.60 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 2.94 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************* REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
The CCC for the toxic pollutant was not encountered within the predicted
  plume region.
********************* 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:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                       CORMIX MIXING ZONE EXPERT SYSTEM
                   Subsystem CORMIX1: Single Port Discharges
                             CORMIX Version 11.0GTH
                    HYDRO1 Version 11.0.0.0 April 2018
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       DEQ Accute Criteria 90th % Velocity
 FILE NAME:         U:\...r\2018\BayCityMixZn\Output\Accute90thVelocity.prd
 Time stamp:        09/06/2018--16:42:24

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    560.00 AS    =   2016.00 QA    =   1814.40 ICHREG= 1
 HA    =      3.60 HD    =      2.74
 Tidal Simulation at TIME =    2.000 h
 PERIOD=    12.40 h UAmax =    1.000 dUa/dt=     0.450 (m/s)/h
 UA    =     0.900 F     =     0.020 USTAR =0.4554E-01
 UW    =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U          RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT      DISTB =     1.00
 D0    =     0.203 A0    =     0.032 H0    =      0.30 SUB0  =      2.44
 THETA =     10.00 SIGMA =    90.00
 U0    =     3.257 Q0    =     0.106       =0.1056E+00
 RHO0  =  998.0000 DRHO0 =0.1474E+02 GP0   =0.1427E+00
 C0    =0.6790E+01 CUNITS= mg/l
 IPOLL = 1          KS    =0.0000E+00 KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00 M0    =0.3440E+00 J0    =0.1507E-01 SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18 LM    =      3.66 Lm    =      0.65 Lb    =      0.02
                                     Lmp   =  99999.00 Lbp   =  99999.00
 Tidal:             Tu    =   0.0930 h Lu    =    14.013 Lmin  =     0.180
 Tidal Cutoffs (m): lmax  =  2529.561 xmax  =  1031.324 ymax  =**********

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12 R     =      3.62

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =    H2     1
 1  Applicable layer depth HS =    2.74    1
 1  Limiting Dilution S =QA/Q0= 17180.70   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01 CUNITS= mg/l
 NTOX  = 1          CMC   =0.1040E+01 CCC   = CSTD
 NSTD  = 1          CSTD  =0.1600E+00
 REGMZ = 0
 XINT  =   5600.00 XMAX  =   5600.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y        Z        S       C        B        Uc        TT
     0.00     0.00     0.30     1.0 0.679E+01   0.10    3.257   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:            THETAE=      9.93  SIGMAE=     83.37
  LE    =      0.11 XE    =      0.01 YE    =      0.11 ZE    =      0.32

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X        Y        Z        S       C        B        Uc        TT
     0.00     0.00     0.30     1.0 0.679E+01   0.10    3.257   .00000E+00
```

```
     0.01      0.11      0.32      1.0 0.679E+01   0.11     3.257   .63274E-02
     1.75      1.26      0.57      6.2 0.109E+01   0.39     0.199   .15633E+01
** CMC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below CMC value of 0.104E+01
   in the current prediction interval.
 This is the extent of the TOXIC DILUTION ZONE.
     3.97      1.60      0.70     10.0 0.682E+00   0.50     0.104   .37547E+01
     6.20      1.81      0.83     12.9 0.525E+00   0.57     0.077   .60399E+01
     8.44      1.97      0.97     15.7 0.433E+00   0.63     0.064   .83655E+01
    10.68      2.08      1.11     18.3 0.371E+00   0.69     0.055   .10715E+02
    12.92      2.18      1.25     20.9 0.324E+00   0.73     0.049   .13082E+02
    15.16      2.26      1.39     23.6 0.288E+00   0.78     0.045   .15461E+02
    17.40      2.33      1.54     26.3 0.258E+00   0.83     0.041   .17850E+02
    19.64      2.38      1.68     29.1 0.234E+00   0.87     0.038   .20248E+02
    21.88      2.43      1.83     31.9 0.213E+00   0.91     0.035   .22644E+02
 Cumulative travel time =          22.6442 sec  (     0.01 hrs)

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        TT
    21.88      2.43      1.83     31.2 0.218E+00   0.91 .22644E+02

 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)
   TT = Cumulative travel time

      X         Y        Z         S        C        BV        BH        ZU       ZL        TT
    20.97      2.42      2.74     31.9 0.213E+00   0.00      0.00      2.74      2.74 .22644E+02
    21.24      2.43      2.74     31.9 0.213E+00   1.13      0.57      2.74      1.61 .22644E+02
    21.52      2.43      2.74     31.9 0.213E+00   1.34      0.81      2.74      1.40 .22644E+02
    21.79      2.43      2.74     31.9 0.213E+00   1.48      0.99      2.74      1.26 .22644E+02
    22.07      2.43      2.74     32.8 0.207E+00   1.58      1.14      2.74      1.16 .22847E+02
    22.34      2.44      2.74     36.8 0.184E+00   1.65      1.28      2.74      1.09 .23152E+02
    22.61      2.44      2.74     42.4 0.160E+00   1.71      1.40      2.74      1.03 .23456E+02
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.160E+00 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
    22.89      2.44      2.74     47.5 0.143E+00   1.75      1.51      2.74      0.99 .23761E+02
    23.16      2.45      2.74     51.0 0.133E+00   1.78      1.61      2.74      0.96 .24065E+02
    23.44      2.45      2.74     52.9 0.128E+00   1.80      1.71      2.74      0.94 .24370E+02
    23.71      2.45      2.74     54.1 0.125E+00   1.80      1.80      2.74      0.94 .24674E+02
 Cumulative travel time =          24.6740 sec  (     0.01 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH
-----------------------------------------------------------------------------------------------
** 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)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
      X         Y        Z         S        C        BV        BH        ZU       ZL        TT
    23.71      2.45      2.74     54.1 0.125E+00   1.80      1.80      2.74      0.94 .24674E+02
    27.41      2.45      2.74     56.0 0.121E+00   1.69      2.00      2.74      1.05 .28788E+02
    31.11      2.45      2.74     57.8 0.118E+00   1.60      2.18      2.74      1.14 .32901E+02
    34.82      2.45      2.74     59.6 0.114E+00   1.54      2.36      2.74      1.20 .37015E+02
    38.52      2.45      2.74     61.5 0.110E+00   1.48      2.53      2.74      1.26 .41128E+02
    42.22      2.45      2.74     63.5 0.107E+00   1.44      2.69      2.74      1.30 .45242E+02
    45.92      2.45      2.74     65.5 0.104E+00   1.41      2.85      2.74      1.33 .49355E+02
    49.63      2.45      2.74     67.7 0.100E+00   1.39      3.01      2.74      1.35 .53469E+02
    53.33      2.45      2.74     70.0 0.971E-01   1.37      3.16      2.74      1.37 .57582E+02
    57.03      2.45      2.74     72.3 0.939E-01   1.36      3.31      2.74      1.38 .61696E+02
    60.73      2.45      2.74     74.9 0.907E-01   1.35      3.45      2.74      1.39 .65809E+02
 Cumulative travel time =          65.8091 sec  (     0.02 hrs)

-----------------------------------------------------------------------------------------------
 Plume is ATTACHED to RIGHT bank/shore.
   Plume width is now determined from RIGHT bank/shore.

 Plume Stage 2 (bank attached):
      X         Y        Z         S        C        BV        BH        ZU       ZL        TT
```

60.73	-1.00	2.74	74.9	0.907E-01	1.35	6.90	2.74	1.39	.65809E+02
65.08	-1.00	2.74	77.5	0.876E-01	1.37	7.07	2.74	1.37	.70634E+02
69.42	-1.00	2.74	80.2	0.847E-01	1.39	7.23	2.74	1.35	.75458E+02
73.76	-1.00	2.74	83.0	0.818E-01	1.41	7.40	2.74	1.33	.80283E+02
78.10	-1.00	2.74	85.9	0.790E-01	1.44	7.56	2.74	1.30	.85107E+02
82.44	-1.00	2.74	89.0	0.763E-01	1.46	7.72	2.74	1.28	.89932E+02
86.79	-1.00	2.74	92.1	0.737E-01	1.49	7.88	2.74	1.25	.94756E+02
91.13	-1.00	2.74	95.3	0.712E-01	1.52	8.03	2.74	1.22	.99581E+02
95.47	-1.00	2.74	98.7	0.688E-01	1.55	8.19	2.74	1.19	.10441E+03
99.81	-1.00	2.74	102.1	0.665E-01	1.58	8.34	2.74	1.16	.10923E+03
104.16	-1.00	2.74	105.7	0.642E-01	1.61	8.49	2.74	1.13	.11405E+03

Cumulative travel time = 114.0546 sec (0.03 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING

Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -0.86m

---

BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = 0.250E-01 m^2/s
Horizontal diffusivity (initial value) = 0.312E-01 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)
TT = Cumulative travel time

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
104.16	-1.00	2.74	105.7	0.642E-01	1.61	8.49	2.74	1.13	.11405E+03

Plume interacts with BOTTOM.
The passive diffusion plume becomes VERTICALLY FULLY MIXED within this prediction interval.

653.74	-1.00	2.74	249.6	0.272E-01	3.60	11.49	2.74	-0.86	.72467E+03
1031.32	-1.00	2.74	273.2	0.249E-01	3.60	13.12	2.74	-0.86	.11442E+04

Cumulative travel time = 1144.1807 sec (0.32 hrs)

CORMIX simulation has been TERMINATED at last prediction interval.
Limiting time due to TIDAL REVERSAL as per (xmax) has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

CORMIX1: Single Port Discharges End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:               Bay City Outfall
  DESIGN CASE:                 DEQ Accute Criteria 90th % Velocity
  FILE NAME:                   U:\rstillmaker\2018\BayCityMixZn\Output\Accute90thVelocity.prd
  Using subsystem CORMIX1:    Single Port Discharges
  Start of session:            09/06/2018--16:42:24
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = bounded
  Width                          BS       = 560 m
  Channel regularity             ICHREG = 1
  Ambient flowrate               QA       = 1814.40 m^3/s
  Average depth                  HA       = 3.6 m
  Depth at discharge             HD       = 2.74 m
  Darcy-Weisbach friction factor  F       = 0.0205
    Calculated from Manning's n           = 0.02
  Wind velocity                  UW       = 5.7 m/s
TIDAL SIMULATION at time         Tsim    = 2 hours
  Instantaneous ambient velocity  UA      = 0.9 m/s
  Maximum tidal velocity         UaMAX   = 1 m/s
Rate of tidal reversal          dUA/dt = 0.45 (m/s)/hour
  Period of reversal             T        = 12.4 hours
  Stratification Type            STRCND = U
  Surface density                RHOAS   = 1012.74 kg/m^3
  Bottom density                 RHOAB   = 1012.74 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                            = right
  Distance to bank               DISTB   = 1 m
  Port diameter                  D0       = 0.2032 m
  Port cross-sectional area      A0       = 0.0324 m^2
  Discharge velocity             U0       = 3.26 m/s
  Discharge flowrate             Q0       = 0.105613 m^3/s
  Discharge port height          H0       = 0.30 m
  Vertical discharge angle       THETA   = 10 deg
  Horizontal discharge angle     SIGMA   = 90 deg
  Discharge density              RHO0    = 998 kg/m^3
  Density difference             DRHO    = 14.7400 kg/m^3
  Buoyant acceleration           GP0      = 0.1427 m/s^2
  Discharge concentration        C0       = 6.79 mg/l
  Surface heat exchange coeff.   KS       = 0 m/s
  Coefficient of decay           KD       = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m        Lm  = 0.65 m         Lb  = 0.02 m
  LM  = 3.66 m        Lm' = 99999 m        Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.0930 hours      Lu  = 14.01 m         Lmin= 0.18 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0     = 19.12
  Velocity ratio                 R        = 3.62
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = yes
  CMC concentration              CMC      = 1.04 mg/l
  CCC concentration              CCC      = 0.16 mg/l
  Water quality standard specified        = given by CCC value
  Regulatory mixing zone                  = no
  Region of interest                      = 5600 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 2.74 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 17180.7

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.1255 mg/l
   Dilution at edge of NFR              s = 54.1
   NFR Location:                        x = 23.71 m
     (centerline coordinates)           y = 2.45 m
                                        z = 2.74 m
   NFR plume dimensions:  half-width (bh) = 1.80 m
                           thickness (bv) = 1.80 m
 Cumulative travel time:       24.6740 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.
 -----------------------------------------------------------------------------
 FAR-FIELD MIXING SUMMARY:
   Plume becomes vertically fully mixed at 653.74 m downstream.
 -----------------------------------------------------------------------------
 PLUME BANK CONTACT SUMMARY:
   Plume in bounded section contacts one bank only at 60.73 m downstream.
 -----------------------------------------------------------------------------
 UNSTEADY TIDAL ASSESSMENT:
  Because of the unsteadiness of the ambient current during the tidal
   reversal, CORMIX predictions have been TERMINATED at:
                                        x = 1031.32 m
                                        y = -1 m
                                        z = 2.74 m.
   For this condition AFTER TIDAL REVERSAL, mixed water from the previous
   half-cycle becomes re-entrained into the near field of the discharge,
   increasing pollutant concentrations compared to steady-state predictions.
   A pool of mixed water formed at slack tide will be advected downstream
   in this phase.
 *********************** TOXIC DILUTION ZONE SUMMARY ***********************
 Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
   Technical Support Document (TSD) for Water Quality-based Toxics Control,
   1991 (EPA/505/2-90-001).
   Criterion maximum concentration (CMC)  = 1.04  mg/l
 Corresponding dilution                   = 6.528846
 The CMC was encountered at the following plume position:
   Plume location:                      x = 1.90 m
     (centerline coordinates)           y = 1.29 m
                                        z = 0.58 m
   Plume dimension:       half-width (bh) = 0.03 m
                           thickness (bv) = 0.03 m

  Computed distance from port opening to CMC location = 2.31 m.
  CRITERION 1: This location is within 50 times the discharge length scale of
              Lq = 0.18 m.
  +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

  Computed horizontal distance from port opening to CMC location = 2.29 m.
  CRITERION 2: This location is within 5 times the ambient water depth of
              HD = 2.74 m.
  ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

  CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
              test for the TDZ cannot be applied.

  The diffuser discharge velocity is equal to 3.26 m/s.
  This exceeds the value of 3.0 m/s recommended in the TSD.

  *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
 ********************** REGULATORY MIXING ZONE SUMMARY **********************
 No RMZ has been specified.
 However:
 The CCC was encountered at the following plume position:
 The CCC for the toxic pollutant was encountered at the following
   plume position:
   CCC                                    = 0.16  mg/l
 Corresponding dilution                   = 42.4
   Plume location:                      x = 22.62 m
     (centerline coordinates)           y = 2.44 m
                                        z = 2.74 m
  Computed horizontal distance from port opening to CCC location = 22.88
   Plume dimensions:      half-width (bh) = 1.40 m
                           thickness (bv) = 1.71 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:
1111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                    CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX1: Single Port Discharges
                      CORMIX Version 11.0GTH
                 HYDRO1 Version 11.0.0.0 April 2018
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:  Bay City Outfall
 Design case:      DEQ Chronic Criteria 50th % Velocity (Ebb)
 FILE NAME:        U:\...18\BayCityMixZn\Output\Chronic50thVelocityEbb.prd
 Time stamp:       09/06/2018--16:43:45

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =      4.11  HD    =      2.94
 Tidal Simulation at TIME =      2.100 h
 PERIOD=    12.40 h UAmax =      1.000 dUa/dt=      0.238 (m/s)/h
 UA    =     0.500 F     =      0.020 USTAR =0.2475E-01
 UW    =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U          RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT      DISTB =      1.00
 D0    =     0.203 A0    =      0.032 H0    =      0.30  SUB0  =      2.64
 THETA =     10.00  SIGMA =     90.00
 U0    =     3.257 Q0    =      0.106       =0.1056E+00
 RHO0  =  998.0000  DRHO0 =0.1474E+02  GP0   =0.1427E+00
 C0    =0.6790E+01  CUNITS=  mg/l
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00  M0    =0.3440E+00  J0    =0.1507E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =      3.66  Lm    =      1.17  Lb    =      0.12
                                       Lmp   =  99999.00  Lbp   =  99999.00
 Tidal:             Tu    =   0.1422 h Lu    =    17.325 Lmin  =     0.180
 Tidal Cutoffs (m): lmax  =  1469.837  xmax  =   601.606  ymax  =   233.886

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12  R     =      6.51

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =    H2    1
 1  Applicable layer depth HS =    2.94   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS=  mg/l
 NTOX  =  1         CMC   =0.1040E+01  CCC   =  CSTD
 NSTD  =  1         CSTD  =0.1600E+00
 REGMZ =  0
 XINT  =   5600.00  XMAX  =   5600.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
        1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  10 display intervals per module
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X         Y        Z          S       C         B        Uc         TT
     0.00      0.00     0.30       1.0 0.679E+01   0.10     3.257    .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:            THETAE=      9.98  SIGMAE=      86.31
  LE    =      0.51  XE    =      0.02  YE    =      0.51  ZE    =       0.39

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X         Y        Z          S       C         B        Uc         TT
     0.00      0.00     0.30       1.0 0.679E+01   0.10     3.257    .00000E+00
     0.02      0.51     0.39       1.0 0.679E+01   0.11     3.257    .66510E-02
     0.37      1.53     0.59       2.6 0.264E+01   0.27     1.249    .47274E+00
```

```
      1.22      2.22     0.77      5.6 0.122E+01   0.46     0.429   .15043E+01
** CMC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below CMC value of 0.104E+01
   in the current prediction interval.
 This is the extent of the TOXIC DILUTION ZONE.
      2.28      2.63     0.92      8.6 0.791E+00   0.59     0.237   .29921E+01
      3.35      2.91     1.06     11.2 0.609E+00   0.69     0.170   .46374E+01
      4.44      3.12     1.19     13.5 0.502E+00   0.76     0.137   .63853E+01
      5.56      3.29     1.33     15.8 0.429E+00   0.83     0.116   .82454E+01
      6.66      3.42     1.47     18.0 0.377E+00   0.89     0.103   .10102E+02
      7.80      3.54     1.61     20.2 0.336E+00   0.94     0.093   .12042E+02
      8.90      3.64     1.75     22.4 0.304E+00   1.00     0.086   .13958E+02
     10.00      3.73     1.89     24.5 0.277E+00   1.05     0.080   .15894E+02
 Cumulative travel time =          15.8941 sec  (     0.00 hrs)

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        TT
     10.00      3.73     1.89     24.4 0.279E+00   1.05 .15894E+02

 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)
   TT = Cumulative travel time

       X         Y        Z         S         C        BV       BH       ZU       ZL        TT
      8.96      3.69     2.94     24.5 0.277E+00   0.00     0.00     2.94     2.94 .15894E+02
      9.27      3.71     2.94     24.5 0.277E+00   1.32     0.67     2.94     1.62 .15894E+02
      9.59      3.72     2.94     24.5 0.277E+00   1.57     0.94     2.94     1.37 .15894E+02
      9.90      3.73     2.94     24.5 0.277E+00   1.73     1.15     2.94     1.21 .15894E+02
     10.22      3.74     2.94     25.2 0.269E+00   1.84     1.33     2.94     1.10 .16316E+02
     10.53      3.75     2.94     28.3 0.240E+00   1.93     1.49     2.94     1.01 .16943E+02
     10.84      3.76     2.94     32.6 0.208E+00   2.00     1.63     2.94     0.94 .17570E+02
     11.16      3.78     2.94     36.6 0.186E+00   2.05     1.76     2.94     0.89 .18197E+02
     11.47      3.79     2.94     39.2 0.173E+00   2.08     1.88     2.94     0.86 .18824E+02
     11.78      3.80     2.94     40.7 0.167E+00   2.10     2.00     2.94     0.84 .19451E+02
     12.10      3.81     2.94     41.6 0.163E+00   2.11     2.11     2.94     0.83 .20078E+02
 Cumulative travel time =          20.0782 sec  (     0.01 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH
-----------------------------------------------------------------------------------------------
** 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)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X         Y        Z         S         C        BV       BH       ZU       ZL        TT
     12.10      3.81     2.94     41.6 0.163E+00   2.11     2.11     2.94     0.83 .20078E+02
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.160E+00 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
     14.98      3.81     2.94     43.2 0.157E+00   1.89     2.44     2.94     1.05 .25845E+02
     17.86      3.81     2.94     44.5 0.153E+00   1.73     2.75     2.94     1.21 .31612E+02
     20.75      3.81     2.94     45.7 0.149E+00   1.61     3.04     2.94     1.33 .37379E+02
     23.63      3.81     2.94     46.7 0.145E+00   1.51     3.32     2.94     1.43 .43146E+02
     26.51      3.81     2.94     47.7 0.142E+00   1.43     3.59     2.94     1.51 .48914E+02
     29.40      3.81     2.94     48.7 0.140E+00   1.36     3.85     2.94     1.58 .54681E+02
     32.28      3.81     2.94     49.5 0.137E+00   1.30     4.10     2.94     1.64 .60448E+02
     35.16      3.81     2.94     50.4 0.135E+00   1.25     4.35     2.94     1.69 .66215E+02
     38.05      3.81     2.94     51.2 0.133E+00   1.21     4.58     2.94     1.73 .71982E+02
     40.93      3.81     2.94     52.1 0.130E+00   1.17     4.81     2.94     1.77 .77749E+02
 Cumulative travel time =          77.7488 sec  (     0.02 hrs)

-----------------------------------------------------------------------------------------------
 Plume is ATTACHED to RIGHT bank/shore.
   Plume width is now determined from RIGHT bank/shore.

 Plume Stage 2 (bank attached):
       X         Y        Z         S         C        BV       BH       ZU       ZL        TT
     40.93     -1.00     2.94     52.1 0.130E+00   1.17     9.63     2.94     1.77 .77749E+02
     95.18     -1.00     2.94     63.0 0.108E+00   1.04    13.53     2.94     1.90 .18624E+03
```

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   149.42     -1.00     2.94     78.0 0.871E-01   1.06     16.93     2.94     1.88 .29473E+03
   203.66     -1.00     2.94     98.0 0.693E-01   1.16     20.01     2.94     1.78 .40321E+03
   257.91     -1.00     2.94    123.5 0.550E-01   1.31     22.87     2.94     1.63 .51170E+03
   312.15     -1.00     2.94    154.8 0.439E-01   1.51     25.57     2.94     1.43 .62019E+03
   366.40     -1.00     2.94    191.9 0.354E-01   1.74     28.12     2.94     1.20 .72868E+03
   420.64     -1.00     2.94    235.2 0.289E-01   2.00     30.57     2.94     0.94 .83717E+03
   474.89     -1.00     2.94    284.6 0.239E-01   2.29     32.92     2.94     0.65 .94566E+03
   529.13     -1.00     2.94    340.4 0.199E-01   2.60     35.19     2.94     0.34 .10541E+04
   583.37     -1.00     2.94    402.7 0.169E-01   2.94     37.39     2.94     0.00 .11626E+04
 Cumulative travel time =        1162.6353 sec  (     0.32 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------------------------
 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -1.17m
-----------------------------------------------------------------------------------------------
BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)    = 0.147E-01 m^2/s
  Horizontal diffusivity (initial value) = 0.188E+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)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X          Y        Z         S        C        BV       BH       ZU       ZL        TT
   583.37     -1.00     2.94    402.7 0.169E-01   2.94     37.39     2.94     0.00 .11626E+04
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
   601.61     -1.00     2.94    410.6 0.166E-01   2.98     37.69     2.94    -0.04 .11991E+04
 Cumulative travel time =        1199.0968 sec  (     0.33 hrs)

 CORMIX simulation has been TERMINATED at last prediction interval.
   Limiting time due to TIDAL REVERSAL as per (xmax) has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
```

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                      HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                Bay City Outfall
  DESIGN CASE:                  DEQ Chronic Criteria 50th % Velocity (Ebb)
  FILE NAME:                    U:\rstillmaker\2018\BayCityMixZn\Output\Chronic50thVelocityEbb.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             09/06/2018--16:43:45
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                  HA      = 4.11 m
  Depth at discharge             HD      = 2.94 m
  Darcy-Weisbach friction factor F       = 0.0196
    Calculated from Manning's n          = 0.02
  Wind velocity                  UW      = 5.7 m/s
TIDAL SIMULATION at time         Tsim    = 2.1 hours
  Instantaneous ambient velocity UA      = 0.5 m/s
  Maximum tidal velocity         UaMAX   = 1 m/s
Rate of tidal reversal          dUA/dt = 0.2381 (m/s)/hour
  Period of reversal             T       = 12.4 hours
  Stratification Type            STRCND = U
  Surface density                RHOAS   = 1012.74 kg/m^3
  Bottom density                 RHOAB   = 1012.74 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                           = right
  Distance to bank               DISTB   = 1 m
  Port diameter                  D0      = 0.2032 m
  Port cross-sectional area      A0      = 0.0324 m^2
  Discharge velocity             U0      = 3.26 m/s
  Discharge flowrate             Q0      = 0.105613 m^3/s
  Discharge port height          H0      = 0.30 m
  Vertical discharge angle       THETA   = 10 deg
  Horizontal discharge angle     SIGMA   = 90 deg
  Discharge density              RHO0    = 998 kg/m^3
  Density difference             DRHO    = 14.7400 kg/m^3
  Buoyant acceleration           GP0     = 0.1427 m/s^2
  Discharge concentration        C0      = 6.79 mg/l
  Surface heat exchange coeff.   KS      = 0 m/s
  Coefficient of decay           KD      = 0 /s
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m         Lm  = 1.17 m         Lb  = 0.12 m
  LM  = 3.66 m         Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.1422 hours     Lu  = 17.32 m        Lmin= 0.18 m
----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 19.12
  Velocity ratio                  R      = 6.51
----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration              CMC     = 1.04 mg/l
  CCC concentration              CCC     = 0.16 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 5600 m downstream
****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 2.94 m
****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.163 mg/l
  Dilution at edge of NFR              s = 41.6
  NFR Location:                        x = 12.10 m
    (centerline coordinates)           y = 3.81 m
                                       z = 2.94 m
```

```
  NFR plume dimensions:  half-width (bh) = 2.11 m
                          thickness (bv) = 2.11 m
Cumulative travel time:       20.0782 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 1085.04 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 40.93 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                      x = 601.61 m
                                      y = -1 m
                                      z = 2.94 m.
  For this condition AFTER TIDAL REVERSAL, mixed water from the previous
  half-cycle becomes re-entrained into the near field of the discharge,
  increasing pollutant concentrations compared to steady-state predictions.
  A pool of mixed water formed at slack tide will be advected downstream
  in this phase.
************************ TOXIC DILUTION ZONE SUMMARY ************************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                     x = 1.53 m
    (centerline coordinates)          y = 2.36 m
                                      z = 0.82 m
  Plume dimension:        half-width (bh) = 0.07 m
                           thickness (bv) = 0.07 m

 Computed distance from port opening to CMC location = 2.86 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.81 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 2.94 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                   = 0.16  mg/l
Corresponding dilution                  = 42.4
  Plume location:                     x = 13.53 m
    (centerline coordinates)          y = 3.81 m
                                      z = 2.94 m
 Computed horizontal distance from port opening to CCC location = 14.30
  Plume dimensions:       half-width (bh) = 2.27 m
                           thickness (bv) = 1.99 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:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                       CORMIX MIXING ZONE EXPERT SYSTEM
                   Subsystem CORMIX1: Single Port Discharges
                             CORMIX Version 11.0GTH
                     HYDRO1 Version 11.0.0.0 April 2018
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Bay City Outfall
 Design case:       DEQ Chronic Criteria 50% Velocity (Flood)
 FILE NAME:         U:\...\BayCityMixZn\Output\Chronic50thVelocityFlood.prd
 Time stamp:        09/06/2018--16:45:12

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =      4.11  HD    =      4.74
 Tidal Simulation at TIME =     -1.000 h
 PERIOD=    12.40 h UAmax =      1.000 dUa/dt=      0.500 (m/s)/h
 UA    =     0.500 F     =      0.020 USTAR =0.2475E-01
 UW    =     5.700 UWSTAR=0.6815E-02
 Uniform density environment
 STRCND= U          RHOAM = 1012.7400

DISCHARGE PARAMETERS (metric units)
 BANK  = RIGHT      DISTB =      1.00
 D0    =     0.203 A0    =      0.032 H0    =      0.30  SUB0  =      4.44
 THETA =     10.00  SIGMA =     90.00
 U0    =     3.257 Q0    =      0.106       =0.1056E+00
 RHO0  = 998.0000  DRHO0 =0.1474E+02  GP0   =0.1427E+00
 C0    =0.6790E+01  CUNITS= mg/l
 IPOLL = 1          KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1056E+00  M0    =0.3440E+00  J0    =0.1507E-01  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =      3.66  Lm    =      1.17  Lb    =      0.12
                                        Lmp   =  99999.00  Lbp   =  99999.00
 Tidal:             Tu    =   0.0867 h Lu    =     13.529 Lmin  =      0.180
 Tidal Cutoffs (m): lmax  =   793.855  xmax  =  5580.000  ymax  =   182.641

NON-DIMENSIONAL PARAMETERS
 FR0   =     19.12  R     =      6.51

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =     H2     1
 1  Applicable layer depth HS =    4.74    1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.6790E+01  CUNITS= mg/l
 NTOX  = 1          CMC   =0.1040E+01  CCC   = CSTD
 NSTD  = 1          CSTD  =0.1600E+00
 REGMZ = 0
 XINT  =   5600.00  XMAX  =   5600.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         1.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 10 display intervals per module
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y        Z        S       C        B       Uc        TT
      0.00     0.00     0.30     1.0 0.679E+01  0.10    3.257   .00000E+00

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

 Jet-like motion in weak crossflow.

 Zone of flow establishment:              THETAE=      9.98  SIGMAE=     86.31
  LE    =      0.51  XE    =      0.02  YE    =      0.51  ZE    =      0.39

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X        Y        Z        S       C        B       Uc        TT
      0.00     0.00     0.30     1.0 0.679E+01  0.10    3.257   .00000E+00
      0.02     0.51     0.39     1.0 0.679E+01  0.11    3.257   .10946E-01
      1.17     2.19     0.76     5.5 0.124E+01  0.46    0.440   .14712E+01
```

** CMC HAS BEEN FOUND **
The pollutant concentration in the plume falls below CMC value of 0.104E+01
in the current prediction interval.
This is the extent of the TOXIC DILUTION ZONE.

3.26	2.89	1.05	11.0	0.616E+00	0.68	0.173	.45394E+01
5.44	3.27	1.31	15.7	0.434E+00	0.82	0.118	.80807E+01
7.64	3.53	1.59	20.0	0.339E+00	0.94	0.094	.11810E+02
9.79	3.72	1.86	24.3	0.280E+00	1.04	0.081	.15564E+02
12.00	3.87	2.15	28.7	0.236E+00	1.13	0.071	.19471E+02
14.20	3.99	2.43	33.3	0.204E+00	1.22	0.064	.23432E+02
16.41	4.09	2.71	38.0	0.179E+00	1.31	0.059	.27435E+02

WATER QUALITY STANDARD OR CCC HAS BEEN FOUND
The pollutant concentration in the plume falls below water quality standard
or CCC value of 0.160E+00 in the current prediction interval.
This is the spatial extent of concentrations exceeding the water quality
standard or CCC value.

18.62	4.17	2.99	42.9	0.158E+00	1.39	0.054	.31472E+02
20.78	4.24	3.26	47.8	0.142E+00	1.47	0.050	.35433E+02

Cumulative travel time = 35.4333 sec (0.01 hrs)

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	TT
20.78	4.24	3.26	47.6	0.143E+00	1.47	.35433E+02

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)
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
19.31	4.21	4.74	47.8	0.142E+00	0.00	0.00	4.74	4.74	.35433E+02
19.75	4.22	4.74	47.8	0.142E+00	1.85	0.93	4.74	2.89	.35433E+02
20.19	4.23	4.74	47.8	0.142E+00	2.19	1.31	4.74	2.55	.35433E+02
20.63	4.23	4.74	47.8	0.142E+00	2.41	1.61	4.74	2.33	.35433E+02
21.08	4.24	4.74	49.1	0.138E+00	2.57	1.86	4.74	2.17	.36023E+02
21.52	4.25	4.74	55.2	0.123E+00	2.69	2.08	4.74	2.05	.36907E+02
21.96	4.25	4.74	63.6	0.107E+00	2.78	2.27	4.74	1.96	.37790E+02
22.40	4.26	4.74	71.3	0.952E-01	2.85	2.46	4.74	1.89	.38674E+02
22.84	4.27	4.74	76.6	0.887E-01	2.90	2.63	4.74	1.84	.39558E+02
23.28	4.27	4.74	79.4	0.855E-01	2.93	2.79	4.74	1.81	.40441E+02
23.73	4.28	4.74	81.3	0.836E-01	2.94	2.94	4.74	1.80	.41325E+02

Cumulative travel time = 41.3249 sec (0.01 hrs)

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** 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)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
23.73	4.28	4.74	81.3	0.836E-01	2.94	2.94	4.74	1.80	.41325E+02
26.46	4.28	4.74	83.2	0.817E-01	2.75	3.21	4.74	1.99	.46786E+02
29.19	4.28	4.74	84.9	0.800E-01	2.60	3.47	4.74	2.14	.52247E+02
31.92	4.28	4.74	86.5	0.785E-01	2.47	3.72	4.74	2.27	.57708E+02
34.65	4.28	4.74	88.0	0.772E-01	2.36	3.96	4.74	2.38	.63169E+02
37.38	4.28	4.74	89.4	0.759E-01	2.27	4.19	4.74	2.47	.68630E+02
40.11	4.28	4.74	90.8	0.748E-01	2.19	4.42	4.74	2.55	.74091E+02
42.84	4.28	4.74	92.2	0.737E-01	2.11	4.64	4.74	2.63	.79552E+02
45.57	4.28	4.74	93.5	0.727E-01	2.05	4.86	4.74	2.69	.85013E+02
48.30	4.28	4.74	94.7	0.717E-01	1.99	5.07	4.74	2.75	.90474E+02
51.03	4.28	4.74	96.0	0.708E-01	1.94	5.28	4.74	2.80	.95935E+02

Cumulative travel time = 95.9350 sec (0.03 hrs)

Plume is ATTACHED to RIGHT bank/shore.
Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
51.03	-1.00	4.74	96.0	0.708E-01	1.94	10.56	4.74	2.80	.95935E+02
124.99	-1.00	4.74	119.3	0.569E-01	1.65	15.58	4.74	3.09	.24386E+03

```
   198.96     -1.00     4.74    151.8 0.447E-01   1.66     19.88     4.74     3.08 .39179E+03
   272.92     -1.00     4.74    196.2 0.346E-01   1.81     23.75     4.74     2.93 .53971E+03
   346.88     -1.00     4.74    254.4 0.267E-01   2.06     27.33     4.74     2.68 .68764E+03
   420.85     -1.00     4.74    327.4 0.207E-01   2.37     30.69     4.74     2.37 .83556E+03
   494.81     -1.00     4.74    416.3 0.163E-01   2.75     33.87     4.74     1.99 .98349E+03
   568.77     -1.00     4.74    522.0 0.130E-01   3.18     36.92     4.74     1.56 .11314E+04
   642.73     -1.00     4.74    645.3 0.105E-01   3.66     39.84     4.74     1.08 .12793E+04
   716.70     -1.00     4.74    787.0 0.863E-02   4.18     42.65     4.74     0.56 .14273E+04
   790.66     -1.00     4.74    947.8 0.716E-02   4.74     45.38     4.74     0.00 .15752E+04
 Cumulative travel time =        1575.1919 sec  (     0.44 hrs)

END OF MOD141: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------------------------
 Due to the attachment or proximity of the plume to the bottom, the bottom
   coordinate for the FAR-FIELD differs from the ambient depth, ZFB = 0 m.
 In a subsequent analysis set "depth at discharge" equal to "ambient depth".
-----------------------------------------------------------------------------------------------
BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)   = 0.236E-01 m^2/s
  Horizontal diffusivity (initial value) = 0.243E+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)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X         Y         Z         S        C        BV        BH        ZU       ZL        TT
   790.66     -1.00     4.74    947.8 0.716E-02   4.74     45.38     4.74     0.00 .15752E+04
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
   793.84     -1.00     4.74    948.9 0.716E-02   4.74     45.44     4.74     0.00 .15816E+04
 Cumulative travel time =        1581.5564 sec  (     0.44 hrs)

 CORMIX simulation has been TERMINATED at last prediction interval.
   Limiting distance (lmax) due to TIDAL REVERSAL has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0GTH
                       HYDRO1:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                 Bay City Outfall
  DESIGN CASE:                   DEQ Chronic Criteria 50% Velocity (Flood)
  FILE NAME:                     U:\rstillmaker\2018\BayCityMixZn\Output\Chronic50thVelocityFlood.prd
  Using subsystem CORMIX1:      Single Port Discharges
  Start of session:              09/06/2018--16:45:12
***************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = unbounded
  Average depth                   HA      = 4.11 m
  Depth at discharge              HD      = 4.74 m
  Darcy-Weisbach friction factor  F       = 0.0196
    Calculated from Manning's n           = 0.02
  Wind velocity                   UW      = 5.7 m/s
TIDAL SIMULATION at time          Tsim    = -1 hours
  Instantaneous ambient velocity  UA      = 0.5 m/s
  Maximum tidal velocity          UaMAX   = 1 m/s
Rate of tidal reversal          dUA/dt = 0.5 (m/s)/hour
  Period of reversal              T       = 12.4 hours
  Stratification Type             STRCND = U
  Surface density                 RHOAS   = 1012.74 kg/m^3
  Bottom density                  RHOAB   = 1012.74 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                            = right
  Distance to bank                DISTB   = 1 m
  Port diameter                   D0      = 0.2032 m
  Port cross-sectional area       A0      = 0.0324 m^2
  Discharge velocity              U0      = 3.26 m/s
  Discharge flowrate              Q0      = 0.105613 m^3/s
  Discharge port height           H0      = 0.30 m
  Vertical discharge angle        THETA   = 10 deg
  Horizontal discharge angle      SIGMA   = 90 deg
  Discharge density               RHO0    = 998 kg/m^3
  Density difference              DRHO    = 14.7400 kg/m^3
  Buoyant acceleration            GP0     = 0.1427 m/s^2
  Discharge concentration         C0      = 6.79 mg/l
  Surface heat exchange coeff.    KS      = 0 m/s
  Coefficient of decay            KD      = 0 /s
---------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m         Lm  = 1.17 m         Lb  = 0.12 m
  LM  = 3.66 m         Lm' = 99999 m         Lb' = 99999 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.0867 hours     Lu  = 13.53 m         Lmin= 0.18 m
---------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0     = 19.12
  Velocity ratio                  R       = 6.51
---------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = yes
  CMC concentration               CMC     = 1.04 mg/l
  CCC concentration               CCC     = 0.16 mg/l
  Water quality standard specified        = given by CCC value
  Regulatory mixing zone                  = no
  Region of interest                      = 5600 m downstream
***************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = H2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 4.74 m
***************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

---------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    1 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 = 0.0836 mg/l
  Dilution at edge of NFR              s = 81.3
  NFR Location:                        x = 23.73 m
    (centerline coordinates)           y = 4.28 m
                                       z = 4.74 m
```

```
  NFR plume dimensions:  half-width (bh) = 2.94 m
                          thickness (bv) = 2.94 m
Cumulative travel time:       41.3250 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.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed at 1271.59 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section contacts nearest bank at 51.03 m downstream.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                      x = 793.84 m
                                      y = -1 m
                                      z = 4.74 m.
  For this condition BEFORE TIDAL REVERSAL, extensive re-entrainment
  of previously discharged is unlikely.
  To determine the minimum dilution, perform additional simulations
  after slack tide.
************************ TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 1.04  mg/l
Corresponding dilution                   = 6.528846
The CMC was encountered at the following plume position:
  Plume location:                      x = 1.51 m
    (centerline coordinates)           y = 2.35 m
                                       z = 0.81 m
  Plume dimension:       half-width (bh) = 0.10 m
                          thickness (bv) = 0.10 m

 Computed distance from port opening to CMC location = 2.84 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
             Lq = 0.18 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.80 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 4.74 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone
              test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 3.26 m/s.
 This exceeds the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                   = 0.16  mg/l
Corresponding dilution                  = 42.4
  Plume location:                      x = 18.40 m
    (centerline coordinates)           y = 4.16 m
                                       z = 2.96 m
 Computed horizontal distance from port opening to CCC location = 19.05
  Plume dimension:       half-width (bh) = 1.39 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.
```

SHN Geotechnical Drilling Work Scope – Bandon, OR

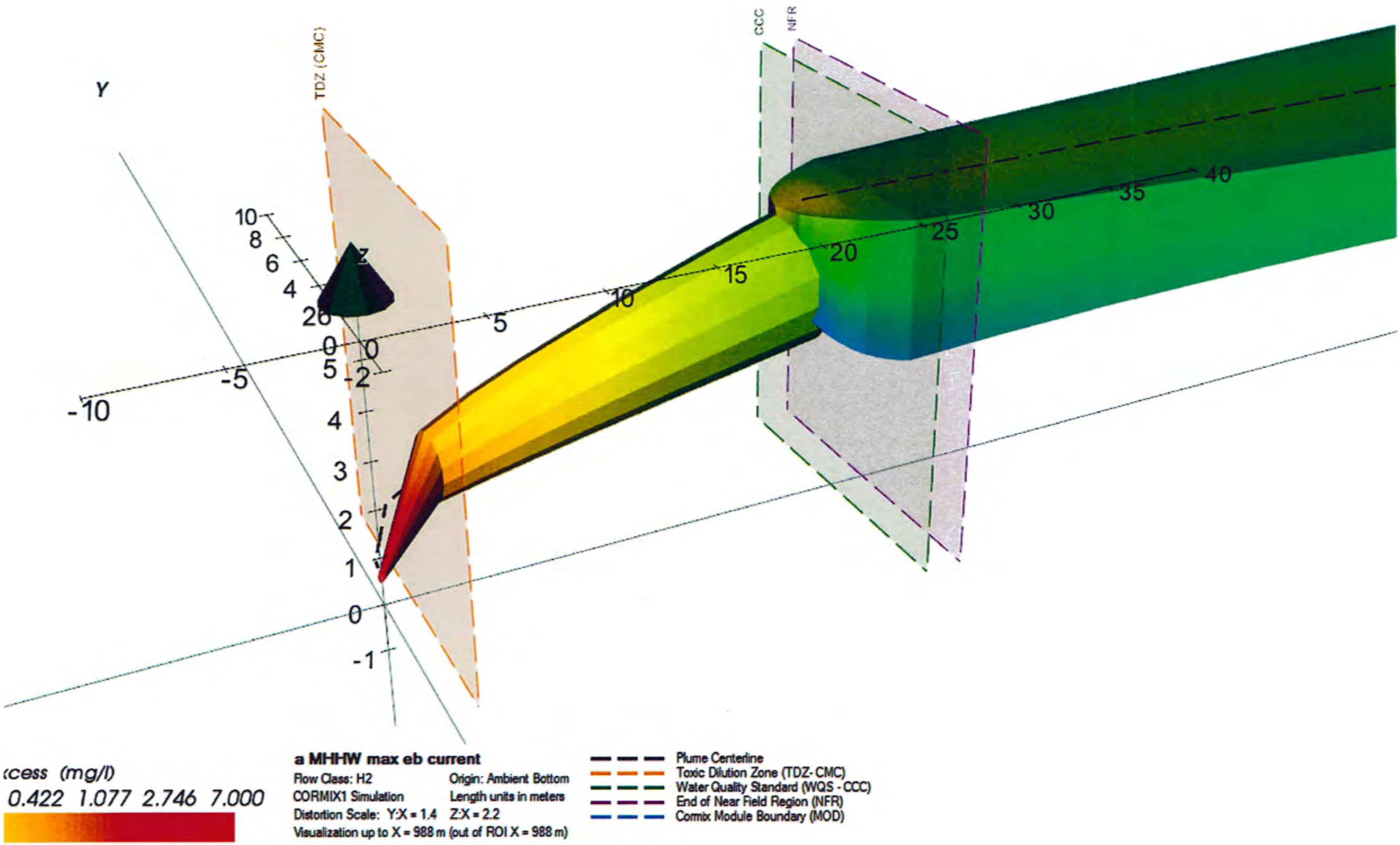
Subsurface Investigation

SHN is to retain the services of an Oregon licensed C-57 drilling subcontractor to advance one (1) geotechnical boring to a depth of approximately 100 feet or refusal (whichever is shallowest) with a truck-mounted rotary wash drilling rig. Mud rotary drilling methods are required in anticipation of the presence of fully saturated loose historic fill materials and soft fine-grained sediments underlying the fill materials.

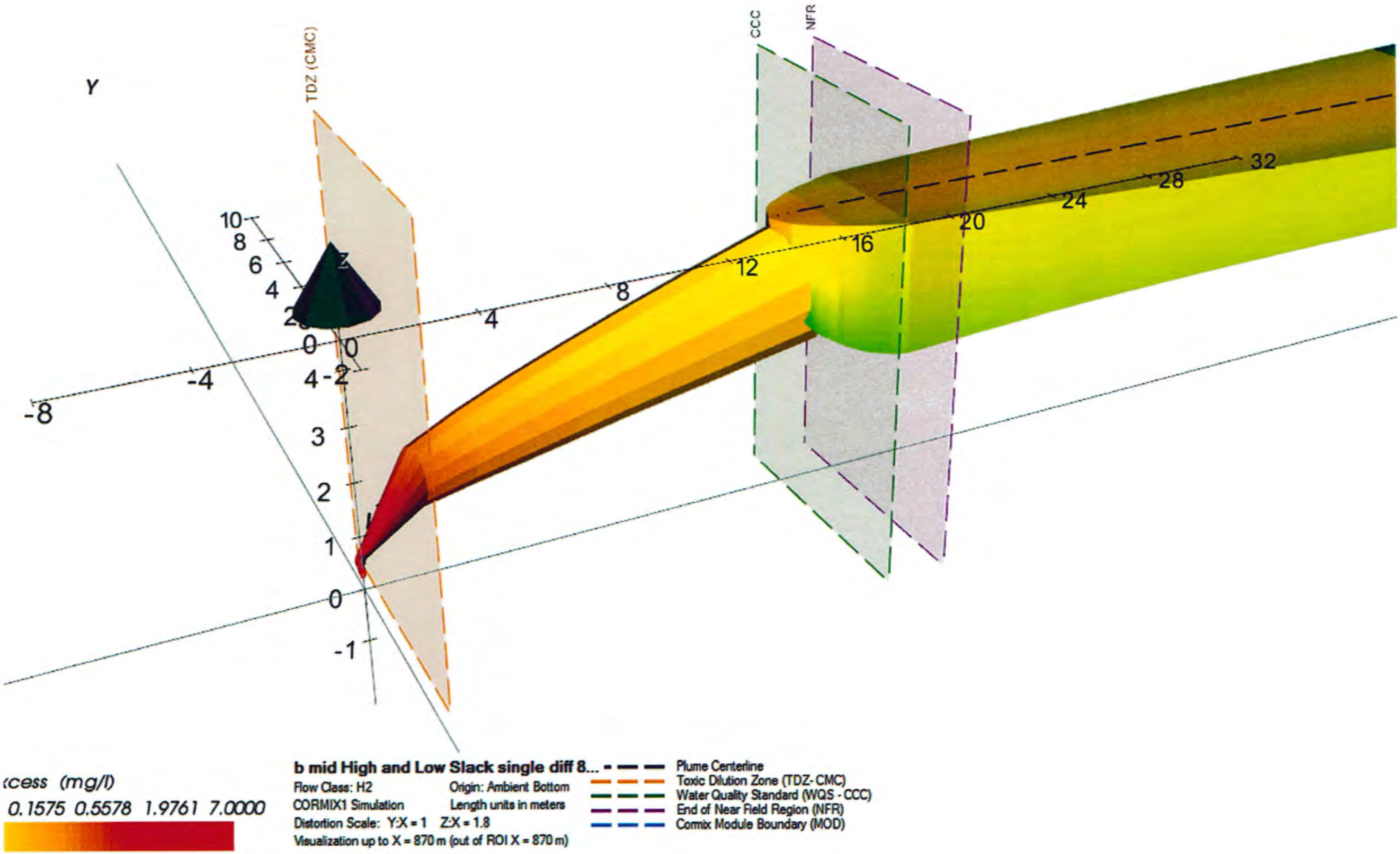
Borehole advancement by mud rotary drilling is achieved by rapid rotation of a drill bit which is mounted at the end of drill pipe. In this method, mud is pumped down the drill pipe and out through the ports in the drill bit. The drill bit cuts the formation into small pieces, called cuttings, which are removed by pumping drilling fluid, called mud, through the drill pipe, out the drill bit and up the annulus between the borehole and drill pipe. The drilling fluid is also used to cool the drill bit and stabilize the borehole wall and prevent fluid loss into the formation. The drilling fluid then flows up the annular space between the borehole walls and the drill pipe carrying cuttings in suspension to the surface. The cuttings are then discharged onto a metal screen placed over the mud tub for viewing, sampling, and logging.

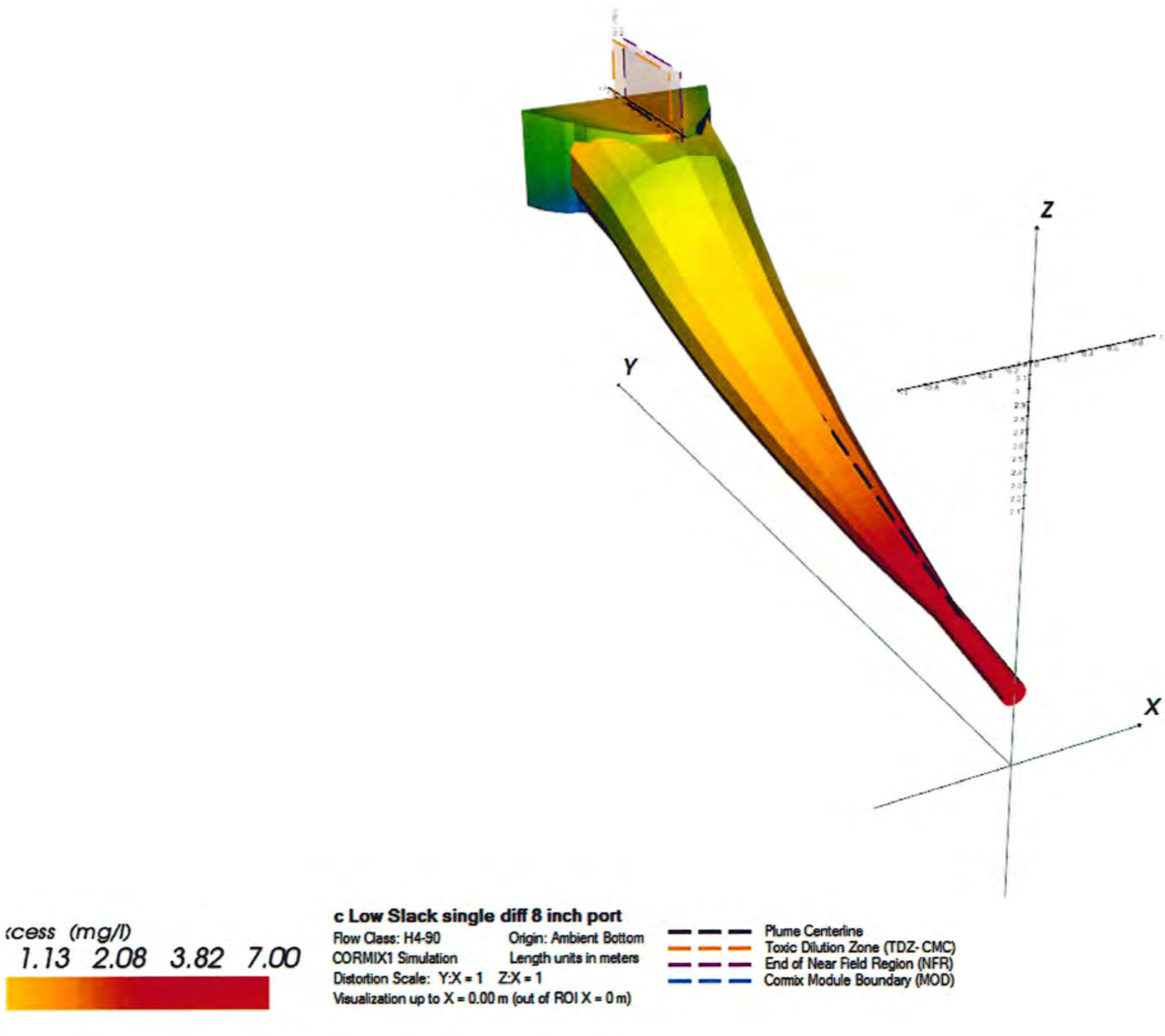
The boring will be centrally located in the proposed building footprint to delineate the thickness of historic fill materials and determine the depth suitably dense foundation load bearing materials. The boring will be closed with Portland cement grout slurry from the bottom of the borehole to the ground surface using the tremie method. All drilling fluid and drill cuttings will be contained in 55-gallon drums, and left on-site. Disposal of the drummed materials will be left to the discretion of the Project Owner.

SHN will supervise the drilling of the geotechnical boring, perform laboratory testing on selected samples to characterize material strength and index properties. The soil and laboratory data will be utilized to develop recommendations for ground improvements and deep foundation support of the proposed structure.

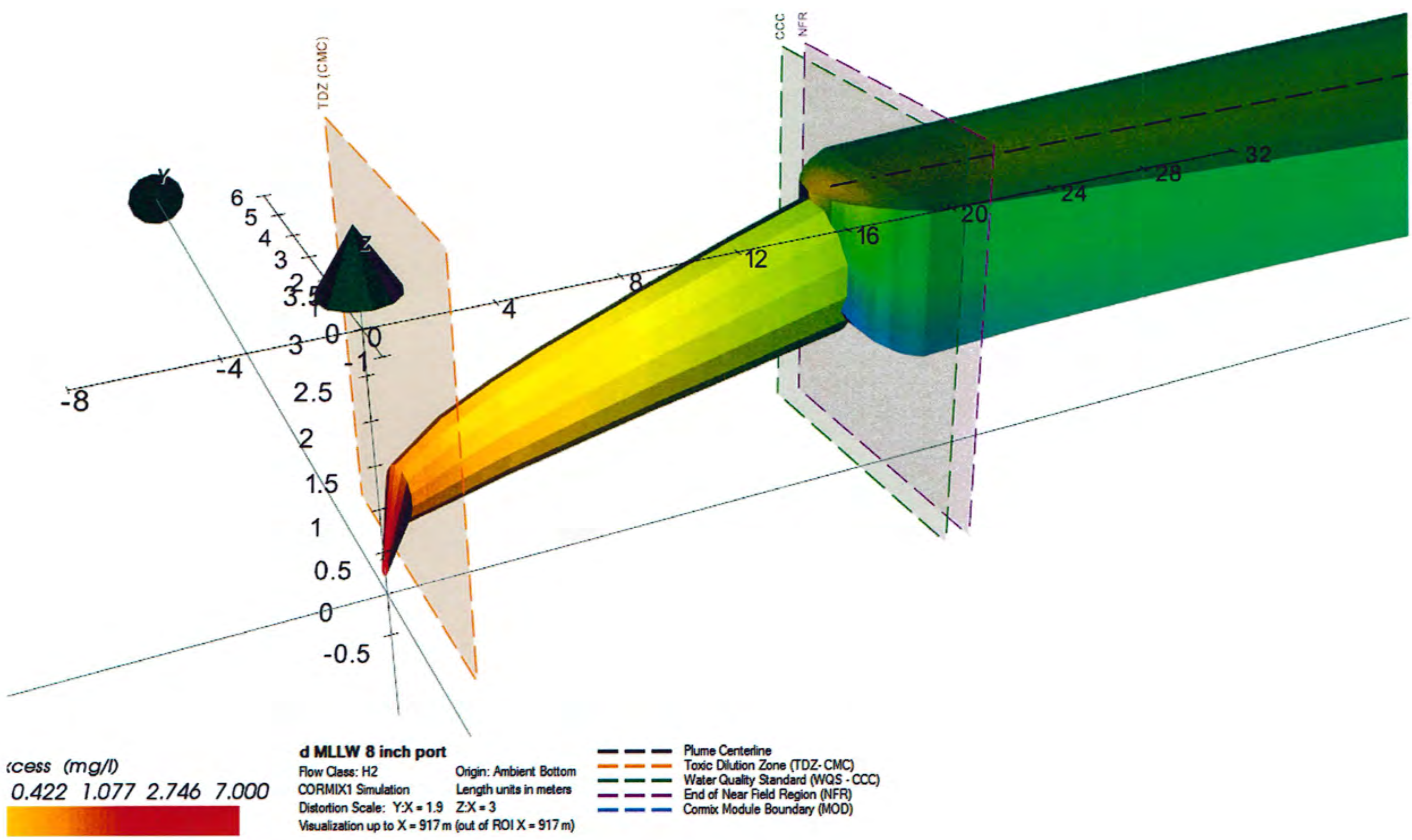


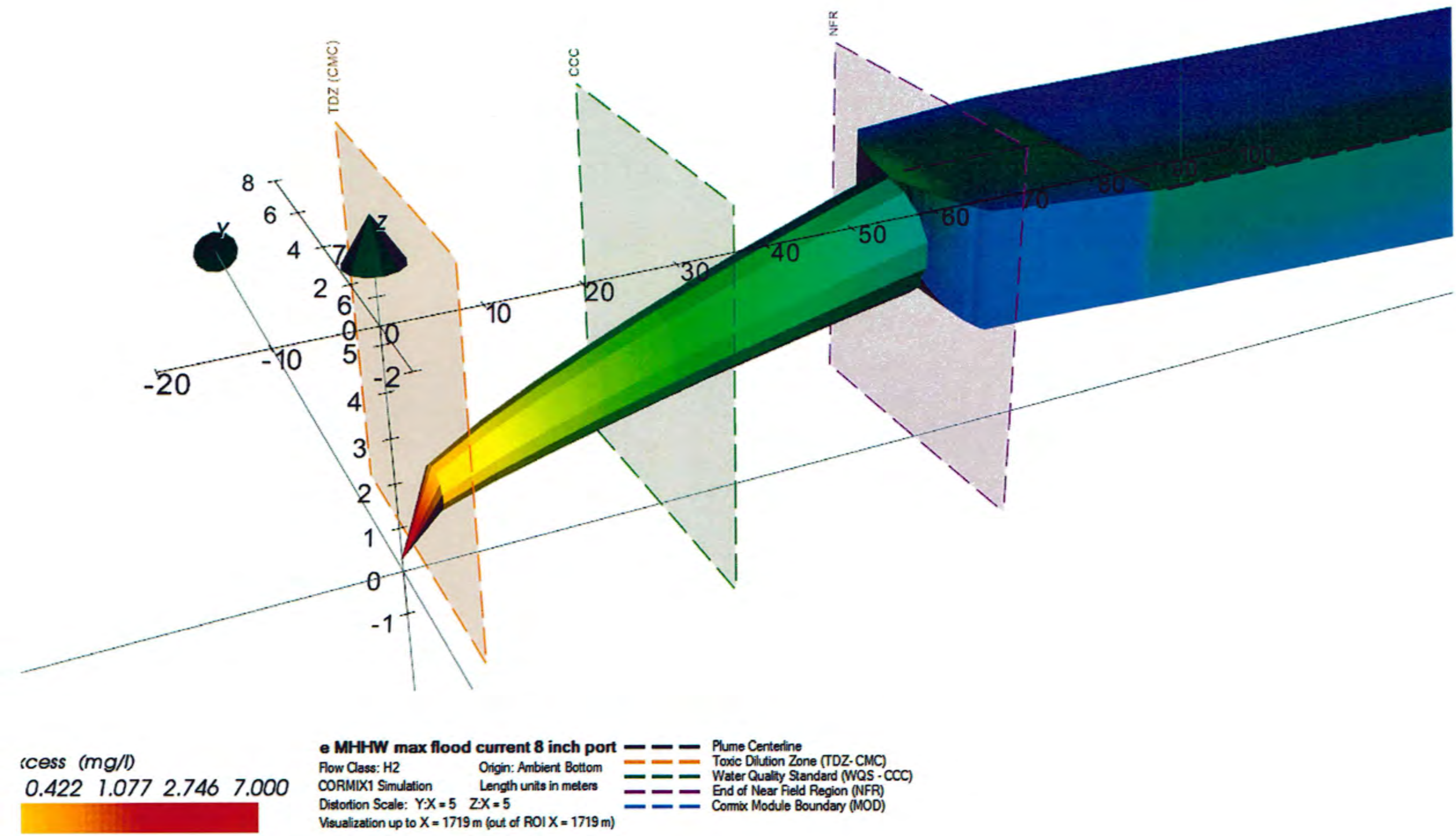
TDZ (CMC)
CCC
NFR
Y
Z
‹cess (mg/l)
0.422 1.077 2.746 7.000
a MHHW max eb current
Flow Class: H2
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 1.4 Z:X = 2.2
Visualization up to X = 988 m (out of ROI X = 988 m)
Plume Centerline
Toxic Dilution Zone (TDZ-CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)


Y
TDZ (CMC)
CCC
NFR
Z
-8
-4
0
4
8
12
16
20
24
28
32
10
8
6
4
2
0
-2
4
3
2
1
0
-1
ɛcess (mg/l)
0.1575 0.5578 1.9761 7.0000
b mid High and Low Slack single diff 8...
Flow Class: H2
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 1 Z:X = 1.8
Visualization up to X = 870 m (out of ROI X = 870 m)
Plume Centerline
Toxic Dilution Zone (TDZ-CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)



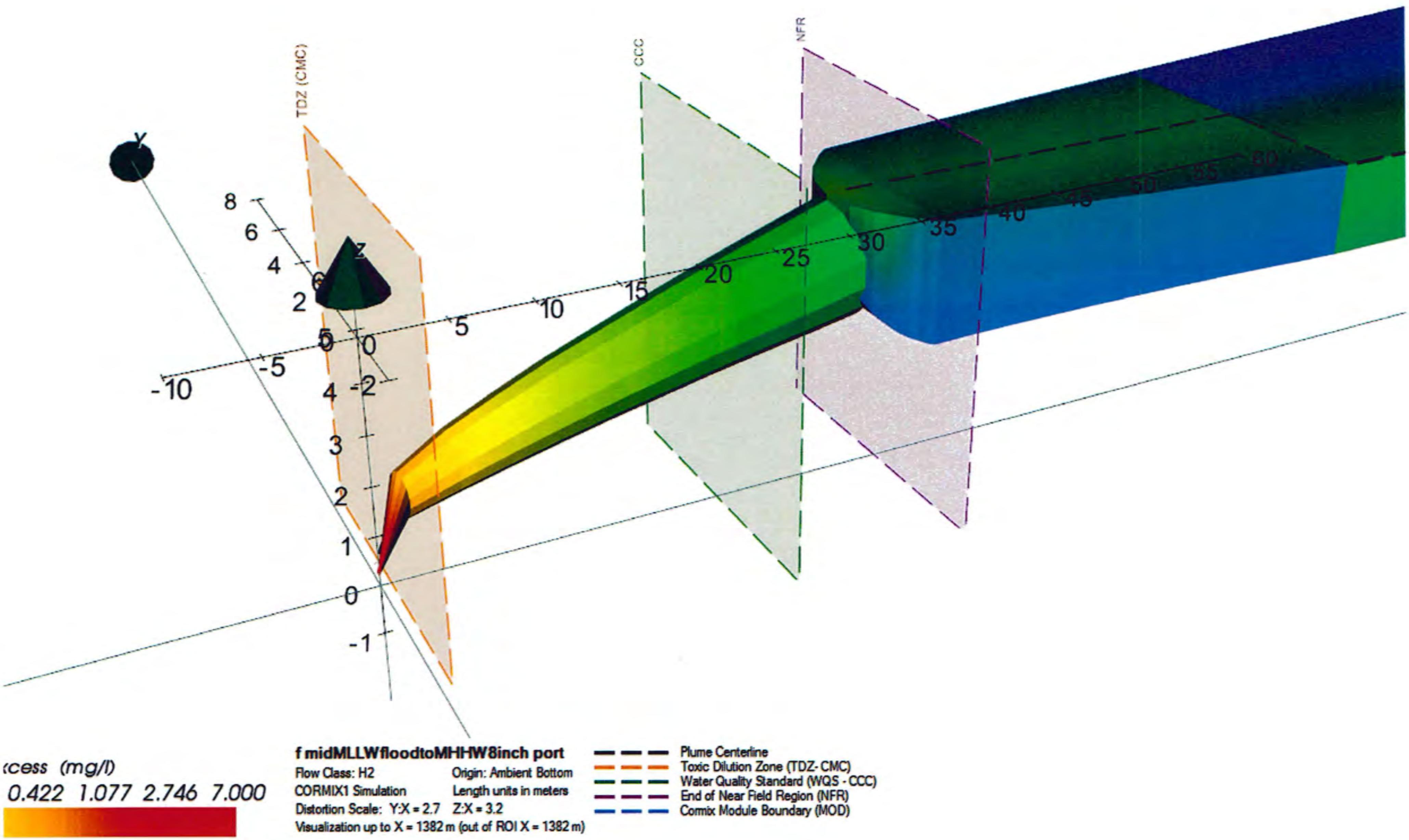
Z
Y
X
‹cess (mg/l)
1.13 2.08 3.82 7.00
c Low Slack single diff 8 inch port
Flow Class: H4-90
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 1 Z:X = 1
Visualization up to X = 0.00 m (out of ROI X = 0 m)
Plume Centerline
Toxic Dilution Zone (TDZ- CMC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)


TDZ (CMC)
CCC
NFR
-8
-4
0
4
8
12
16
20
24
28
32
6
5
4
3
2
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
Y
Z
‹cess (mg/l)
0.422 1.077 2.746 7.000
d MLLW 8 inch port
Flow Class: H2
CORMIX1 Simulation
Distortion Scale: Y:X = 1.9 Z:X = 3
Visualization up to X = 917 m (out of ROI X = 917 m)
Origin: Ambient Bottom
Length units in meters
Plume Centerline
Toxic Dilution Zone (TDZ- CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)

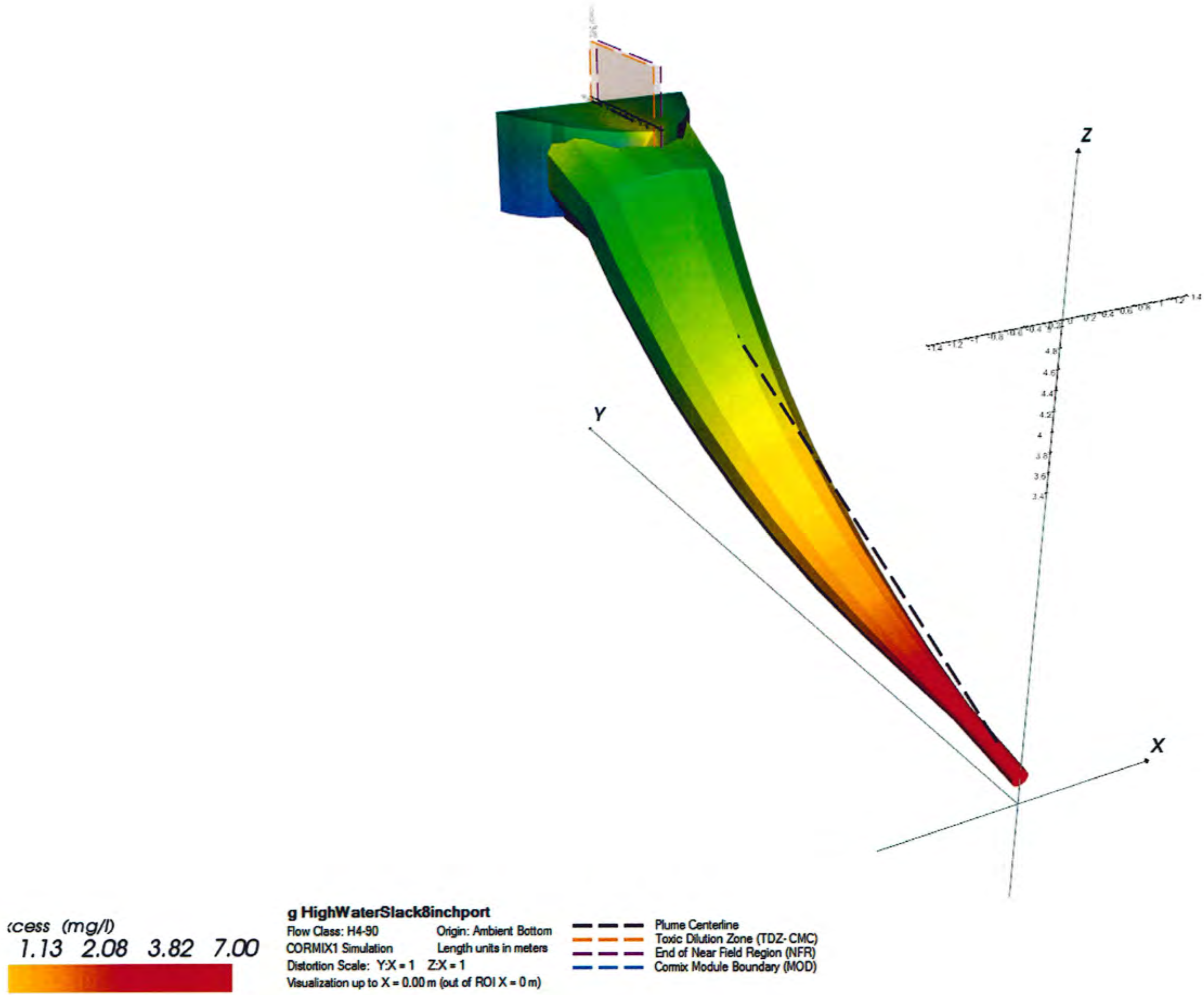


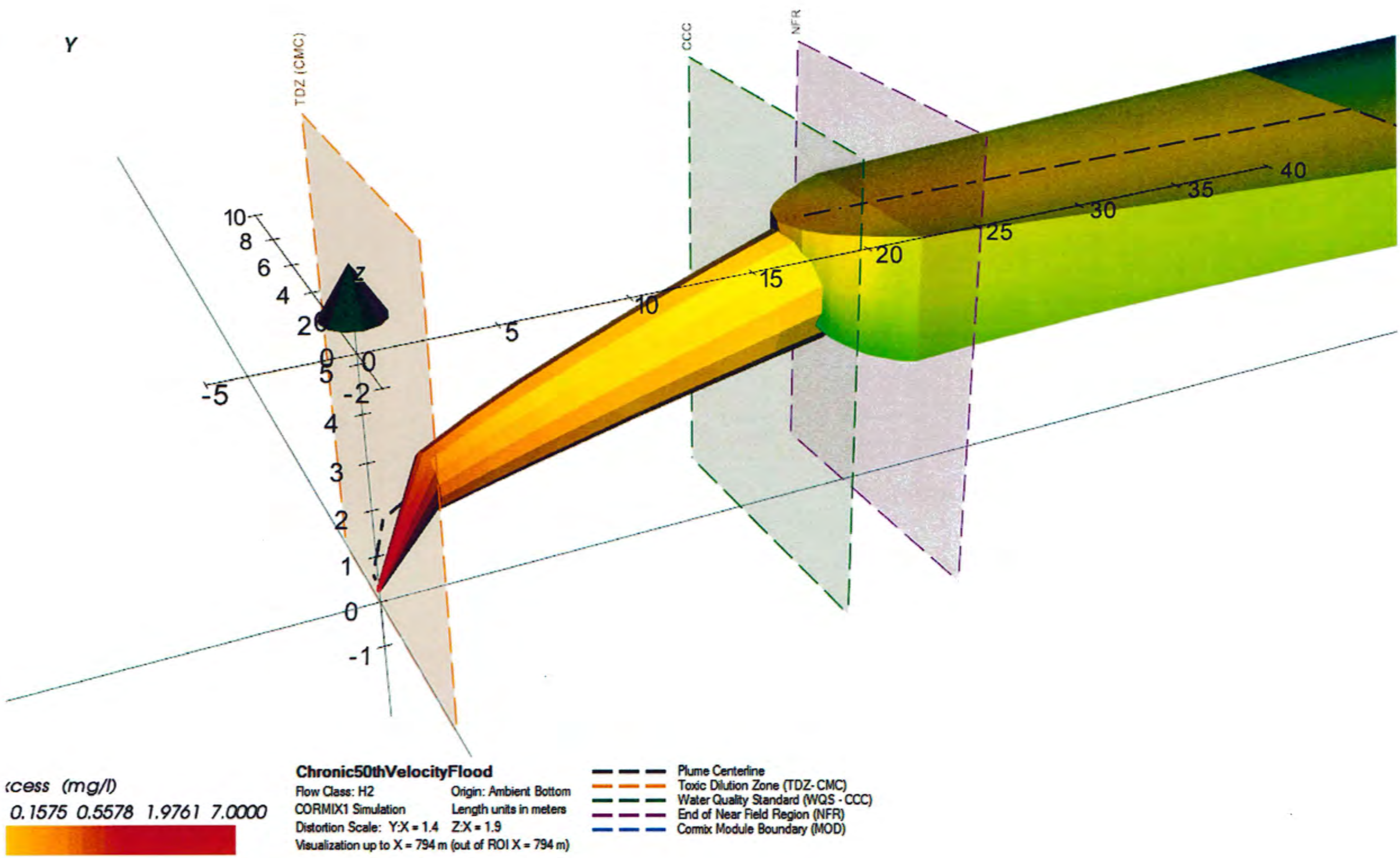
TDZ (CMC)
CCC
NFR
-20
-10
10
20
30
40
50
60
70
80
90
100
8
6
4
2
0
-2
7
6
5
4
3
2
1
0
-1
y
z

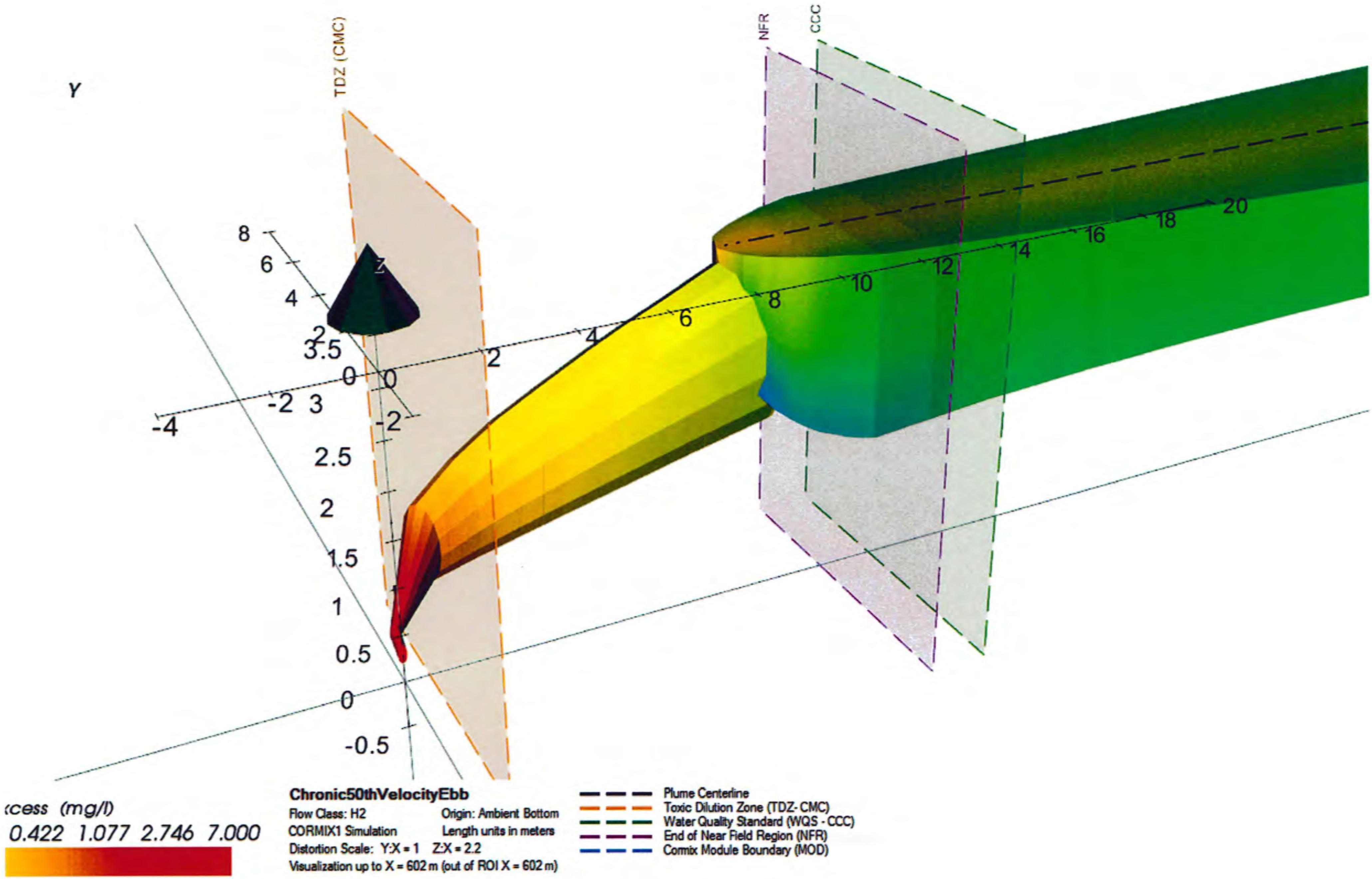
‹cess (mg/l)
0.422 1.077 2.746 7.000
e MHHW max flood current 8 inch port
Flow Class: H2
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 5 Z:X = 5
Visualization up to X = 1719 m (out of ROI X = 1719 m)
Plume Centerline
Toxic Dilution Zone (TDZ- CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)



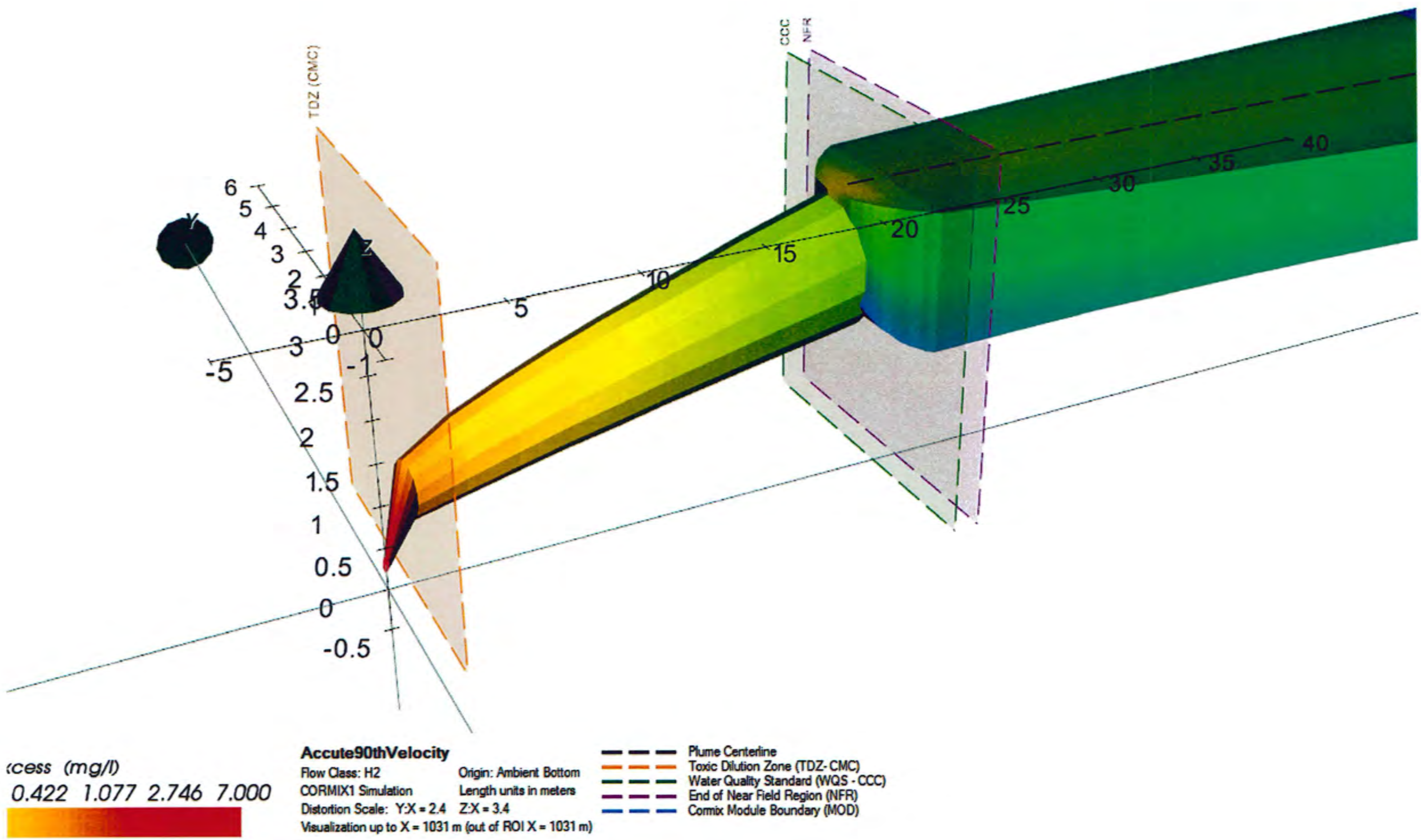
TDZ (CMC)
CCC
NFR
Y
Z
-10
-5
5
10
15
20
25
30
35
40
45
50
55
60
8
6
4
2
0
-2
3
1
-1
‹cess (mg/l)
0.422 1.077 2.746 7.000
f midMLLWfloodtoMHHW8inch port
Flow Class: H2
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 2.7 Z:X = 3.2
Visualization up to X = 1382 m (out of ROI X = 1382 m)
Plume Centerline
Toxic Dilution Zone (TDZ-CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)

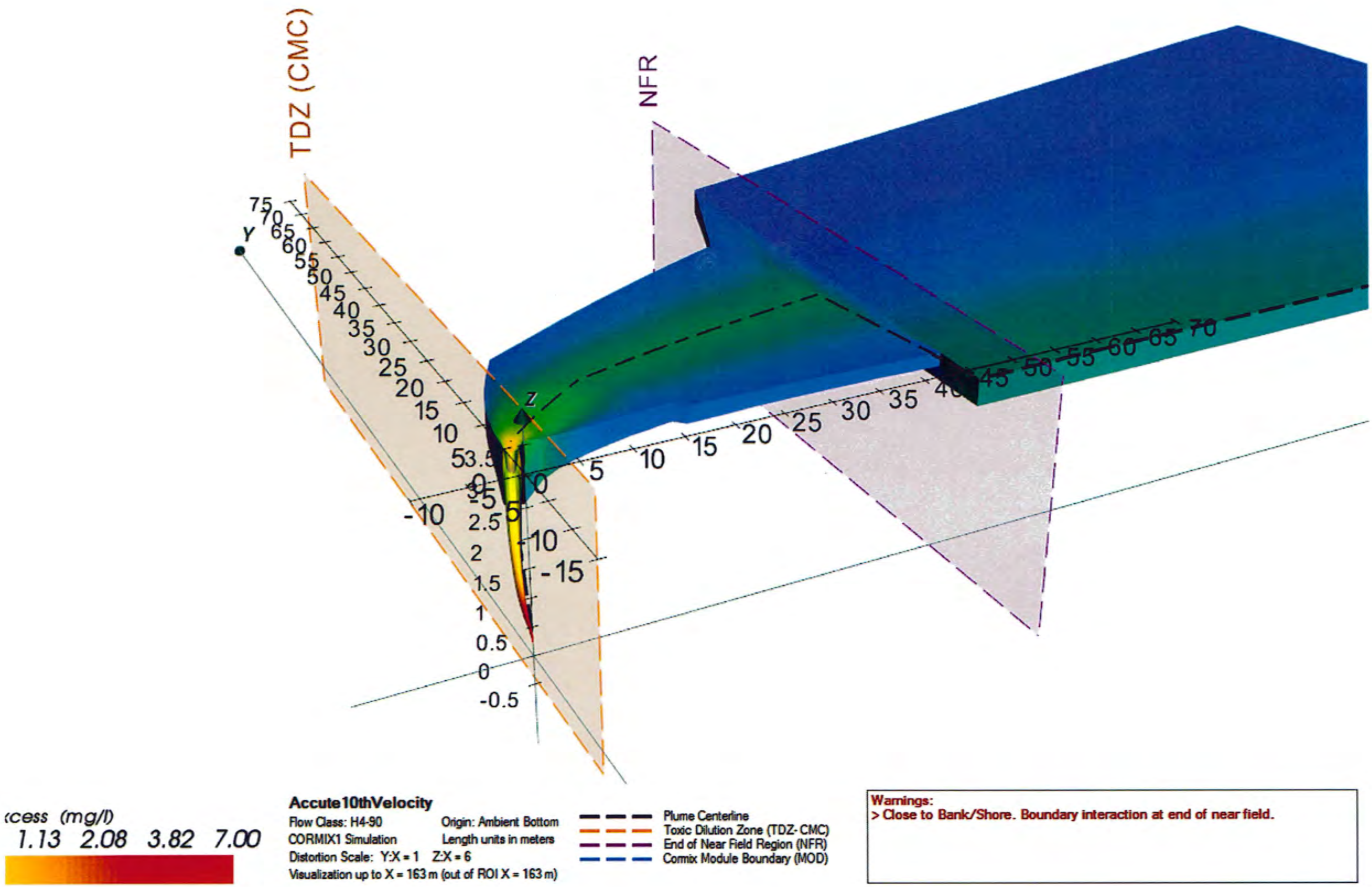

Z
Y
X
‹cess (mg/l)
1.13 2.08 3.82 7.00
g HighWaterSlack8inchport
Flow Class: H4-90
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 1 Z:X = 1
Visualization up to X = 0.00 m (out of ROI X = 0 m)
Plume Centerline
Toxic Dilution Zone (TDZ-CMC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)


Y
TDZ (CMC)
CCC
NFR
Z
‹cess (mg/l)
0.1575 0.5578 1.9761 7.0000
Chronic50thVelocityFlood
Flow Class: H2
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 1.4 Z:X = 1.9
Visualization up to X = 794 m (out of ROI X = 794 m)
Plume Centerline
Toxic Dilution Zone (TDZ- CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)



TDZ (CMC)
NFR
CCC
Y
Z
8
6
4
2
3.5
0
3
2.5
2
1.5
1
0.5
0
-0.5
-4
-2
0
-2
2
4
6
8
10
12
14
16
18
20
xcess (mg/l)
0.422 1.077 2.746 7.000
Chronic50thVelocityEbb
Flow Class: H2
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 1 Z:X = 2.2
Visualization up to X = 602 m (out of ROI X = 602 m)
Plume Centerline
Toxic Dilution Zone (TDZ- CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)


TDZ (CMC)
CCC
NFR
Y
Z
‹cess (mg/l)
0.422 1.077 2.746 7.000
Accute90thVelocity
Flow Class: H2
CORMIX1 Simulation
Distortion Scale: Y:X = 2.4 Z:X = 3.4
Visualization up to X = 1031 m (out of ROI X = 1031 m)
Origin: Ambient Bottom
Length units in meters
Plume Centerline
Toxic Dilution Zone (TDZ-CMC)
Water Quality Standard (WQS - CCC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)


TDZ (CMC)
NFR
Y
Z
ιcess (mg/l)
1.13 2.08 3.82 7.00
Accute10thVelocity
Flow Class: H4-90
Origin: Ambient Bottom
CORMIX1 Simulation
Length units in meters
Distortion Scale: Y:X = 1 Z:X = 6
Visualization up to X = 163 m (out of ROI X = 163 m)
Plume Centerline
Toxic Dilution Zone (TDZ-CMC)
End of Near Field Region (NFR)
Cormix Module Boundary (MOD)
Warnings:
> Close to Bank/Shore. Boundary interaction at end of near field.

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