Brown AND Caldwell

Prepared for
City of Medford, Oregon

Medford Regional Water Reclamation Facility

Mixing Zone and Biological Assessment Study

April 25, 2014

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$\mu m^3/cm^2$	cubic microns per square centimeter
µg/L	micrograms per liter
ABA	Aquatic Biological Associates
ACDP	Acoustic Doppler Current Profile
cfs	cubic feet per second
City	City of Medford
cm^2	square centimeter
CV	coefficient of variation
DEQ	Oregon Department of Environmental Quality
DIN	dissolved inorganic nitrogen
DO	dissolved oxygen
DPS	distinct population segment
EPT	*Ephemoptera, Plecoptera,* and *Trichoptera*
ESU	evolutionarily significant unit
F	Fahrenheit
GPS	global positioning system
HBI	Hilsenhof Biotic Index
IBI	Index of Biotic Integrity
IMD	Internal Management Directive
KMP	Klamath Mountains Province
LS	Lower Sites (Hafele's)
mgd	million gallons per day
mg/L	milligrams per liter
N	nitrogen
NPDES	National Pollutant Discharge Elimination System
ODFW	Oregon Department of Fish and Wildlife
Oregon Plan	*Oregon Plan for Salmon and Watersheds*
P	phosphorus
PIBS	Portable Invertebrate Box Sampler
RM	river mile
RMZ	Regulatory Mixing Zone
RPA	reasonable potential analysis
RWRF	Medford Regional Water Reclamation Facility
SONCC	Southern Oregon/Northern California Coast
SRP	soluble reactive phosphorus
Study Plan	*Mixing Zone and Biological Assessment Study Plan*
USBOR	U.S. Bureau of Reclamation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
ZID	zone of initial dilution

Section 1

Introduction

This section provides a brief project background and summarizes the purpose of this report.

1.1 Background

The Medford Regional Water Reclamation Facility (RWRF) discharges secondary-treated and disinfected effluent to the Rogue River at River Mile 130.5. In December 2011, the Oregon Department of Environmental Quality (DEQ) issued National Pollutant Discharge Elimination System (NPDES) Permit No. 100985 to the City of Medford (City). The NPDES permit (Schedule B, Section 4.c) requires the City to submit the results of a mixing zone study for DEQ approval by June 1, 2016. Although not specifically stated in the permit, DEQ-identified report elements are guided by the requirements of the Regulatory Mixing Zone Internal Management Directive (IMD) (DEQ, 2012).

The City met with DEQ in May 2013 to discuss the scope of the required mixing zone study as well as concerns raised by a third party study of aquatic macroinvertebrates and attached benthic algae upstream and downstream of the RWRF's outfall (Hafele, 2013). DEQ provided recommendations, included in Appendix A[1], for a combined mixing zone and biological assessment field study that meets the requirements of a Level 2 mixing zone study of the IMD and addresses biological concerns. The City subsequently prepared a *Mixing Zone and Biological Assessment Study Plan* (*Study Plan*) (Brown and Caldwell, September 2013) to outline the methodology for completing a field study that meets DEQ requirements. The *Study Plan* was approved by DEQ via e-mail on September 17, 2013.

1.2 Purpose

This *Mixing Zone and Biological Assessment Study* fulfills DEQ requirements for the mixing zone study identified in the NPDES permit and approved *Study Plan*. To address biological concerns, the study included sample collection for nutrients (nitrogen and phosphorus) and other physical characteristics (dissolved oxygen, temperature, and pH) of the Rogue River upstream and downstream of the RWRF outfall location. Field study activities were performed between October 14 and October 17, 2013. This report fulfills the following:

- Confirms outfall/diffuser integrity and performance with respect to port flow distribution based on in-water inspections completed in September 2013 (see Section 5.1)
- Maps effluent plume lateral spreading and downstream travel via injection of fluorescent dye and aerial photography
- Presents field data to support selection and calibration of a DEQ-approved hydrodynamic model
- Predicts critical effluent dilution ratios using the calibrated hydrodynamic model
- Performs an analysis of the effluent's reasonable potential to exceed applicable numeric water quality criteria from Oregon Administrative Rule 340-041-0011

[1] Additional discussion between the City, its consultants, and DEQ later modified the recommendations provided by DEQ in its May 28, 2013, letter. Final study requirements were documented in the DEQ-approved Study Plan.

- Presents water quality and benthic macroinvertebrate/algae sample results to support evaluation of effluent impacts on ambient aquatic life populations and better understand the concerns raised by the third-party study submitted to DEQ (Hafele, 2013)

As required in Part 2 of the IMD, a completed Mixing Zone Study Checklist is included in Appendix B to support DEQ review of this report.

Section 2

Site Description

This section describes the site conditions, including the Medford RWRF outfall and NPDES permit-established mixing zone, and presents results of environmental mapping in the vicinity of the outfall.

2.1 Outfall

Treated and disinfected effluent from the RWRF is discharged to the Rogue River at river mile 130.5 via a 54-inch-diameter high-density polyethylene submerged outfall. The outfall terminates in a three-port diffuser beginning approximately 20 feet offshore of the river bank and at a depth of approximately 10 feet during low river flow. Diffuser ports consist of 36-inch-diameter riser pipes and elastomeric check valves at 6-foot intervals on center (total diffuser length is 12 feet). The diffuser ports are fanned at varying angles with respect to the downstream river flow. Appendix C includes a drawing of the outfall and diffuser profile, cross section, and details.

2.2 Mixing Zone

Schedule A, Section 1.e of the NPDES permit establishes the Regulatory Mixing Zone (RMZ), for the City's effluent discharge as that portion of the Rogue River contained within a band up to 100 feet from the south bank of the river, extending from a point 10 feet upstream of the outfall to a point 300 feet downstream of the outfall. The zone of initial dilution (ZID) is defined as the portion of the RMZ that is within 2 feet upstream and 30 feet downstream of the outfall.

Figure 2-1 presents a plan view of the outfall and the RMZ and ZID boundaries overlaid on an aerial photo of the vicinity.

2.3 Environmental Mapping

This section provides results of environmental mapping activities. For a Level 2 study, DEQ requires mapping of the following 0.5 mile upstream and downstream of the outfall:

- Commercial or recreational shellfish areas
- Fish spawning/rearing habitat
- Cold water refugia for fish
- Areas identified as having species (fish or non-fish) that may be sensitive to impacts of the outfall effluent
- Public access areas
- Drinking water intakes
- Other NPDES outfalls

2.3.1 Environmental Features

Results of environmental mapping activities are as shown in Figure 2-2. Identified environmental features are shown in relationship to biological/nutrient sampling and continuous monitoring probe locations during the field study. There are no known commercial or recreational shellfish areas, cold water refugia, drinking water intakes, or other NPDES outfalls within 0.5 mile upstream or downstream of the RWRF outfall. However, the City's municipal water intake is located approximately 3,600 feet upstream of the RWRF outfall. A public boat ramp and park (TouVelle State Park) are located approximately 2,500 feet upstream of the outfall.

Present within 0.5 mile downstream of the outfall are salmon spawning, rearing, and migration areas. There are several pieces of large woody debris--all at the edges of the channel--and one off-channel area that is likely used for rearing and as a refuge by salmonids and other fish. At the time of the field study, Chinook salmon were observed spawning in locations downstream of TouVelle State Park and within .5 mile downstream of the outfall. Numerous live and dead fish were observed, along with multiple redds.

2.3.2 Fish Habitat

When threatened or endangered species, or species that may be sensitive to impacts from the effluent are present, a Level 2 study requires a description of those species and the habitat within the RMZ. Streamnet (www.streamnet.org) lists the Rogue River at the outfall location as providing spawning, rearing, and migration habitat for spring Chinook, fall Chinook and winter steelhead; and rearing and migration habitat for Coho and summer steelhead. The species present belong to the following evolutionarily significant units (ESU) of salmon and distinct population segments (DPS) of steelhead.

- Klamath Mountains Province (KMP) steelhead DPS
- Southern Oregon/Northern California Coast (SONCC) Coho ESU
- SONCC Chinook ESU

All of these species, as well as cutthroat trout, and any other native species present, potentially could be sensitive to impacts from the effluent.

The SONCC Coho is listed as *threatened* under the Endangered Species Act. The Rogue River at the outfall location contains designated critical habitat for SONCC Coho. However, the Rogue River population is not considered to be at risk of extinction by the Oregon Department of Fish and Wildlife (ODFW) (ODFW, 2005). High water in 2012 prevented investigators from completing redd surveys. Therefore, the most recent information available is from 2011. In 2011, an estimated 5,073 adult Coho returned to the Rogue River. Between 1990 and 2011 the run size ranged from 572 in 2008 to 33,578 in 2004, with a mean of 10,691 (Lewis, et al., 2012).

Chinook in the Rogue River have both a fall and winter component to the run. The spring Chinook population in the Rogue Basin is considered by ODFW to be potentially at risk due to almost total reliance on hatchery release to mitigate for habitat loss due to the presence of Lost Creek Dam. Fall Chinook are considered by ODFW to be generally not at risk in the Rogue and Southern Oregon Coastal Watersheds (ODFW, 2005).

Both summer and winter steelhead are present in the Rogue Basin, while most other coastal basins support only winter steelhead. However, there is not much spawning of summer steelhead in the main stem Rogue River (ODFW timing tables). ODFW does not consider Rogue River steelhead to be at risk of extinction (ODFW, 2005). Precise numbers are not provided, but between 2003 and 2009 the run size ranged from approximately 1,100 in 2003 and 2008 to approximately 2,800 in 2009 (Brown et al., 2011).

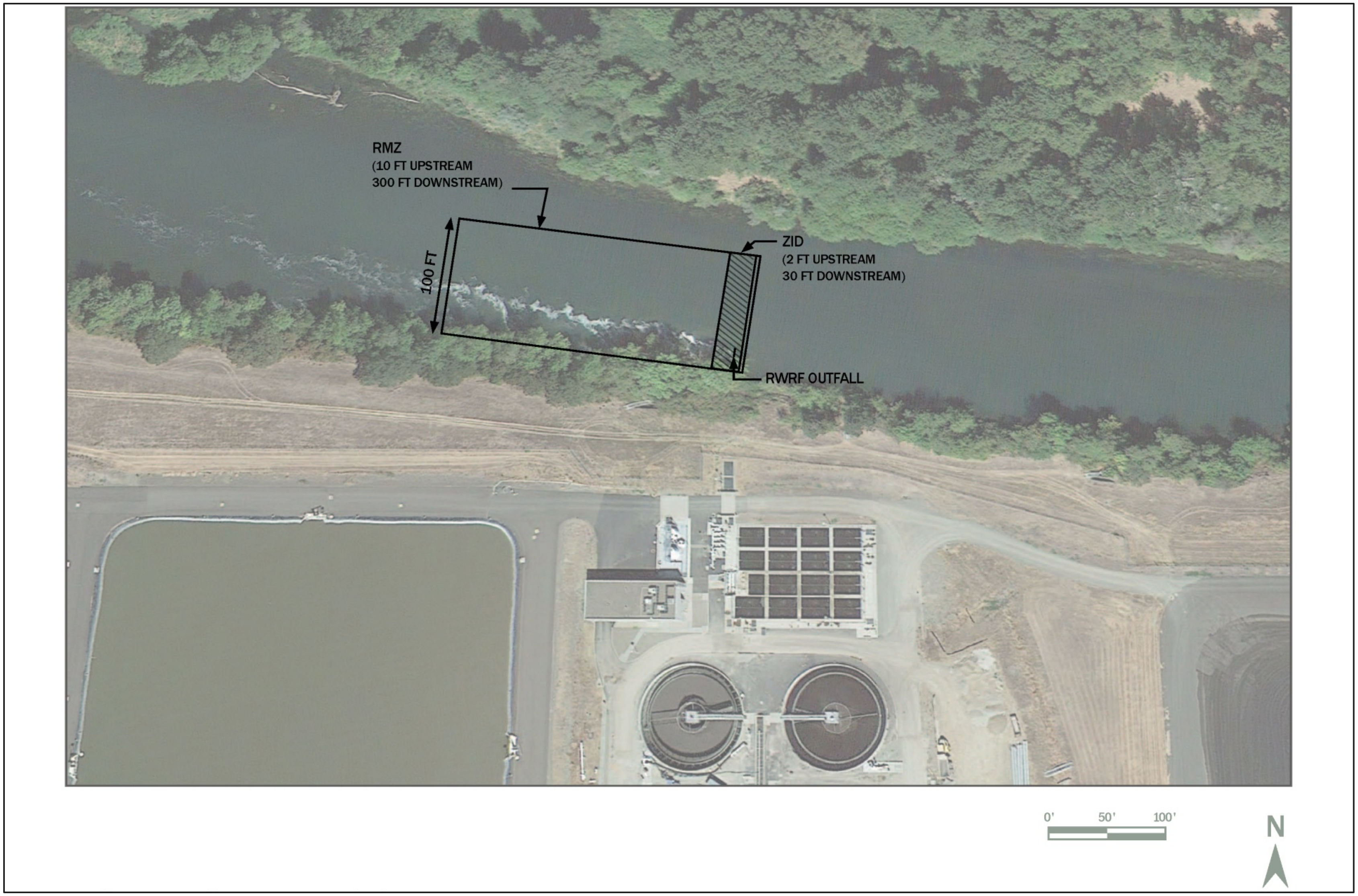

Figure 2-1. RWRF Outfall and vicinity map

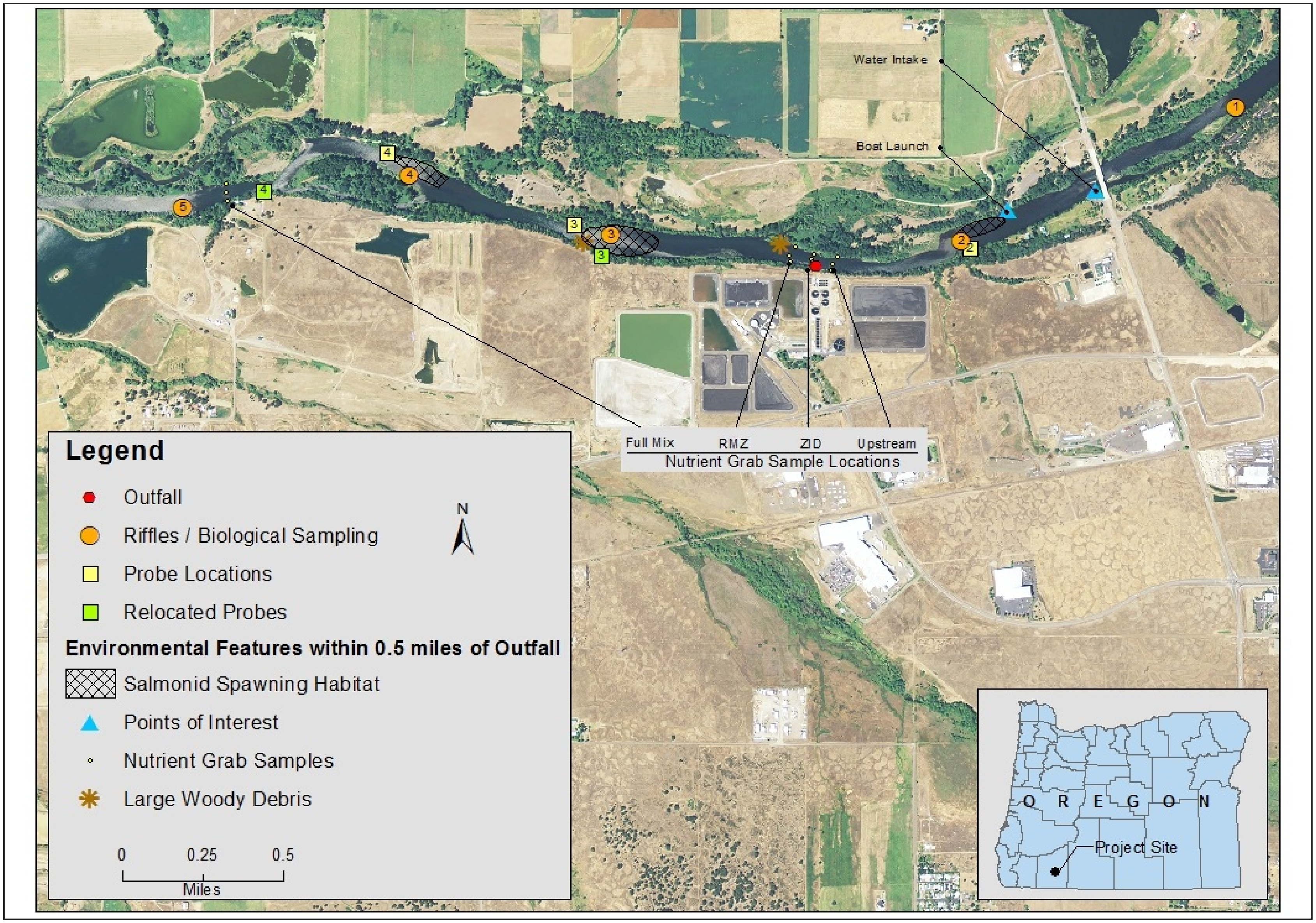

Figure 2-2. Environmental mapping and biological assessment study sampling locations

Because of variations in timing of use by various species and runs, the Rogue River at the outfall location would see use by anadromous salmonids every month of the year. Table 2-1 illustrates timing of the various species and runs in the main stem Rogue River between Marial and Lost Creek (ODFW timing tables).

Table 2-1. Approximate Timing of Anadromous Salmonid Presence at the Medford Outfall Location (Rogue River Main Stem from Marial to Lost Creek)

Species ESU/DPS	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
KPM Steelhead																								
Winter run																								
Adult migration	░	░	░	░	░	░	░	░	░								░	░	░	░	░	░	░	░
Adult holding	░	░	░														░	░	░	░	░	░	░	░
Spawning				░	░	░	░	░	░															
Egg incubation				░	░	░	░	░	░	░	░	░												
Juvenile rearing	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
Juvenile migration				▓	▓	▓	■	■	■	■	▓	▓												
Summer run																								
Adult migration							░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
Adult holding							░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░		
Juvenile rearing	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
Juvenile migration				▓	▓	▓	■	■	■	■	▓	▓												
Southern Oregon and Northern California Coastal Chinook Salmon																								
Spring run																								
Adult migration					░	░	░	░	░	░	░	░	░	░	░	░								
Adult holding					░	░	░	░	░	░	░	░	░	░	░	░								
Spawning																	░	░	░	░				
Egg incubation	░	░	░	░	░	░	░	░	░	░							░	░	░	░	░	░	░	░
Juvenile rearing						░	░	░	░	░	░	░	░	░	░	░	░	░						
Juvenile migration					▓	▓	▓	■	■	■	■	■	▓	▓	▓	▓	▓	▓	▓	▓				
Fall run																								
Adult migration															░	░	░	░						
Adult holding															░	░	░	░						
Spawning																			░	░	░	░		
Egg incubation	░	░	░	░	░	░	░	░	░	░									░	░	░	░	░	░
Juvenile rearing						░	░	░	░	░	░	░	░	░	░	░								
Juvenile migration					▓	▓	▓	■	■	■	■	■	▓	▓	▓	▓	▓	▓	▓	▓				
Southern Oregon/Northern California Coast Coho																								
Adult migration																			░	░	░			
Spawning	░	░																			░	░	░	░
Egg incubation	░	░	░	░	░	░	░	░	░	░											░	░	░	░
Juvenile rearing	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░
Juvenile migration				▓	▓	▓	■	■	■	▓	▓	▓	▓	▓										

■ *Represents peak level of use.*

▓ *Represents lesser level of use.*

░ *Represents known presence with uniform or unknown level of use.*

Source: ODFW timing tables (http://rainbow.dfw.state.or.us/nrimp/information/timing/index.htm) ESU/DPS.

Section 3

Critical Conditions

The Oregon DEQ specifies that mixing zone and water quality analyses must reference critical ambient and effluent conditions to ensure that impacts to receiving waters are assessed conservatively. For rivers, the critical condition occurs typically in late summer or early fall, when stream flows are low and temperatures are high. This section presents critical riverine and effluent flows and temperatures for the Medford RWRF effluent as defined by the Regulatory Mixing Zone Internal Management Directive.

For the analyses herein, the period between June and October was selected to represent the critical period based on the sampling schedule specified in the NPDES permit for ammonia. Figure 3-1 confirms that critical low river flows occur in October.

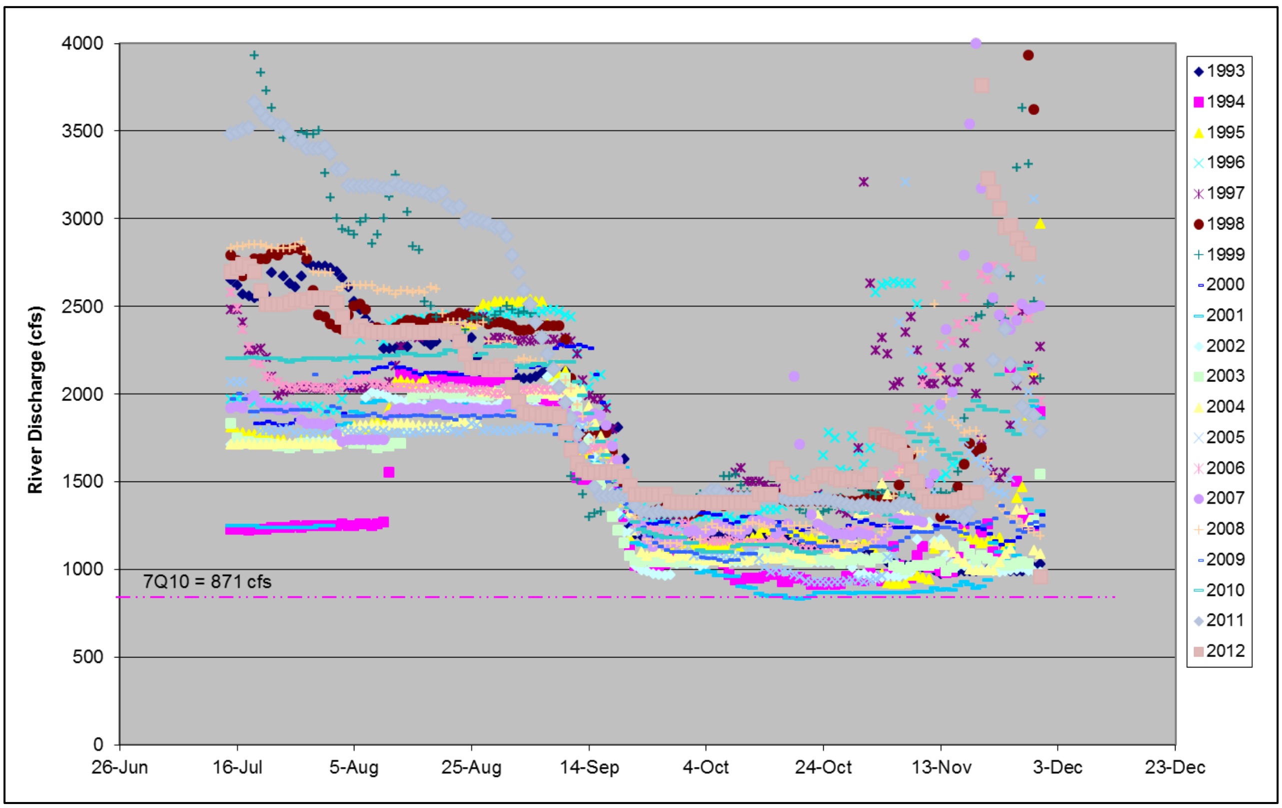

Figure 3-1. Medford Rogue River effluent

3.1 Critical River Flow and Temperature

Critical river flows were calculated using the USEPA DFLOW (v3.1) software program (USEPA, 2006). DFLOW uses average daily river flow records and calculates the specified hydrologically-based flow statistics. Daily Rogue River flow records were obtained from USGS Gauging Station No. 14339000 (at Dodge Bridge near Eagle Point, Oregon), approximately 8 miles upstream of the RWRF's outfall. Using daily data from 1970 to the present, DFLOW calculated the following specified critical river flow statistics:

- 1Q10 flow = 838 cubic feet per second (cfs)
- 7Q10 flow = 871 cfs
- 30Q5 flow = 981 cfs
- harmonic mean flow = 1,850 cfs

A minor tributary, Little Butte Creek, contributes flow to the Rogue River downstream of the reference USGS Gauging Station and upstream of the outfall. The NPDES permit fact sheet cites critical low flows for Little Butte Creek and considers river flows at the RWRF to be the sum of the reference Rogue River station and Little Butte Creek flows. Critical river flow statistics for Little Butte Creek are provided below. For this study, it is assumed the 1Q10 flow for Little Butte Creek (not cited in the NPDES permit fact sheet) is 10 cfs.

- 7Q10 = 11.1 cfs
- 30Q5 = 17.5 cfs
- harmonic mean flow = 48 cfs

Critical river flow at the RWRF outfall location is the sum of critical flows calculated for the Rogue River and Little Butte Creek. Combined Rogue River and Little Butte Creek flows (see Table 6-1) are used for all critical model runs discussed in Section 6.4. The combined critical low river flows are:

- 1Q10 flow = 848 cfs
- 7Q10 flow = 882 cfs
- 30Q5 flow = 998 cfs
- harmonic mean flow = 1898 cfs

DEQ does not specify criteria for critical ambient temperatures. For the analyses herein, the 90th percentile highest daily maximum ambient temperature (63.7 degrees Fahrenheit [F]) and average annual (using daily average data) temperature (48.4 degrees F) are used as the aquatic life and human health critical model run input values, respectively. Critical ambient river temperatures were calculated using daily river temperature data collected at USGS Gauging Station No. 14339000 from 1970 to present.

3.2 Critical Effluent Flow and Temperature

Critical effluent characteristics are based on data collected during the critical period over the most recent 3-year period (October 2010 through October 2013). Table 3-1 provides a summary of the critical effluent flow and temperature data for the RWRF effluent, including the water quality criteria for which they apply. Daily effluent flow and temperature data summary statistics for the RWRF are provided in Appendix D.

Table 3-1. Critical Effluent Flow and Temperature Statistics

Applicable water quality criteria categories	Critical effluent flow, million gallons per day		Critical effluent temperature, degrees F	
	Applicable flow statistic	RWRF data, 2010-2013	Applicable temperature statistic	RWRF data, 2010-2013
Aquatic life: acute	Max daily flow for critical period	26.0	90th percentile of daily max temp for critical period	74.4
Aquatic life: chronic	Max monthly flow for critical period	18.2	Average daily temp for critical period	70.9
Human health: non-carcinogen	Max monthly flow for critical period	18.2	Annual average temperature	65.6
Human health: carcinogen	Annual average flow	18.2	Annual average temperature	65.6

Section 4

Study Methodology

This section provides a summary of the field study sampling schedule and methods, but does not provide detailed information which is provided in the approved *Mixing Zone and Biological Assessment Study Plan* (*Study Plan*) (Brown and Caldwell, September 2013). Any deviations to the schedule or methodology proposed in the *Study Plan* are noted in this section.

4.1 Sampling Schedule

Study dates proposed in the *Study Plan* were delayed 2 weeks due to heavy rain in late September 2013 and identification of diffuser port obstructions during the preliminary outfall inspection (see Section 5.1). The Oregon DEQ was notified of the delay and new study dates were approved via e-mail.

Field study activities were performed between October 14 and October 17, 2013. Dye injection and related plume mapping/aerial photo activities occurred between approximately 10:00 and 13:00 on October 16. The schedule of field study activities is summarized as follows:

- Preliminary
  - equipment mobilization and calibration
  - initial outfall and diffuser dive inspection (September 13)
  - follow-up debris removal dive (September 24)
- Day 1 (October 14) site reconnaissance and continuous monitoring probe deployment
- Day 2 (October 15)
  - upstream data collection
  - velocity transect data collection
  - dye study preparation on site
- Day 3 (October 16)
  - dye injection and plume mapping
  - downstream data collection
  - aerial photos
- Day 4 (October 17)
  - continued downstream data collection
  - retrieval of continuous monitoring probes

4.2 Dye Injection

Rhodamine WT dye was injected into the plant's effluent at a fixed rate immediately upstream of the effluent Parshall flume (downstream of bisulfite addition). The target effluent dye concentration was selected so that the effluent plume fringes would be clearly visible at complete mix conditions with the Rogue River(to allow aerial and in-water mapping of the plume) in accordance with DEQ's May 2013 letter containing expectations for the City's mixing zone study (see Appendix A).

The target dye injection rate of 4 gallons per hour of Rhodamine WT stock 23 percent solution was achieved using a Watson-Marlow model 504U peristaltic pump. This actual dye injection rate was increased from the Study Plan's (BC, May 2013) targeted dye injection rate to account for lower effluent flow and higher river flows (above 7Q10 conditions) observed for the field study and to match the intended complete mix dye concentration target. The actual field study conditions complete mix dilution of effluent to river water was 51:1 calculated using the measured Rogue River flow of 1,380 cfs at the time of the field study and an effluent flow rate of 18 mgd (during dosing period).

The dye-tinted effluent plume was observed outside of the study area (beyond Riffle 5 shown in Figure 2-2) and continued to be visible downstream of Grants Pass, Oregon. The presence of a visible plume continuing downstream beyond the point of complete mix dilution was an expected result of the study methodology. However, the degree of visibility was unintended. The target dye concentration at the complete mix condition was established by empirically comparing what was believed would be a "clearly visible concentration in the river" at complete mix conditions to previously prepared calibrated dye standards of known concentrations placed in clear sample bottles. Two factors served to increase the degree of river tint to what in hindsight was greater than needed to meet study objectives:

1. Dye dosing was conservative to ensure that the plume fringes would be clearly visible for the aerial photography and in-water plume mapping. The consequence of underdosing would have been repeat work at significant cost to the City (i.e., loss of investment in the study mobilization, materials, aerial photography, and labor).
2. The dye standards belie the visibility of the dye plume in a much more expansive and deeper water body. Figure 4-1 compares the tint apparent in a bottled sample collected at Riffle 5 (at complete mix conditions) to distilled water and to a sample collected in the centerline of the plume at the RMZ. The visibility of the dye at complete mix conditions is slight and almost indistinguishable in this smaller sample than was perceived in the river.

The dye observed during the field study after complete mixing has been achieved is representative of the normal distribution of plant effluent throughout the river on a continuous basis. There are few significant flow contributions downstream of the City's facilities to further dilute the effluent. Just as was observed with the dye, plant effluent is continually present and disbursed throughout the stream once complete mixing is achieved.

Figure 4-1. Dye concentration comparison (left to right: distilled water, RMZ, and downstream of Riffle 5 at complete mix conditions)

4.3 Sampling Locations and Methodology

The field study consisted of three primary components, summarized as follows:

- Plume mapping and aerial photography. Mapping of the lateral spreading of the effluent plume and downstream plume travel was performed by recording the position of the plume boundary by visual observation and GPS equipment. GPS coordinates were used to develop a map of the effluent plume in plan view with respect to the river bank and other river features and sampling locations (see Section 5.3). GPS mapping was supported by aerial photos collected during the period of dye injection study (see Section 5.2).
- Measurement of river physical characteristics. River width, depth, and current speed data were collected by towing an Acoustic Doppler Current Profiler across the river along three separate transect locations (one upstream and two within the mixing zone).
- Collection of water quality data and benthic macroinvertebrate/algae samples. Water quality and biological data were collected to support an evaluation of effluent impacts on ambient aquatic life populations and understand better the concerns raised by the third-party study submitted to DEQ (Hafele, 2013).

No changes were made to the proposed sampling methods, locations, and equipment discussed in the approved *Study Plan*. Actual sample locations, results, and analysis are presented in Section 5.

Section 5

Field Study Results and Analysis

This section presents field study results and analysis of data collected during the field study. Additional analyses utilizing the collected data are presented in Sections 6 and 7.

5.1 Outfall Inspection

A dive inspection was performed prior to the field study to assess the condition of the outfall pipe and diffuser, and to confirm that the diffuser was performing as designed (i.e., no blockage and evenly distributed flow through all ports). An initial dive inspection performed on September 13, 2013, indicated that several boulders and a log located near the near-shore portion of the diffuser were positioned in such a way that they could be forcing open the elastomeric check valve on diffuser port 1 (nearest to shore); creating flow through port 1 greater than that of the other two ports. The boulders and log were removed during a subsequent dive (September 19, 2013). The resulting diffuser port flow appeared to be even across the diffuser following removal of the boulders. No other concerns related to flow distribution or structural integrity of the outfall were identified during the dive inspections. The dive inspection report is provided in Appendix E.

5.2 Aerial Photos

Aerial photos were taken by Pacific Aviation Northwest, Inc. during the period of dye injection. The photos show the extent of lateral plume spreading with downstream distance. The observed location where "complete mix" conditions occurred was approximately 2 miles downstream of the outfall, at a point just downstream of an unnamed island where the bifurcated Rogue River flow re-combines. Aerial photos confirmed ground observations of field staff mapping the plume via GPS coordinates. General observations related to lateral plume spreading and travel of the effluent plume downstream along with GPS mapping of the effluent plume are provided in Section 5.3.

Aerial photos including a key map indicating the approximate location of each picture are included in Appendix F.

5.3 Effluent Plume and Sample Collection Mapping

GPS data collected during the field study are summarized in two separate figures. Figure 2-2 shows the entire river reach sampled, including the locations of biological, continuous monitoring, and nutrient sampling, as well as the environmental mapping components. Sampling locations shown in Figure 2-2 are discussed further in Sections 5-7 through 5-9.

Figure 5-1 shows a larger scale view of the area up to approximately 1,500 feet downstream of the outfall. Included are the Acoustic Doppler Current Profile (ADCP) transect locations, mapped positions of the river bank and observed offshore plume edge and centerline. Observations related to plume mapping shown in Figure 5-1 include the following:

- The visual plume edge location shown in Figure 5-1 is consistent with the aerial photos provided in Appendix F.
- The effluent plume was in contact with the bank a very short distance downstream of the outfall, and continued as a bank-attached plume downstream.

- Visual plume width at the RMZ boundary was approximately 100 feet, coinciding with the RMZ boundary (see Figure 5-1).

Lateral plume spreading across approximately 75 percent of the river width occurred relatively quickly (at a location approximately 1,000 feet downstream). However, plume spreading beyond this point was slow, with additional spreading occurring only after the plume had traveled over downstream riffles.

Complete mixing, or no visually detected change of plume concentration across the entire river cross-section, occurred approximately 2 miles downstream. This location is following three sets of downstream riffles (see Figure 2-2).

5.4 River Flow

Rogue River flow measured at USGS Gauging Station No. 14339000 was a constant 1,380 cfs for the approximate 48-hour period surrounding the dye injection period (1 day before and after). Actual river flow was greater than the anticipated conditions for the field study period. Average flow for mid-October over the period of record for USGS Gauging Station No. 14339000 is approximately 1,200 cfs (see Figure 3-1).

Little Butte Creek flow, as measured at the U.S. Bureau of Reclamation (USBOR) stream gauge LBEO (located downstream of Eagle Point, Oregon), was approximately 57 cfs during the field study period.

5.5 ADCP Transects

River width, depth, and current speed data were collected by towing an ADCP across the river at three separate transect locations (one upstream and two within the mixing zone). Transect locations were selected to represent ambient conditions immediately upstream of the outfall as well as river conditions at the ZID and RMZ boundaries. Due to challenges maintaining position with respect to strong river currents, actual transect locations were 36 feet upstream, 36 feet downstream, and 411 feet downstream. Data collection at the ZID is not complete because dissolved gas entrained in the effluent and released through turbulence in the outfall prior to the diffuser discharge ports impacted the ADCP sensors. Manual depth measurements within the plume at this location determined river depth to be approximately 8 feet.

Cross-section data collected by the ADCP are shown graphically in Figure 5-2.

Data for the top and bottom portions of the water column cannot be quantified reliably and are omitted because of the reflection of sound waves (used to measure current speed). ADCP transects immediately upstream and downstream of the outfall show greater river depths and current speeds near the left bank of the river at the approximate outfall offshore distance. Between 30 and 400 feet downstream of the outfall, the river thalweg transitions to a point closer to the right bank. The ADCP measurements confirm plume behavior observed in the first 15 minutes following dye injection (see Figure 5-3). The effluent plume was observed to travel down the river in a relatively narrow band at a greater speed before becoming fully established over the entire velocity field at steady state conditions dye plume development (as seen in photos in Appendix F). The narrow band depicts the highest cross-sectional current speed with downstream travel. Note that surface bubbles/foam also follow this band.

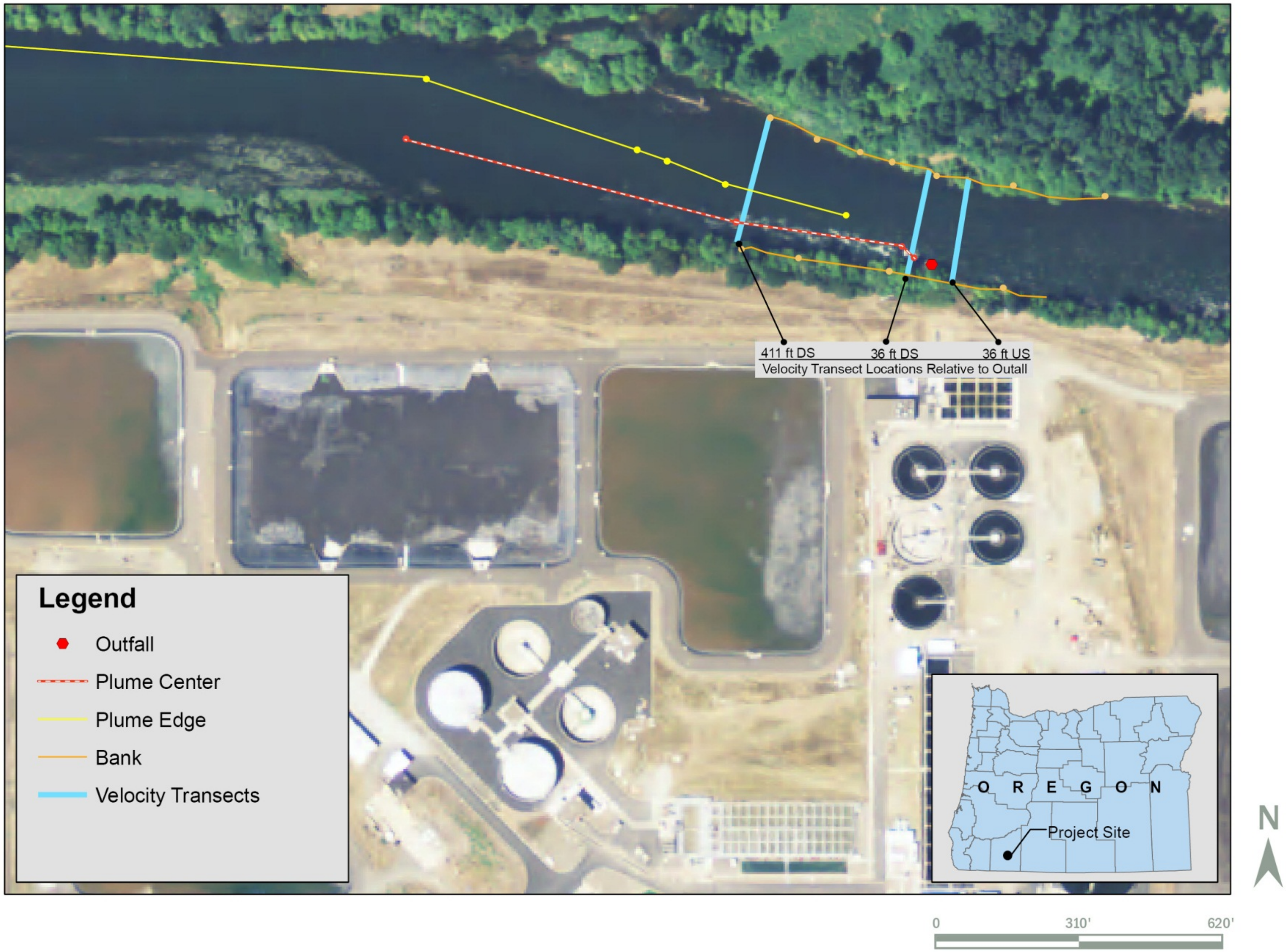

Figure 5-1. Effluent plume mapping

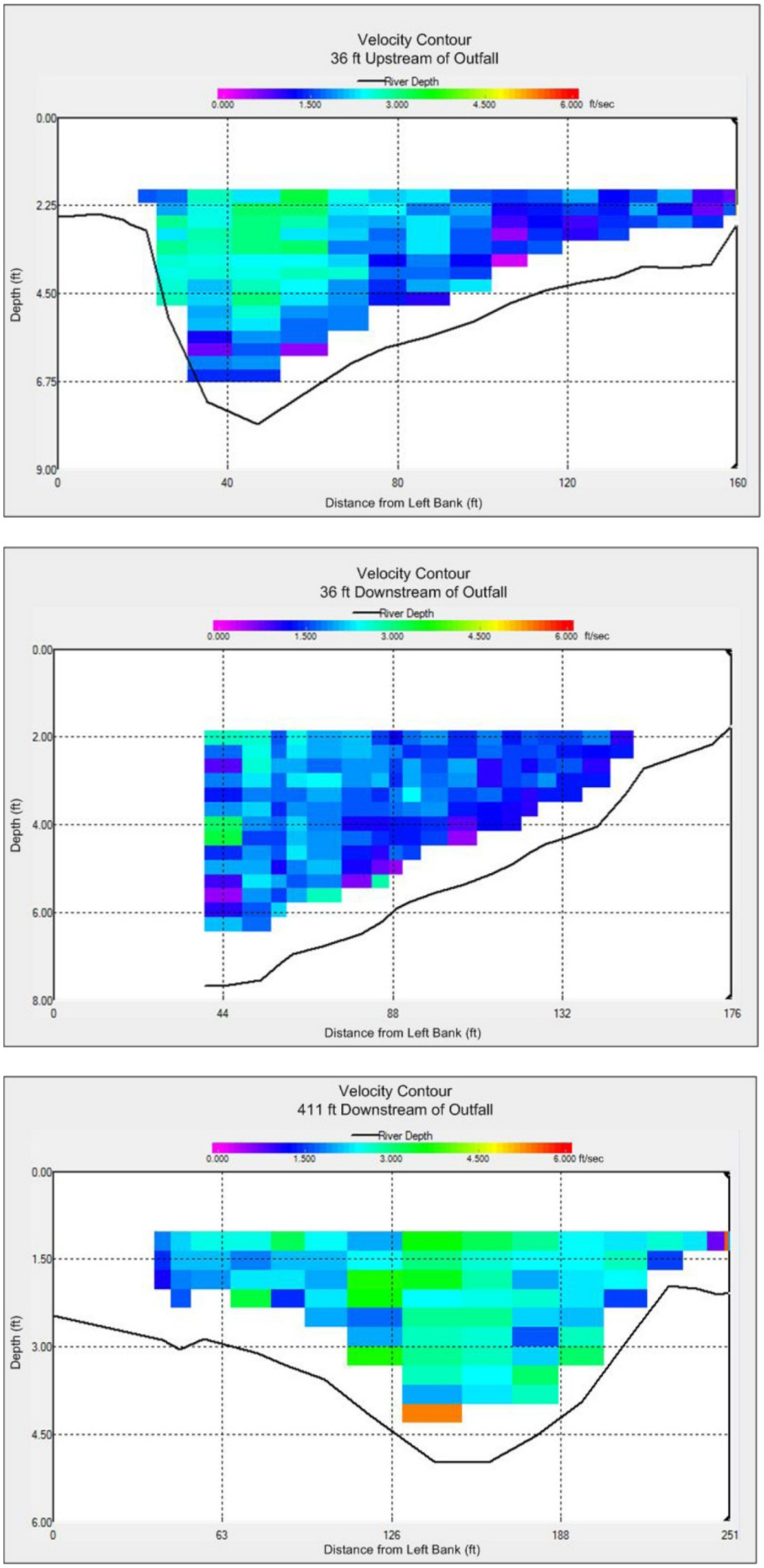

Figure 5-2. ADCP cross-section data

Figure 5-3. Photo of early plume development

Table 5-1 summarizes the river physical characteristics, including calculated river flow, river width, average depth, and average current speed, measured at the 36-foot upstream and 411-foot downstream transects. Calculated river flow from ADCP data were consistent between transects, but approximately 10 percent higher than total river flow measured by the reference USGS and USBOR gauging stations (see Section 5.4). Because data collected using the ADCP equipment are specific to the site and downstream of the reference gauges, model analysis performed for field study conditions will use the ADCP calculated river flow. Critical condition model runs will use critical ambient condition statistics from USGS and USBOR gauges (see Section 3.1.1).

Table 5-1. Rogue River Physical Characteristics Summary

	36-foot upstream transect	411-foot downstream transect
Calculated river flow, cfs	1,583	1,612
River width, feet	168	229
Average river depth, feet	4.85	3.45
Average current speed, feet per second	1.96	2.35

5.6 Effluent Flow Rate and Temperature

Effluent flow rate and temperature data were collected at 15-minute intervals during the dye injection period by existing Medford RWRF monitoring equipment. For the entire period of dye injection, the average effluent flow was 18.7 mgd, with minimum and maximum values of 15.8 mgd and 22.3 mgd, respectively[2]. However, in-river plume mapping did not begin until approximately 11:00 to allow for the dye spread to establish steady-state conditions within the mixing zone. The average effluent flow rate between 11:00 and 13:00 was 18.2 mgd. Average effluent temperature between 11:00 and 13:00 was 68.3 degrees F, with minimum and maximum values of 68.2 and 68.6 degrees F, respectively. Effluent flow and temperature data collected during the dye injection period are provided in Appendix G.

Based on an effluent flow rate of 18.2 mgd and the ADCP-calculated river flow of 1,600 cfs (transect average – see Table 5-1), the calculated complete mix dilution factor at field study conditions is 57.

5.7 Continuous Monitoring Probes

Continuous monitoring probes were installed upstream of Riffle 2 (upstream of the outfall), and just downstream of Riffles 3 and 4 (downstream of the outfall), which correspond to the upstream and two downstream riffles sampled by Hafele (2013) (see Figure 2-2).

The probes used and their deployment methods are detailed in the *Mixing Zone and Biological Assessment Study Plan* (Study Plan). The probes measured temperature, dissolved oxygen (DO), turbidity, conductivity (which was not required by the Study Plan) and pH. The Study Plan called for the downstream probes to be deployed within the effluent plume. Deployment was conducted prior to the dye study, at which time—based on bubbles and surface disturbance from the outfall--it appeared that the effluent plume extended all the way across to the north side of the river by the time it reached the first downstream riffle (Riffle 3). Therefore, the probes downstream of Riffles 3 and 4 were deployed on the north bank, which offered good anchoring sites where they could be concealed in relatively fast-moving, well-mixed water. Conditions for deployment on the south bank near these two riffles were less desirable both with regard to concealment and the availability of fast-moving water.

During the dye study, it became apparent that, while the effluent did extend all the way across the first downstream riffle (Riffle 3), the deeper run habitat next to the north bank adjacent to Riffle 3 remained clear and the dye plume appeared to move back somewhat toward the south bank as it passed Riffle 3. Thus, immediately after the dye study, the two downstream probes were moved to the south bank to ensure that they were both within the relatively concentrated portion of the effluent plume. The probe near Riffle 3 was moved across and slightly upstream from its initial location. The probe at Riffle 4 was moved across and downstream due to a lack of suitable deployment conditions directly across from the initial location. The new locations on the south bank are shown in Figure 2-2.

This relocation proved beneficial in that it helped to demonstrate the across-channel effects of downstream mixing on the various water quality parameters measured by the probes. All data collected are included in Appendix H.

5.7.1 Temperature Data

Water temperatures were very similar at all probes during the period when the probes below the outfall were deployed on the north bank (see Figure 5-4). However, when the probes at Riffles 3 and 4 were moved to new locations on the south bank (at 14:16 and 14:45 on October 16 for the probes at Riffle 3 and Riffle 4, respectively), water temperature immediately increased by 0.91 degrees Celsius at Riffle 3 and remained elevated throughout the remainder of the deployment. The increase was not immediately noticeable at the probe relocated from Riffle 4, but it did exhibit temperatures slightly elevated over background (Riffle 2) for most of the rest of the deployment.

[2] The observed high flow that occurred at approximately 10:00. on October 16, 2013, was due in part to trickling filter maintenance activities as well as normal diurnal flow variations.

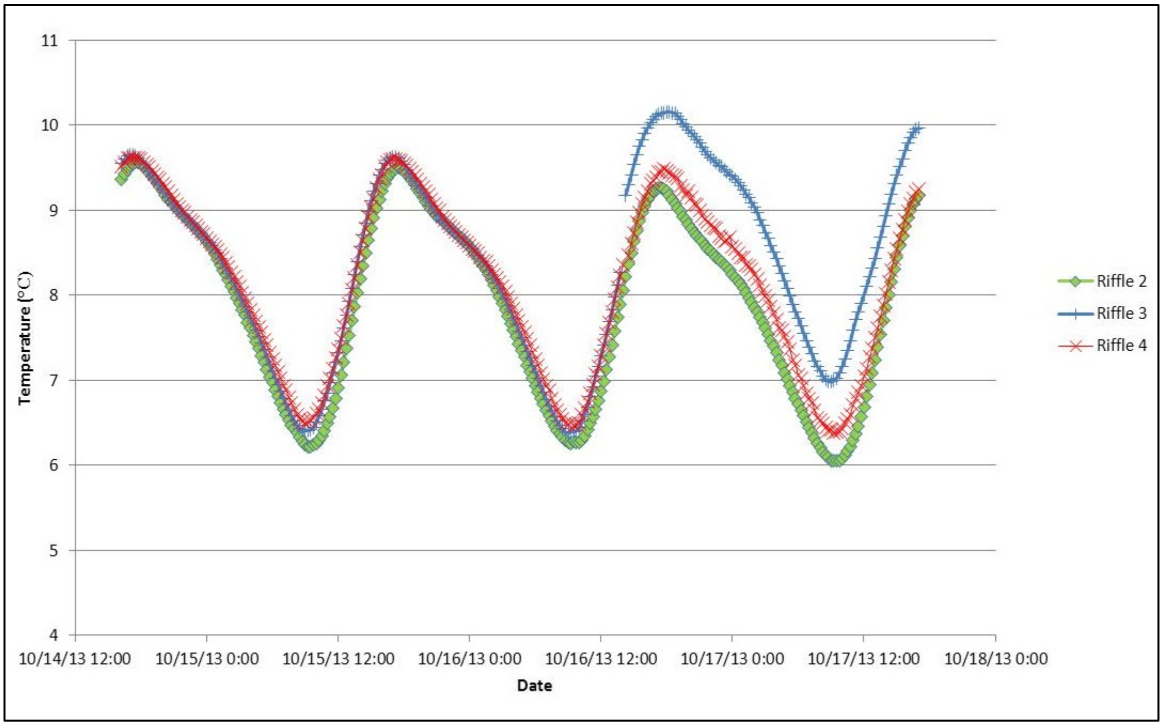

Figure 5-4. Temperature results from the three continuous monitoring probes

5.7.2 DO Data

DO showed diurnal fluctuations both upstream and downstream of the outfall (Figures 5 5 and 5-6), with high levels of concentration/saturation during the afternoon and lower levels at night until dawn. Levels of DO were consistently higher upstream of the outfall, lowest near Riffle 3, and intermediate below Riffle 4. Percent saturation was either above or very close to 100 percent upstream of the outfall and at the probe farthest downstream from the outfall. DO did not show a dramatic difference from one side of the river to the other, except that DO values declined during the third night of deployment at Riffle 3, the only night that the probe was on the south shore within the relatively concentrated portion of the plume.

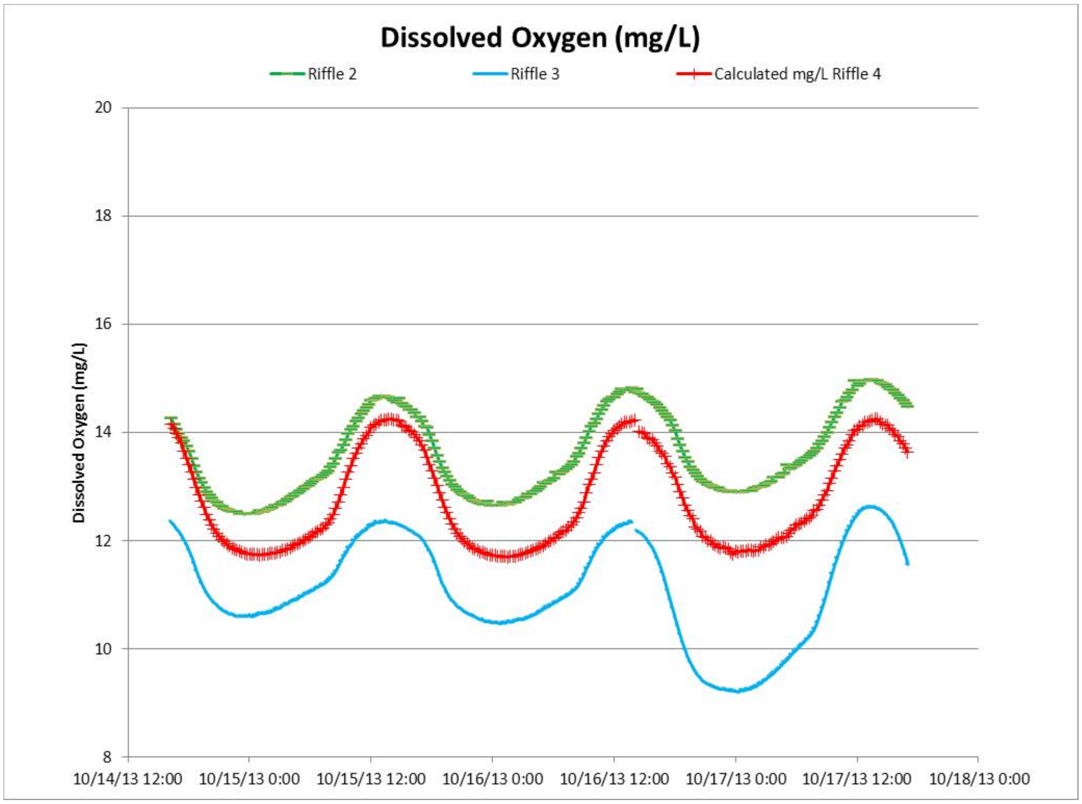

Figure 5-5. DO results from the three continuous monitoring probes

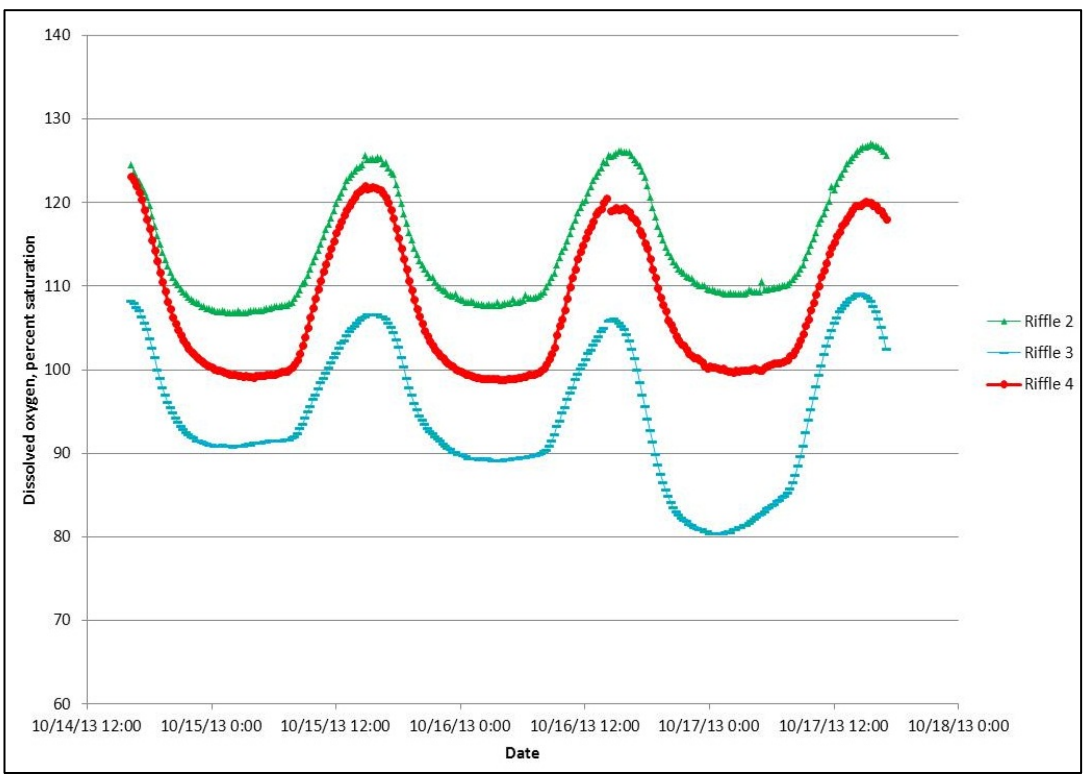

Figure 5-6. DO results (percent saturation) from the three continuous monitoring probes

5.7.3 pH Data

During photosynthesis, phytoplankton remove carbon dioxide from water, which causes a rise in pH. During decomposition of organic matter, carbon dioxide is released as an end product, decreasing pH. Furthermore, when plants respire at night, they release carbon dioxide to the water, resulting in a decrease in pH. These competing processes result in diurnal swings in observed pH. Greater amounts of phytoplankton photosynthesizing, respiring, and decaying leads to wider swings in pH.

All three of the probes showed substantial diurnal fluctuations in pH (Figure 5-7), with daily highs in the 8.4 to 8.6 range and night-time lows near 7.5 (except for the Riffle 3 probe after relocation). The maximum ranges in pH observed at each probe during the study period were as follows:

- Riffle 2 - 7.48 to 8.52
- Riffle 3 - 7.23 to 8.59
- Riffle 4 - 7.51 to 8.66

Interestingly, pH showed opposite trends on opposite sides of the river. When the probes were deployed on the north shore, the pH was slightly elevated, at least during the day, downstream of the outfall. However, when the probe at Riffle 3 was moved to the south shore in the relatively more concentrated portion of the plume, pH dropped sharply, indicating that the effluent was reducing pH, as indicated by the obvious break at 14:16 on October 16. At the probe farthest downstream, pH declined somewhat after relocation to the south bank but the depression was significantly less than at the Riffle 3 probe.

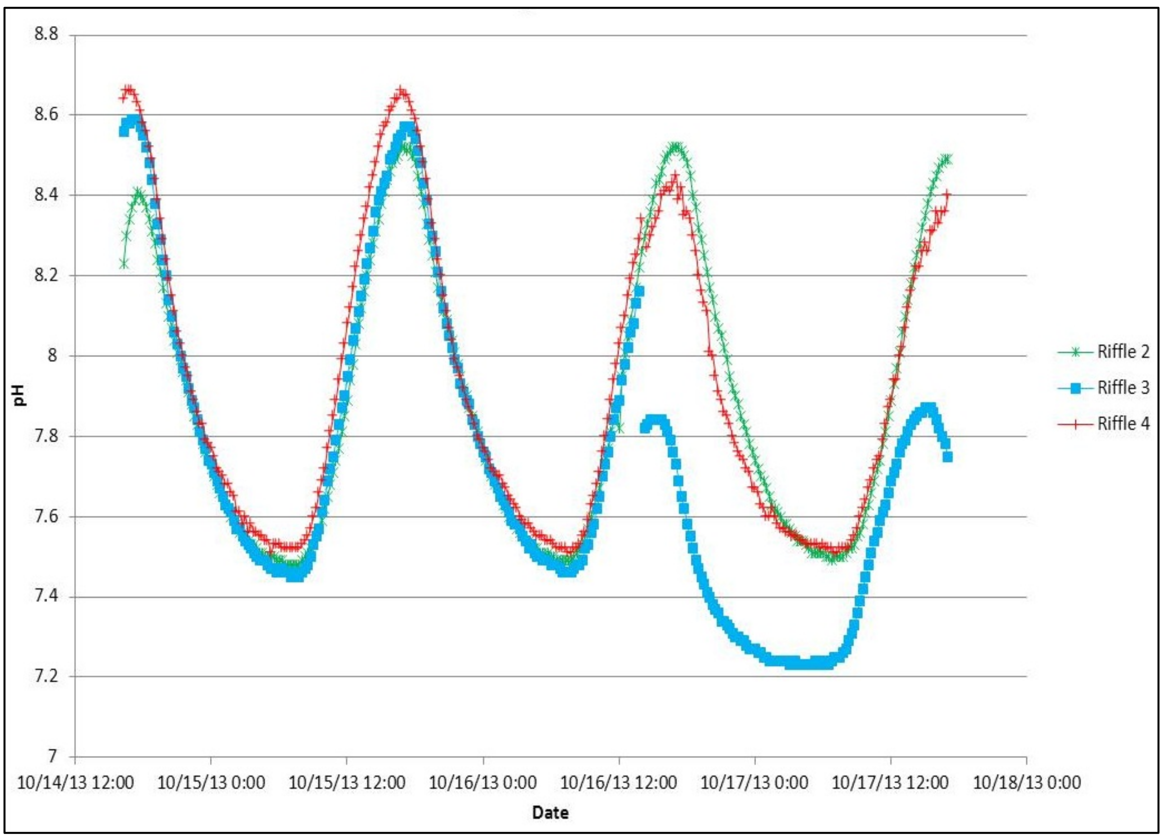

Figure 5-7. pH results from the three continuous monitoring probes

5.7.4 Turbidity Data

In contrast to the results on the other recorded parameters, the effluent plume appears to have little effect on turbidity (Figure 5-8). The spikes at the downstream probes on October 16, 2013 are due to the presence of Rhodamine dye. Spikes (both upstream and downstream) that occur outside of the dye injection period are most likely due to floating debris (i.e., a leaf) passing in front of the sensor probe. The first probe downstream of the outfall generally showed slightly lower turbidity levels than the up-stream probe but the differences were very small, likely due to small differences in probe calibrations.

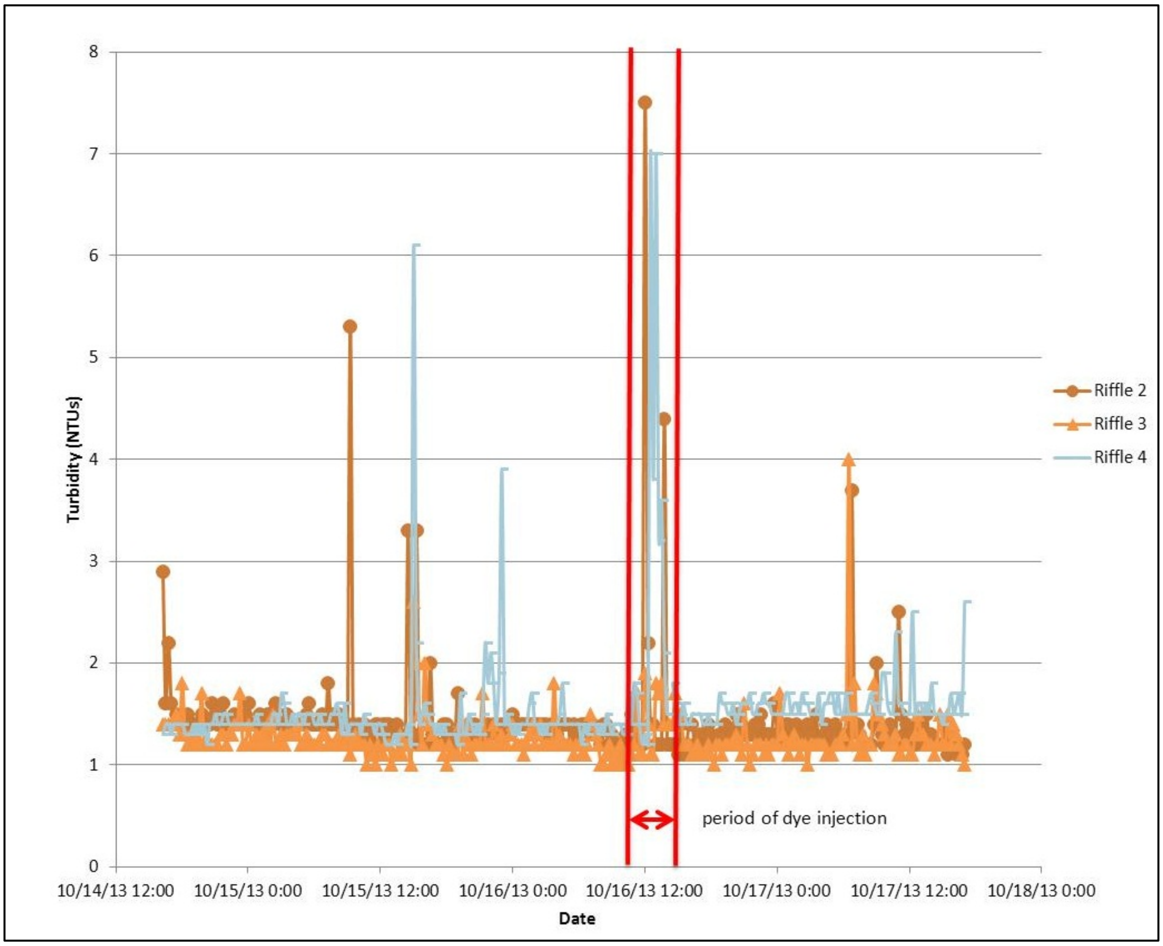

Figure 5-8. Turbidity results from the three continuous monitoring probes

5.7.5 Conductivity Data

During the period in which the probes downstream from the outfall were deployed on the north shore, conductivity was elevated by about 8 microsiemens per centimeter at the Riffle 3 probe relative to the upstream probe but the Riffle 4 probe recorded slightly lower values than the probe upstream of the outfall (Figure 5-8). The elevation in conductivity on the north shore at Riffle 3 indicates that although the dye plume was not visible to the naked eye at this location, there was likely an amount of effluent-bearing water reaching the north side of the channel. After the two probes below the outfall were relo-cated to the south side of the channel, there was a large increase in conductivity at the probe below Riffle 3 and a much smaller but detectible increase at the probe below Riffle 4. These results provide evidence that the plume was more concentrated along the south shore as far as downstream of Riffle 4, a distance of approximately 2.0 miles, but that mixing was nearly complete by this location.

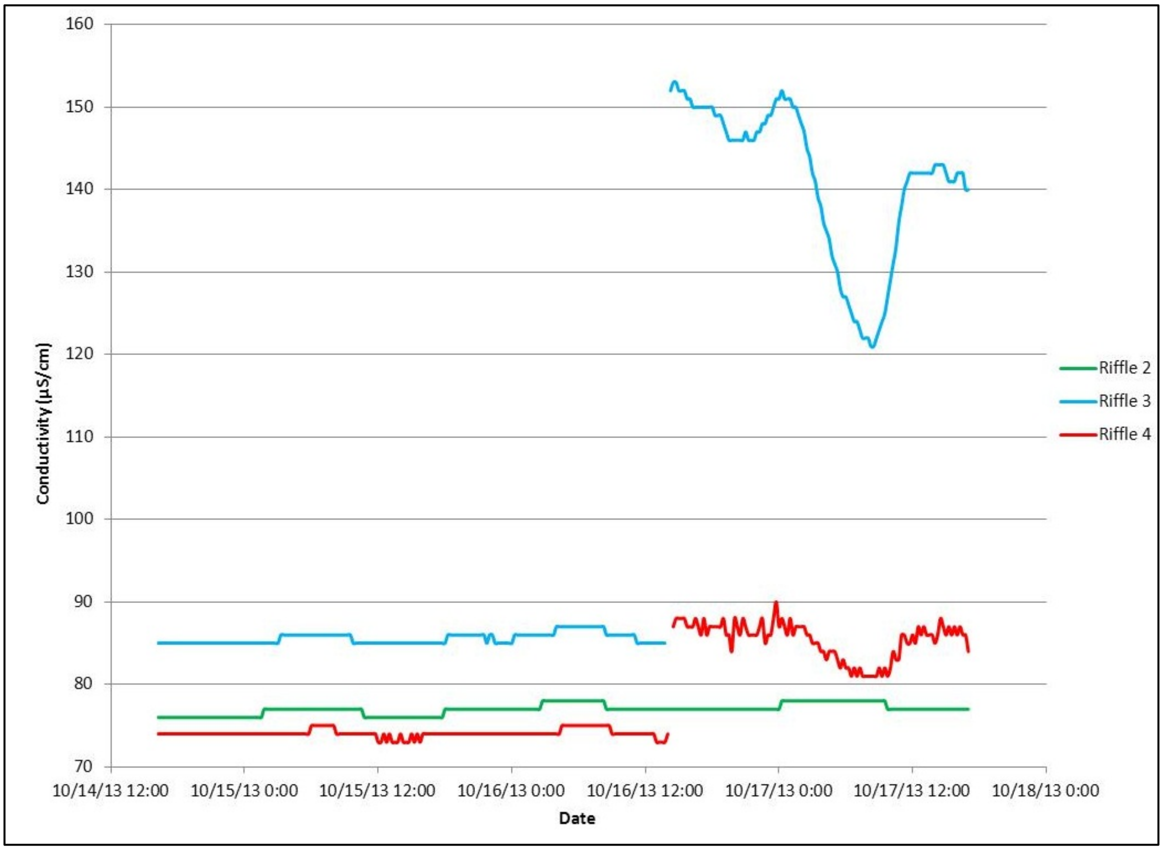

Figure 5-9. Conductivity results from the three continuous monitoring probes

5.7.6 Continuous Monitoring Probe Data Discussion

The data collected by the continuous monitoring probes demonstrated that the RWRF effluent is causing measurable changes to water temperature, DO, pH, and conductivity downstream of the RMZ. These changes were most apparent along the south shore at Riffle 3 where the dye study indicated that the effluent plume was most concentrated. Relatively smaller changes in these water quality parameters were observed at the probe downstream of Riffle 4 (approximately 2 miles downstream of the outfall) where nearly complete mixing of the effluent plume had occurred.

DO and pH showed diurnal fluctuations both upstream and downstream of the RWRF outfall. These fluctuations were largely the result of metabolic processes (photosynthesis and respiration) of aquatic plants. At the upstream probe (Riffle 2), attached benthic algae were the predominant plant growth contributing to the diurnal fluctuations. Downstream of the outfall, extensive beds of rooted aquatic plants (primarily in shallow glide and run habitat) and attached algae likely were both contributing to the diurnal fluctuations.

5.8 Nutrient Grab Samples

Results and discussion of collected data for the nutrient grab samples are presented in the following sub-sections.

5.8.1 Nutrient Data

Nutrients (phosphorus [P] and nitrogen [N] in various chemical forms) were analyzed in water samples taken at four transects (three samples per transect) upstream of the outfall; at or near the ZID boundary, approximately 100 feet downstream of the RMZ boundary (labeled and hereafter referred to as the RMZ samples); and downstream where the effluent is near fully mixed with the river. Samples were taken during dye injection to determine sample location within/outside of the most concentrated portions of the effluent plume. The dye does not contain N or P that would skew the results. The upstream samples and most downstream samples were collected at each bank and midstream. The samples in the ZID and RMZ were collected in the apparent lateral center of the effluent plume, at the margin of the plume and at the far bank (Figure 2-2). Results of the nutrient grab samples are included in Table 5-2. Also included are 2013 results for samples taken in the Rogue River at Dodge Park (approximately 7.9 river miles upstream of the outfall) and north of Gold Hill, (approximately 9.75 river miles (RM) downstream of the outfall) (data were obtained from the Oregon Department of Environmental Quality [DEQ]), and Bear Creek, whose confluence with the Rogue River is approximately 3.6 RM downstream of the outfall.

Table 5-2. Nutrient Sampling Results, Milligrams per Liter (mg/L)

Site	Sample	Total P	Orthophosphate	Total Kjeldahl N	Ammonia-N	Nitrate	Nitrite	Total N
Upstream	Left bank	< 0.07	<0.07	<0.30	<0.07	0.12	<0.05	0.12
	Center	< 0.07	<0.07	0.3	<0.07	0.1	<0.05	0.4
	Right bank	< 0.07	<0.08	<0.30	<0.07	0.18	<0.05	0.18
ZID	Center plume	0.31	0.32	1	0.52	1.12	0.1	2.22
	Fringe	<0.07	< 0.07	<0.03	< 0.07	0.1	<0.05	0.1
	Out of plume	<0.07	<0.07	0.3	<0.07	0.14	<0.05	0.44
RMZ	Center plume	0.22	0.18	0.7	0.18	0.65	0.06	1.41
	Fringe	<0.07	<0.07	<0.30	<0.07	0.14	<0.05	0.14
	Out of plume	<0.07	<0.07	0.3	<0.07	0.09	<0.05	0.39
Full mix	Left bank	<0.07	<0.07	<0.30	<0.07	0.41	<0.05	0.41
	Center	<0.07	< 0.07	0.3	<0.07	0.29	<0.05	0.59
	Right bank	0.08	< 0.07	<0.3	<0.07	0.45	<0.05	0.45
Rogue River at Dodge Park	January	0.04	0.036	Not analyzed	<0.01	0.0207[a]		Not analyzed
	March	0.04	0.0255		0.012	0.0059[a]		
	May	0.03	0.0255		0.01	<0.0005[a]		
	July	0.04	0.0265		<0.01	0.0074[a]		
Rogue River north of Gold Hill	January	0.07	0.051	Not analyzed	0.122	0.249[a]		Not analyzed
	March	0.07	0.042		0.077	0.130[a]		
	May	0.08	0.057		0.136	0.108[a]		
	July	0.09	0.064		0.098	0.196[a]		
Bear Creek at Central Point	January	0.07	0.045	Not analyzed	0.12	1.71[a]		Not analyzed
	March	0.06	0.029		0.12	0.656[a]		
	May	0.13	0.06		0.19	0.738[a]		
	July	0.11	0.063		0.035	0.736[a]		

[a]All DEQ N data reported as combined nitrate + nitrite.

DEQ water quality index criteria for *poor* water quality are > 0.08 mg/L total P and > 0.49 mg/L nitrate + nitrite (Hicks, 2005). All nutrients appear to be elevated within the plume at the ZID and slightly elevated just downstream of the RMZ. However, these effects do not extend across the channel, but are observed only in the samples taken in the center of the effluent plume.

There are detectable increases in nutrients where the effluent is near fully mixed with the river flow for nitrate and to a lesser extent, total N. The three nitrate + nitrite results at the near complete mix conditions are below the DEQ cutoff for poor water quality. All values of nitrate at the near fully mixed sampling transect are higher than at the upstream site. At the near fully mixed location, orthophosphate is below detectable limits, one indication that P is likely limiting to plant growth as opposed to N. The following section is a discussion of nutrient limitations.

5.8.2 Nutrient Discussion

Excess bioavailable P in freshwater systems can result in accelerated plant growth, and a lack of P often limits plant growth. P exists in water in either a dissolved phase or a particulate phase. Dissolved P in natural waters is usually found in one of three forms: inorganic (commonly referred to as orthophosphate), inorganic polyphosphate, and organically-bound phosphate. Particulate P contains P sorbed to inorganic (mineral) and organic particles, including P contained within algae. Dissolved inorganic phosphate (orthophosphate) is the form required by most algae for growth. Thus orthophosphate is immediately available to plants (including algae), while other forms of phosphate contained in the total phosphate analysis are less bioavailable.

N may also be limiting to plant growth in Oregon streams. Like total P, the measurement of total N in a water sample is less indicative of compromised water quality as is the amount of more bioavailable or toxic forms of N. N occurs in natural waters in various forms, including nitrate, nitrite, and ammonia. Ammonia, above certain concentrations, can be toxic to aquatic organisms. Nitrate is relatively non-toxic, but is often the growth limiting nutrient form of N in aquatic systems. Nitrite is extremely toxic to aquatic life but is rapidly oxidized to nitrate.

Dissolved Inorganic N (DIN) includes nitrate, nitrite and ammonia. Soluble reactive P (SRP), is largely analogous to orthophosphate, although it may also contain some polyphosphates. The DIN:SRP ratio (the relative availability of dissolved inorganic forms of N and P) is often used to indicate which nutrient might be regulating algal growth (Carpenter, 2003). A ratio of roughly 7 indicates balanced nutrient availability, whereas higher ratios may indicate P limitation, and lower ratios may indicate N limitation. In the samples collected for this study, the highest concentration of orthophosphate (0.32 mg/L) was in the same sample as the highest DIN concentration (1.74 mg/L). This results in a DIN:SRP ratio of 5.4, indicating that N would be limiting within in the ZID. Likewise, at the RMZ the DIN:SRP ratio is 4.9. Note that detectable concentrations of orthophosphate above the method detection limit for this study are restricted to the effluent plume.

The DEQ data for the Rogue River provide context for the reported results. Samples from the Rogue River at Dodge Park exhibit concentrations of N as nitrate/nitrite less than even the upstream samples collected for this study. However, the downstream (Gold Hill) samples all contain higher concentrations of ammonia-N than at the fully mixed location, and approach the center of plume concentration just downstream of the RMZ (maximum of 0.136 versus 0.18 mg/L). This indicates that water quality just downstream of the RMZ is not more impaired than water quality in the Rogue River at Gold Hill. Three of the four seasonal samples collected at Gold Hill had DIN:SRP ratios of less than 5.0, with the ratio in January being 7.42. The data suggest that N is limiting, except in winter.

Bear Creek is discharging greater total P to the Rogue River than is present at the fully mixed effluent plume location in the Rogue River and greater N as nitrate/nitrite than is present just downstream of the RMZ. Bear Creek has been significantly water quality impaired historically, with TMDLs issued in 1992 for pH, DO, aquatic weeds and algae, temperature, sediment and fecal coliform. A water quality standard for total P in Bear Creek was set at 0.08 mg/L. At Bear Creek RM 10 in Medford, P levels declined from an average high of 0.33 mg/L in July/August 1996 to 1998 to an average low of 0.08 mg/L in September/October 2008 to 2009. All 2013 results were below the 0.08 mg/L target threshold.

Based solely on the grab water samples, it appears likely that the effluent plume is discharging nutrient levels that could stimulate aquatic growth some distance from the RMZ to the complete mix condition. This affect does not extend across the entire channel. A significant fertilizing effect does not appear to be present at the location where the effluent plume is fully mixed with the river. Although N concentrations are somewhat elevated at the complete mix condition, P concentrations may be more limiting to aquatic growth.

5.9 Benthic Macroinvertebrate and Algae Samples

Benthic macroinvertebrate and algae samples were collected at five riffles (see Figure 2-2) labeled 1 through 5 from upstream to downstream (with Riffle 3 being the first riffle downstream of the outfall). Riffle 2 corresponds to the Hafele's (2013) upstream (US) riffle. Riffles 3 and 4 correspond to Hafele's Lower Sites (LS) 1 and 2, respectively.

Different algae species have different preferences and tolerances for habitat variables such as temperature, pH, nutrients, etc. Even if a species is able to tolerate a change in the environment (for instance, an increase in available P), that species may be outcompeted by a different species under altered conditions (e.g., P or N enriched). Thus, changes to water quality and habitat can result in shifts in algal community composition and abundance. The habitat changes, coupled with the changes to the algal community can then result in shifts in the macroinvertebrate community's composition and abundance.

5.9.1 Algae Results

Five riffles were sampled using the methods employed by Hafele (2013) and outlined in the *Mixing Zone and Biological Assessment Study Plan* (*Study Plan*) (BC, 2013), with a duplicate sample collected at the first riffle downstream from the outfall (Riffle 3). Photos of the rocks sampled are included in Appendix I. The duplicate sample was analogous to the quality assurance sample collected by Hafele (2013). The *Study Plan* called for one sample at Riffle 3 to be collected inside the effluent plume and one sample to be collected outside the effluent plume. However, the dye study indicated that the effluent plume extended all the way across Riffle 3. Thus, the rocks for each of the samples were selected randomly from across the entire riffle. A total of 55 periphyton algae taxa were identified from the five riffles and one duplicate sample (Appendix J). Of these, 51 were diatom species, two were blue-green algae, and two were cryptophytes. The species diversity ranged from 21 to 29 taxa at a given riffle (Table 5-3).

Table 5-3. Summary of Periphyton Algae Conditions

Riffle	Total taxa	Dominant three taxa (by density not biovolume)	Total cell density, #cells/cm^{2}[a]	Total biovolume, $\mu m^3/cm^{2}$[b]
1	29	Nitzschia frustulum Calothrix sp. Nitzschia dissipata	446,400	575,288,800
2	26	Nitzschia frustulum Oscillatoria sp. Achnanthes minutissima	493,600	451,188,800
3	24	Nitzschia frustulum Oscillatoria sp. Achnanthes minutissima	1,269,800	360,708,000
3 (dup)	23	Oscillatoria sp. Nitzschia frustulum Nitzschia dissipata	965,000	456,594,100
4	21	Nitzschia frustulum Achnanthes minutissima Navicula cryptocephala veneta	1,008,100	204,341,900
5	24	Nitzschia frustulum Achnanthes minutissima Nitzschia dissipata	1,028,900	271,924,200

[a] *cm^2 = square centimeters*

[b] *$\mu m^3/cm^2$ = cubic microns per square centimeter*

Both the relative abundance of different species and the total abundance (overall amount) of algae can be used to illuminate environmental quality. Total abundance can be expressed as cell density (number of cells per cm^2 of sampled area--in this case 18 cm^2 on each of 15 rocks per sample), or the total biovolume (cubic microns of algae removed per cm^2 of sampled area). Of the two parameters, excess biovolume is the most problematic from an environmental perspective as nuisance growths of algae contribute excess amounts of organic carbon, which can clog interstitial gravel and decrease DO as it decays. However, this tends to be more problematic in lakes and reservoirs than in rivers (see additional discussion below).

The number of taxa (taxa richness) appears to be somewhat depressed downstream of the outfall (Table 5-3). However, the three most abundant taxa at each site are largely the same both upstream and downstream; with the exception being that the blue-green alga, Calothrix, was more prevalent at the most upstream site (Riffle 1).

When the data are graphed (Figure 5-10), it is apparent that while cell density does appear to be higher downstream of the outfall, biovolume is not. In fact, biovolume is highest at Riffle 1, the most upstream riffle.

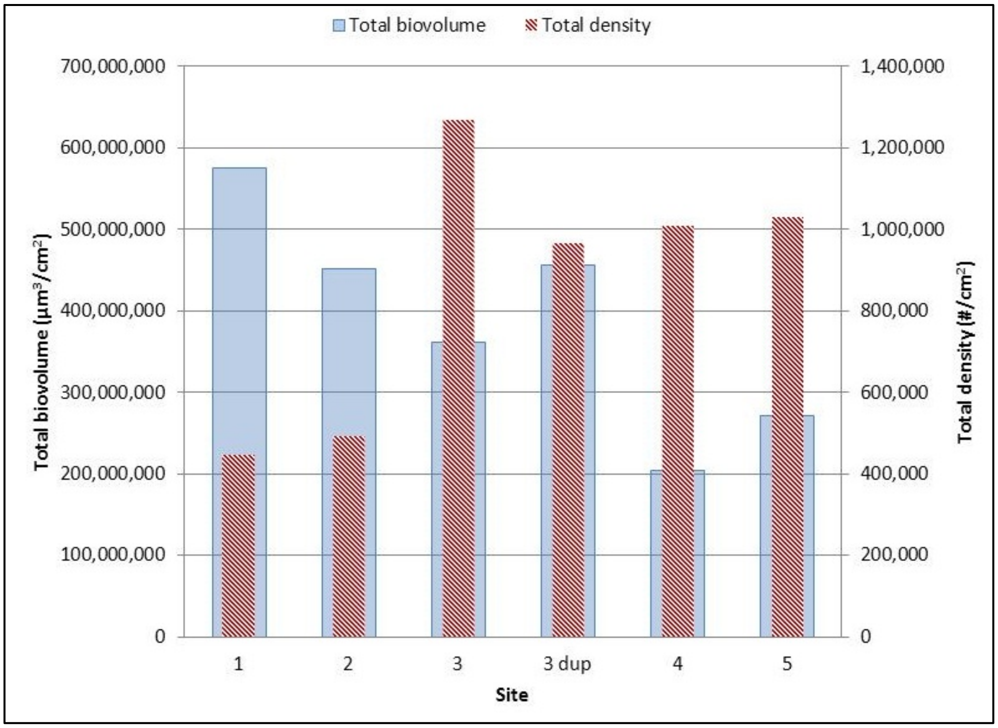

Figure 5-10. Algal biovolume and density 2013

5.9.2 Algae Discussion

Some differences were seen in species composition between Hafele's 2012 study and this study. Table 5-4 includes the results for 2012 and 2013 for each of the riffles that were sampled both years.

Table 5-4. Summary of Periphyton Algae Conditions

Riffle	Total taxa	Dominant three taxa (by density not biovolume)	Total cell density, #cells/cm²	Total biovolume µm³/cm²
2	26	Nitzschia frustulum Oscillatoria sp. Achnanthes minutissima	493,600	451,188,800
US	25	Oscillatoria limnetica Cymbella affinis Synedra ulna	517,677	208,446,248
3	24	Nitzschia frustulum Oscillatoria sp. Achnanthes minutissima	1,269,800	360,708,000
3 (dup)	23	*Oscillatoria sp.* *Nitzschia frustulum* *Nitzschia dissipata*	965,000	456,594,100
LS1	24	*Synedra ulna* *Diatoma vulgare* *Nitzschia frustulum*	6,529,509	2,873,469,430

Table 5-4. Summary of Periphyton Algae Conditions				
Riffle	Total taxa	Dominant three taxa (by density not biovolume)	Total cell density, #cells/cm²	Total biovolume µm³/cm²
LS1 QA	24	*Nitzschia frustulum*	7,477,968	2,448,594,004
		Synedra ulna		
		Nitzschia dissipata		
4	21	*Nitzschia frustulum*	1,008,100	204,341,900
		Achnanthes minutissima		
		Navicula cryptocephala veneta		
LS2	28	*Synedra ulna*	3,578,640	2,031,248,711
		Epithemia turgida		
		Oscillatoria limosa		

[a]*Results from Hafele (2013) are included as the shaded rows*

In 2013, *Nitzschia frustulum* was among the dominant taxa at all riffles, but was among the most dominant only at the first downstream riffle (LS1) in 2012. In contrast, *Synedra ulna* was among the most dominant taxa at all riffles in 2012, but was not in the top three most abundant at any of the riffles in 2013.

When density and biovolume are graphed for the 2 years, it is immediately apparent that biovolume was much lower at the upstream site in 2012 (as reported by Hafele , 2013), and much higher at the downstream sites than was the case in 2013 (Figure 5-11). Again, direct comparisons can be made between the 2 years because Riffle 2 sampled in 2013 is the same riffle as US, sampled in 2012; Riffle 3 is the same as LS1; and Riffle 4 is the same as LS2. In addition, cell density was also much higher at the downstream sites in 2012 than it was in 2013.

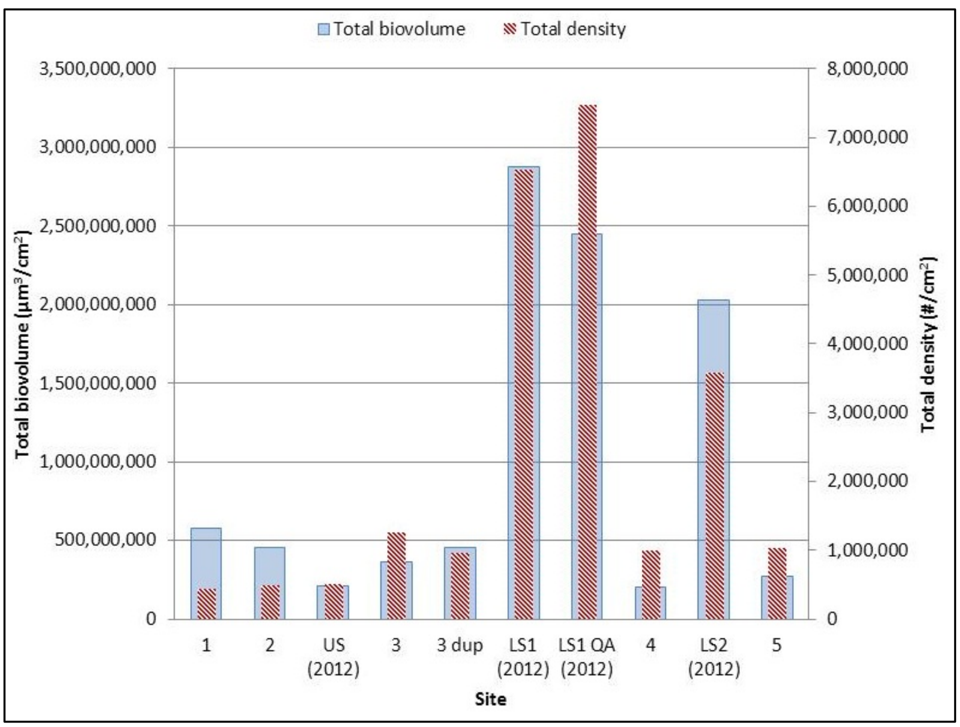

Figure 5-11. Algal biovolume and density 2012 and 2013 from upstream to downstream

Sites US, LS1 and LS2 were sampled and reported by Hafele (2013).

It is unclear how much can be derived from the relative differences in density and biovolume between 2012 and 2013. The reason for this uncertainty is the fact that 2 weeks before sampling in 2013, a rainfall event caused a spike in river flow. Figure 5-12 illustrates the hydrographs for June through October 2012 versus 2013 at the USGS gauge at Ray Gold Dam.

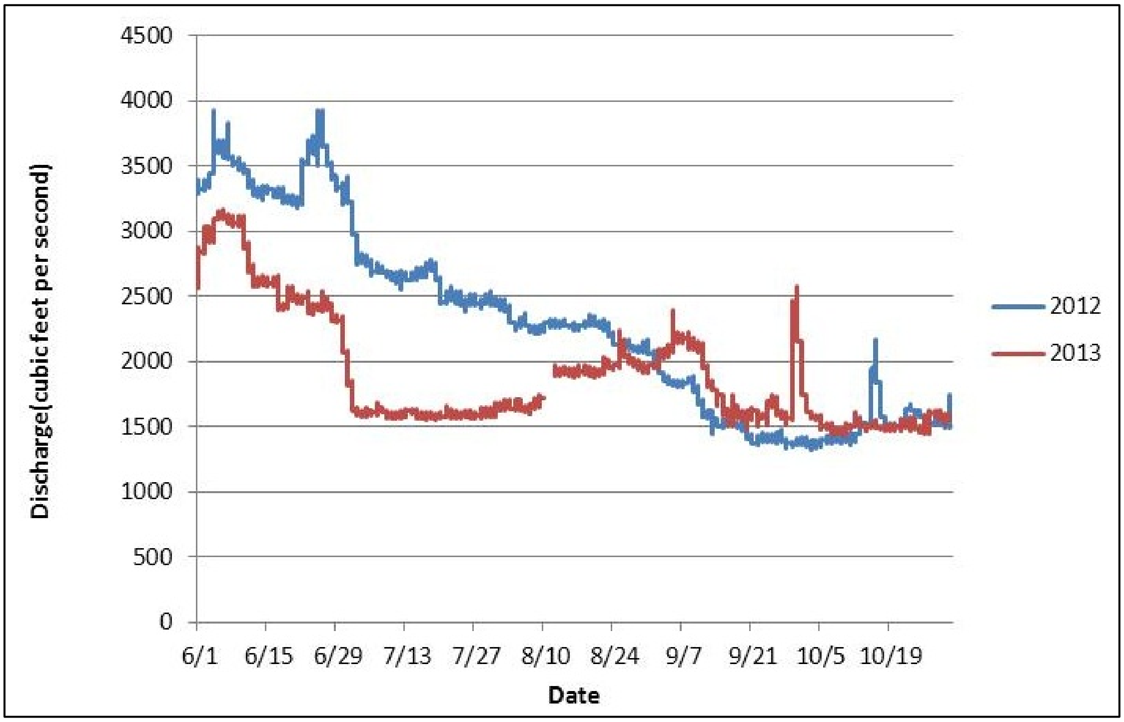

Figure 5-12. Rogue River flow hydrographs, June to October, 2012 and 2013

As can be seen, river flow was lower in 2013 throughout the summer until September 2, at which point there was a spike in flow. Flow then returned to nearly the level of 2012, until September 30; just over 2 weeks before sampling for this study. These flow events may have been high enough to scour some of the algae, leading to the differences seen between 2012 and 2013. Porter et al. (2008) states that excessive phytoplankton biomass is associated with nutrient enrichment in lakes, but biomass in streams and rivers is more related to previous hydraulic stability (lack of high-flow events), water clarity, light availability, and abundance of algal grazers. Porter et al. (2008) did find that biovolume was positively correlated with N as nitrate/nitrite, but that correlation was rather weak, and biovolume was not correlated with the concentration of other nutrients. Cell density was negatively correlated with total suspended solids but not with any of the nutrients analyzed (which included all the nutrients analyzed for this study).

Nonetheless, there is no obvious reason why upstream and downstream sites in 2013 would have been affected differently by a scouring event. And as illustrated in Figure 5-11, algal biomass in 2013 was higher at the upstream riffles than it was at all downstream riffles, with the exception of the duplicated sample at Riffle 3, where biomass was nearly the same as at Riffle 2. Cell density could be affected by nutrients in the effluent, as it was higher in 2013 at all downstream sites than it was at upstream sites.

Another way to examine the effects of the outfall is to assess the presence and abundance of indicator species. An autecological indicator species analysis was conducted on the periphyton assemblages to gauge the degree of nutrient and organic enrichment using species classifications, preferences, and tolerances published in Porter (2008). The assemblages examined included N fixers, taxa indicative of eutrophic (nutrient enriched) systems, taxa indicative of oligotrophic (nutrient poor) systems, tolerance to nutrient and organic enrichment (Bahls, 1993), and taxa indicative of N and P rich and poor environments. Appendix J lists the classifications of all taxa.

In general, the species assemblage present is indicative of good water quality, with 28 taxa classified as the most sensitive to nutrient and organic enrichment and only three taxa being classified in the most tolerant category (the remaining species were either unclassified or classified as somewhat tolerant to nutrient and organic enrichment.

Figure 5-13 illustrates the total biovolume and density of species classified as most sensitive (intolerant) at each of the riffles.

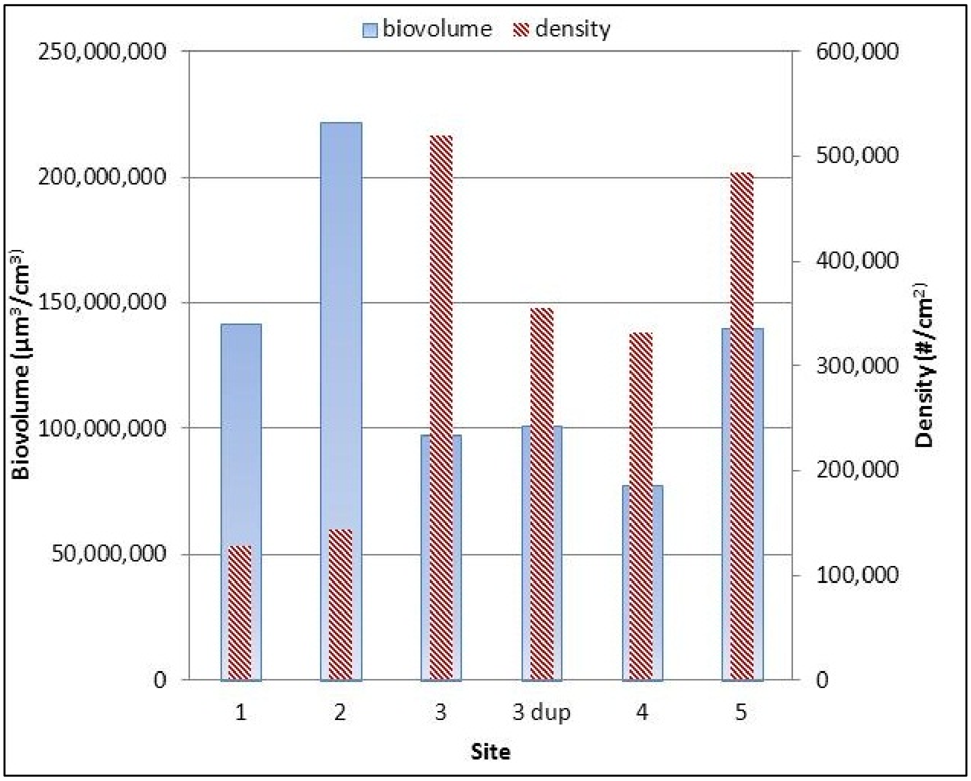

Figure 5-13. Total biovolume and density of intolerant species

Although biovolume of intolerant taxa was higher at the upstream riffles, density was higher at all downstream riffles.

Following the methods of Carpenter et. Al. (2003 and 2008), various assemblages are presented in Figures 5-13 and 5-14 as percentages of the total density and biovolume.

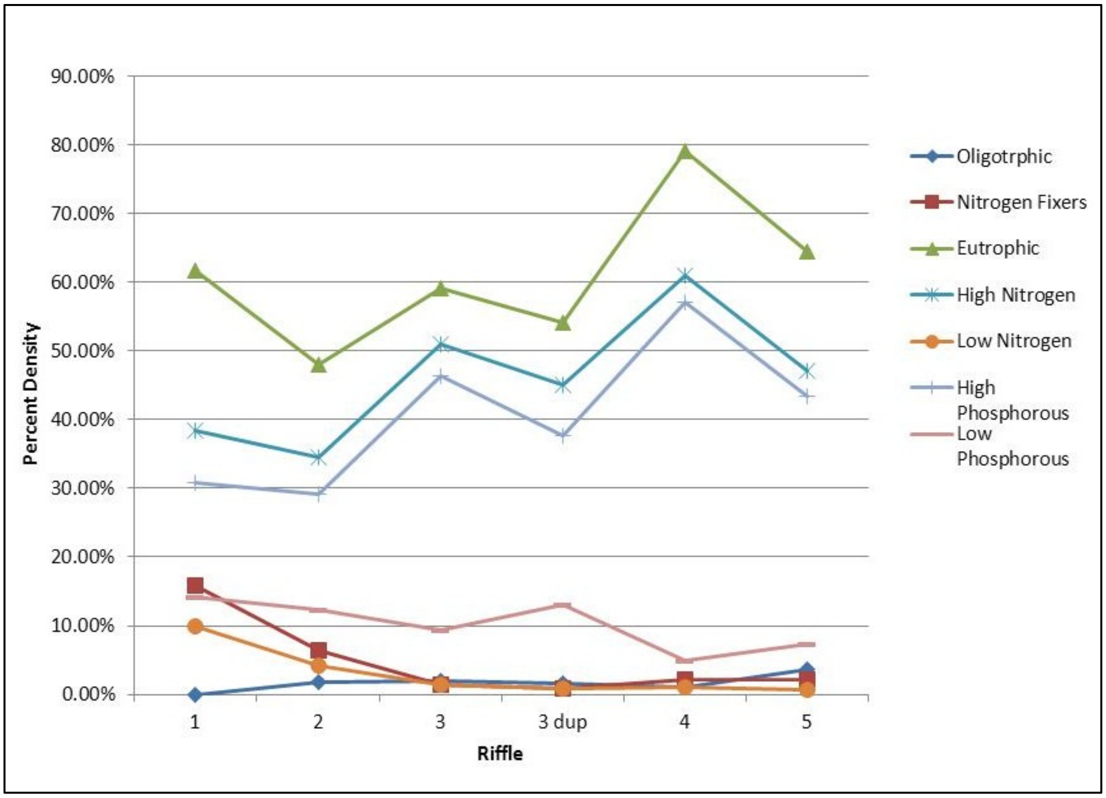

Figure 5-14. Percent of total density of various indicator taxa

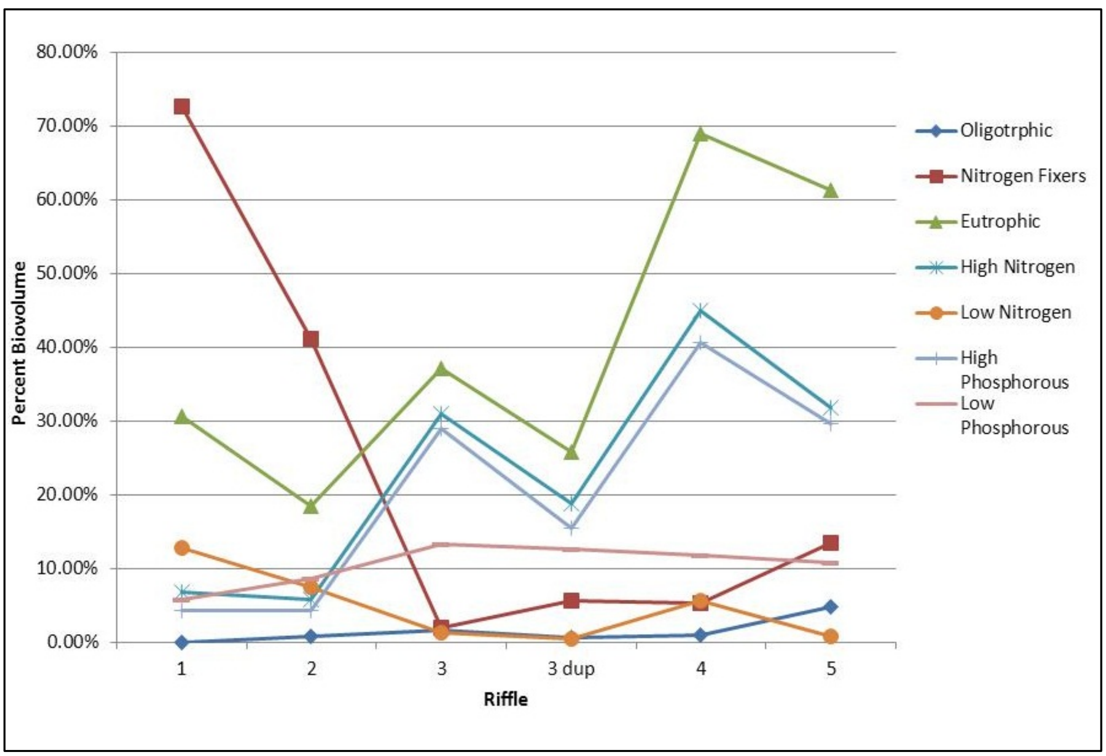

Figure 5-15. Percent of total biovolume of various indicator taxa

At the two upstream riffles, N fixers, primarily the blue-green algae *Calothrix sp.,* contribute a relatively large percentage of the total biovolume, but less of the total density. N fixers decrease sharply at the first downstream riffle, and then begin to rebound by the third riffle downstream. Porter et al. (2008) found that the proportion of N fixers was the best indicator of low N concentrations. This indicates that N may be limiting algae growth upstream, giving an advantage to N fixers. Low P indicators do not show any influence from the outfall, being higher (at least in biovolume) at downstream sites than at upstream sites. Species indicative of low N are somewhat more abundant at upstream sites. Eutrophic indicators and indicators of high N and P show similar patterns, being lowest at the second upstream riffle, and highest at the second downstream riffle. However, cell density of eutrophic indicator taxa was higher at the most upstream site than it was at the first riffle downstream and only slightly lower than it was at the third riffle downstream.

Although they contribute little to the overall periphyton community, two taxa indicative of oligotrophic environments were present, *Gomph*onema angustatum, and Gomphonema ventricosum. These taxa were actually more abundant and more dense downstream of the outfall than they were upstream, and in fact were not found at all at the most upstream riffle. Figures 5-16 and 5-17 illustrate the raw (not percentage) density and biovolume of eutrophic and oligotrophic taxa at the riffles.

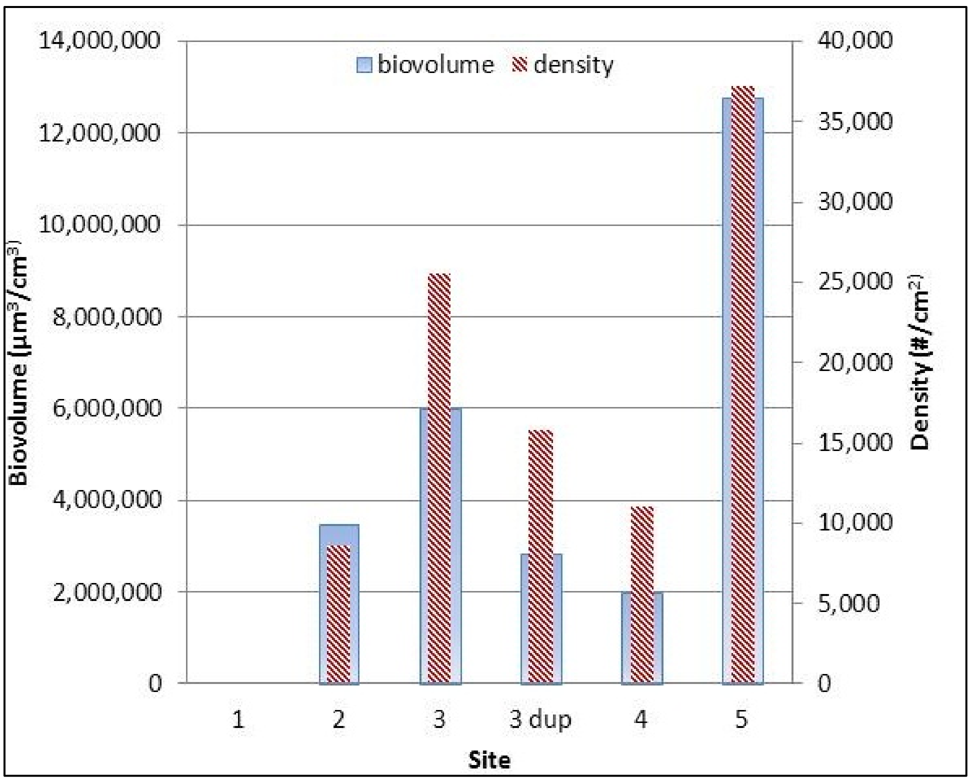

Figure 5-16. Biovolume and density of oligotrophic indicator species

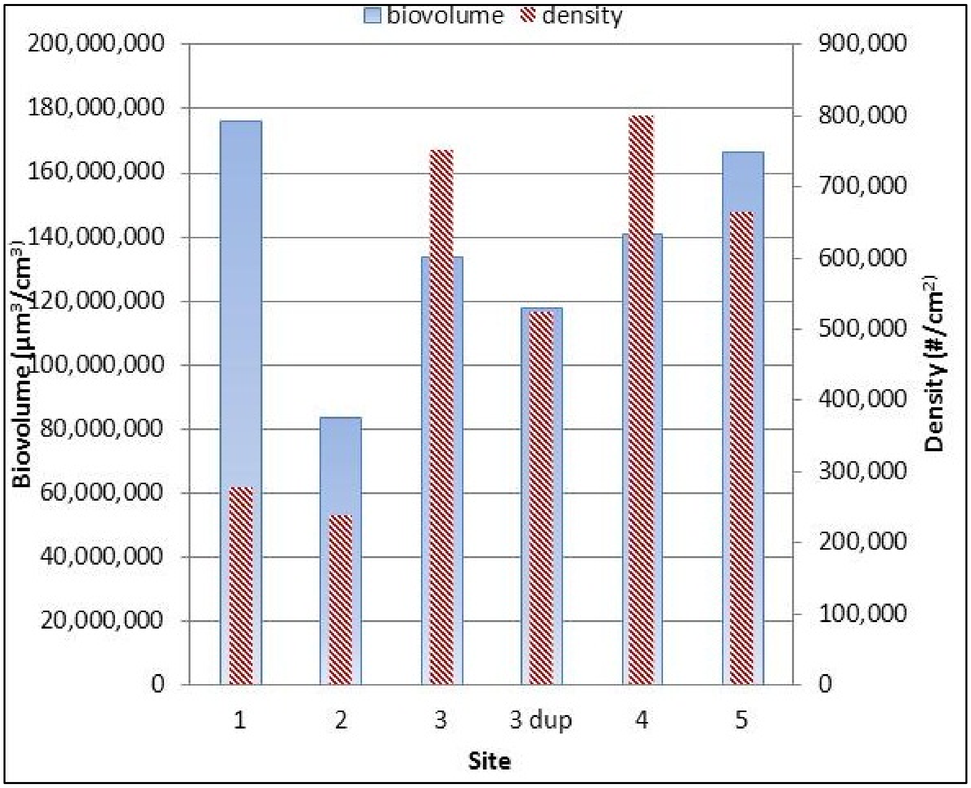

Figure 5-17. Biovolume and density of eutrophic indicator species

These two graphs (Figures 5-15 and 5-16) paint contradictory pictures. Density of eutrophic indicator taxa is higher downstream of the outfall, but biovolume is higher at the most upstream site. Oligotrophic taxa are more dense downstream of the outfall, and have higher biovolume at all downstream sites than the most upstream site, and higher biovolume at two of the downstream sites than at the upstream site closest to the outfall (Riffle 2).

Taken as a whole, the data suggest that the periphyton community downstream of the outfall is likely responding to nutrient enrichment, leading to greater density (but not greater biovolume) downstream of the outfall, and causing some shifts in the algal community. However, this enrichment is not so great as to inhibit the growth of organisms indicative of nutrient poor (oligotrophic) environments. The high river flow event 2 weeks prior to the sampling event could have reset the periphyton community partially and may explain some of the differences observed between Hafele's 2012 study and this study.

5.9.3 Benthic Macroinvertebrate Results

Benthic macroinvertebrates were collected at two locations at each of the five riffles. Samples were collected with a Portable Invertebrate Box Sampler (PIBS) following the methods outlined in the *Study Plan*. One trial sample collected with the PIBS was compared to a sample collected with a kick net (using gear and methods similar to those used by Hafele [2013]). Superficial examination of the two samples indicated that the results from the two different gear types were obviously different, with the PIBS collecting more individual macroinvertebrates, especially oligochaetes (aquatic worms). When algal growth is high, a kick net can become clogged, and macroinvertebrates back-flow out of the net, rather than being captured.

There are many different ways to describe the macroinvertebrate community. We have reported a number of different aspects of the macroinvertebrate community, termed metrics. The metrics selected include those used by Hafele (2013) and additional ones identified by Barbour et al. (1999) as the best candidate for identifying environmental perturbation. The definition and likely response to impaired water quality or degraded habitat of each metric is described below.

- Total abundance: the total number of macroinvertebrates calculated for the sample. This number could be enhanced by a mildly nutrient-enriched environment, but is more likely to go down with increasing environmental impairment.
- EPT abundance: abundance (number of individuals) in the orders *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies). These orders are relatively sensitive to environmental disturbance and their abundance will decrease with increasing environmental impairment.
- Total taxa richness: number of distinct taxa (species, genera, families or orders, depending on the level of taxonomic resolution employed). Number of taxa is generally higher in more pristine environments.
- EPT taxa richness: Number of taxa present from the EPT orders. This is expected to decrease with increasing water quality impairment.
- Percent intolerant taxa: the percent of the invertebrate community made up of taxa tolerant to disturbance. Taxa counted as intolerant are included in the standard laboratory report.
- Percent *Oligochaeta*: Percent of the organisms in the subclass *Oligochaeta* (aquatic worms) which are generally tolerant of environmental disturbance. This percentage will increase as water quality impairment increases.
- Percent non-insect taxa: Percent of the organisms that are not insects (in this case worms, nematodes, leeches, snails, clams, amphipods and mites). Non-insect taxa are generally more tolerant to environmental disturbance than insect taxa.
- Percent grazers: Percent of the macrobenthos that graze upon periphyton. This is expected to decrease with increasing perturbation.
- Percent clingers: Percent of insects that have fixed retreats or adaptations for attachment to surfaces in flowing water. This is expected to decrease with increasing perturbation.
- Percent dominant taxon: Measures the dominance of a given number of the most abundant taxa (in this case the percent of the total number of organisms that were members of the top three taxa). Community complexity is expected to decrease with increasing environmental perturbation, leading to fewer taxa being present and thus a few taxa being more dominant.

A summary of the macroinvertebrate sampling results is included in Table 5-5. Full results including all taxa collected are presented in Appendix K.

Table 5-5. Summary of Aquatic Macroinvertebrate Metrics

Macroinvertebrate metrics	Riffles										
	1	1(dup)	2	2(dup)	3	3(dup)	4	4(dup)	5	5(dup)	Predicted response to increasing perturbation
Total abundance	12,598	6,900	5,448	8,940	2,812	3,746	11,310	8,139	14,051	5,767	Decrease
EPT abundance	5,978	3,000	2,336	3,615	1,280	1,665	915	1,264	5,026	1,614	Decrease
Total taxa richness	47	45	45	41	40	42	34	33	40	42	Decrease
EPT taxa richness	21	19	21	21	15	15	9	9	14	14	Decrease
Percent intolerant taxa	2.04	4.53	5.16	7.21	2	1.00	0.1326	0	0.35	0.16	Decrease
Percent *oligochaeta*	4.42	5.62	6.53	8.39	0.16	0.67	22.55	5.99	3.56	1.30	Increase
Percent non-insect taxa	11.05	11.59	17.04	19.13	5	5.67	38.86	26.72	11.92	31.86	Increase
Percent shredders	13.78	25.72	10.84	13.93	8.33	7.51	6.233	9.522	13.52	10.08	Decrease
Percent clingers	69.22	58.33	59.88	58.05	47.5	47.11	40.05	48.4	53.21	56.43	Decrease
Percent dominant taxon	12.76	17.03	10.32	10.74	17.5	15.85	16.45	10.44	12.81	20.48	Increase

There is little difference in total macroinvertebrate abundance between the first upstream site (Riffle 1) and the second and third downstream sites (Riffles 4 and 5) (Figure 5-18). Riffle 2 (the upstream riffle sampled by Hafele (2013) has intermediate total abundance, and at the first riffle downstream (Riffle 3) total abundance appears to be depressed. Abundance of EPT taxa is highest at Riffle 1, similar at Riffles 2 and 5, and seemingly depressed at Riffles 3 and 4.

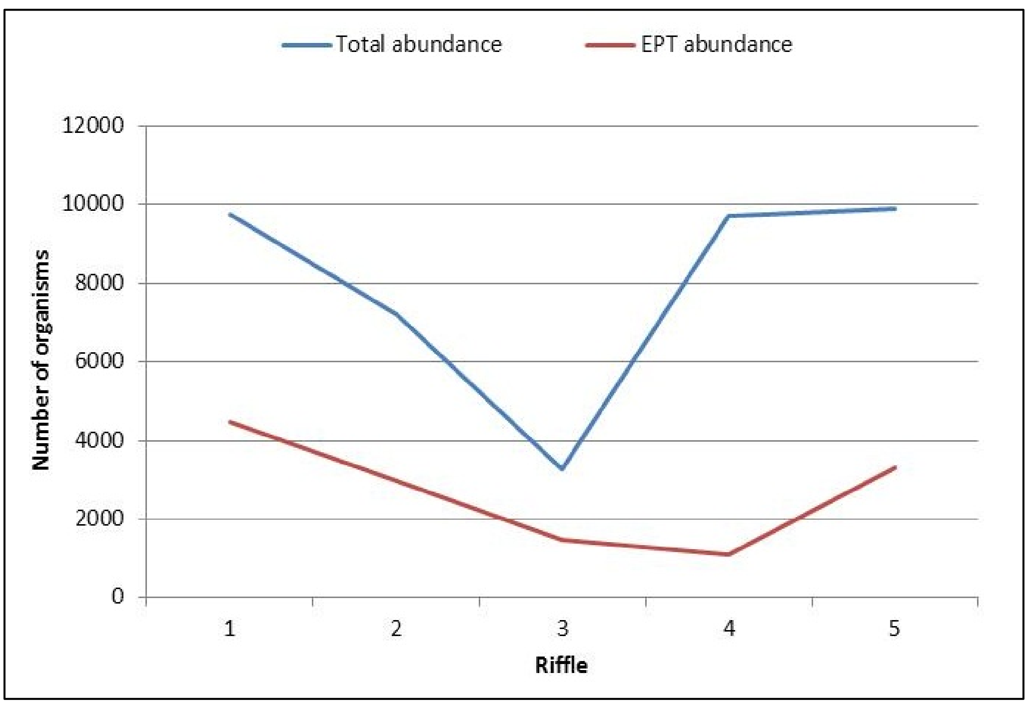

Figure 5-18. Mean total abundance and EPT abundance at each of the five sampled riffles

Total taxa richness and EPT taxa richness show similar patterns: depressed at Riffle 4, and in the case of EPT taxa, slightly depressed at Riffles 3 and 5 (Figure 5-19).

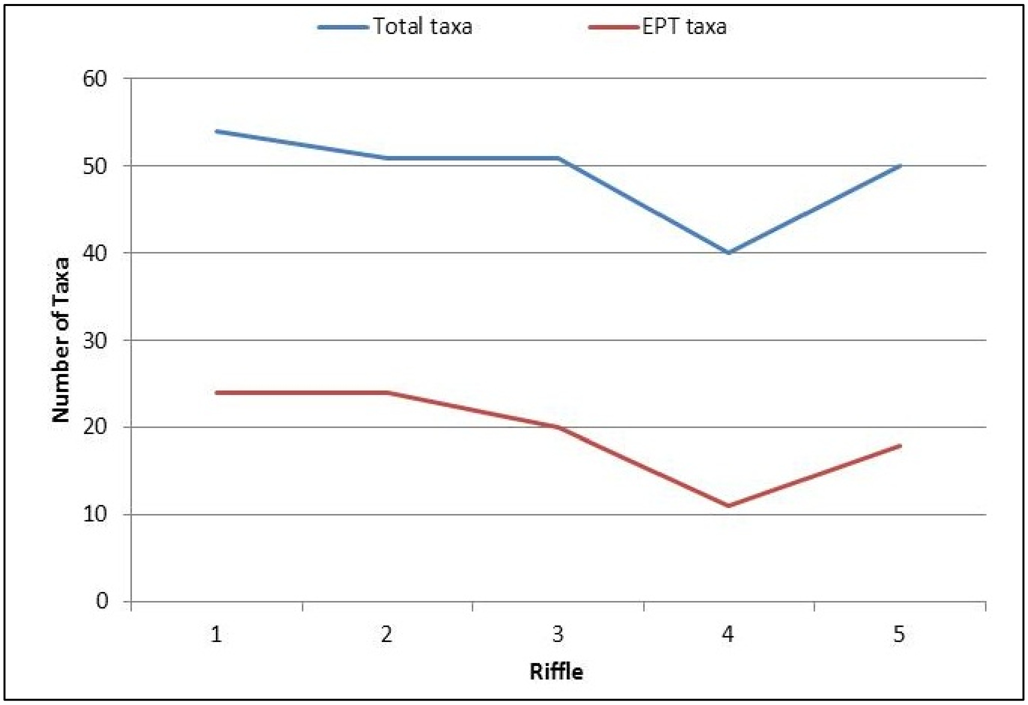

Figure 5-19. Total and EPT taxa richness at each of the five riffles

Other indicator taxa show contradictory responses. The percent clingers and scrapers show a similar pattern to EPT taxa richness (Figure 5-20), but the percent of intolerant taxa is generally low at all riffles.

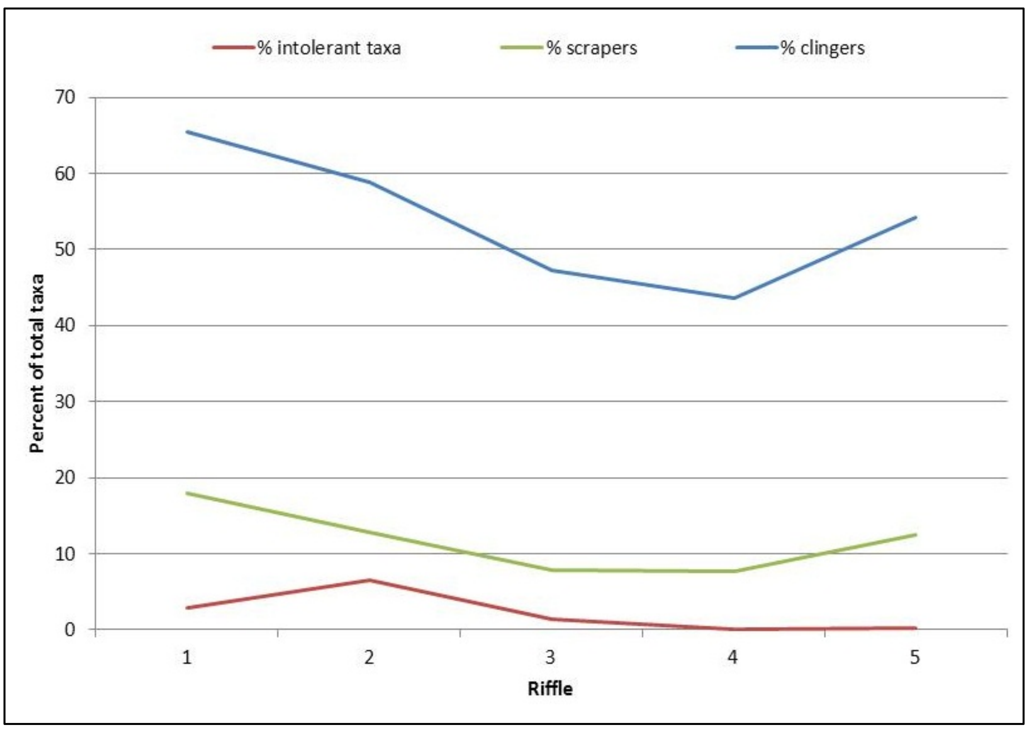

Figure 5-20. Mean values at each of the riffles of several metrics expected to decrease with increasing environmental degradation

The metrics that are expected to increase with increasing degradation show no clear patterns at all. The percent of tolerant taxa, actually shows the same pattern across riffles as the percent of intolerant taxa, with taxa tolerant of environmental degradation being lowest at Riffle 4. Other indicator taxa analyzed are similarly contradictory (Figure 5-21).

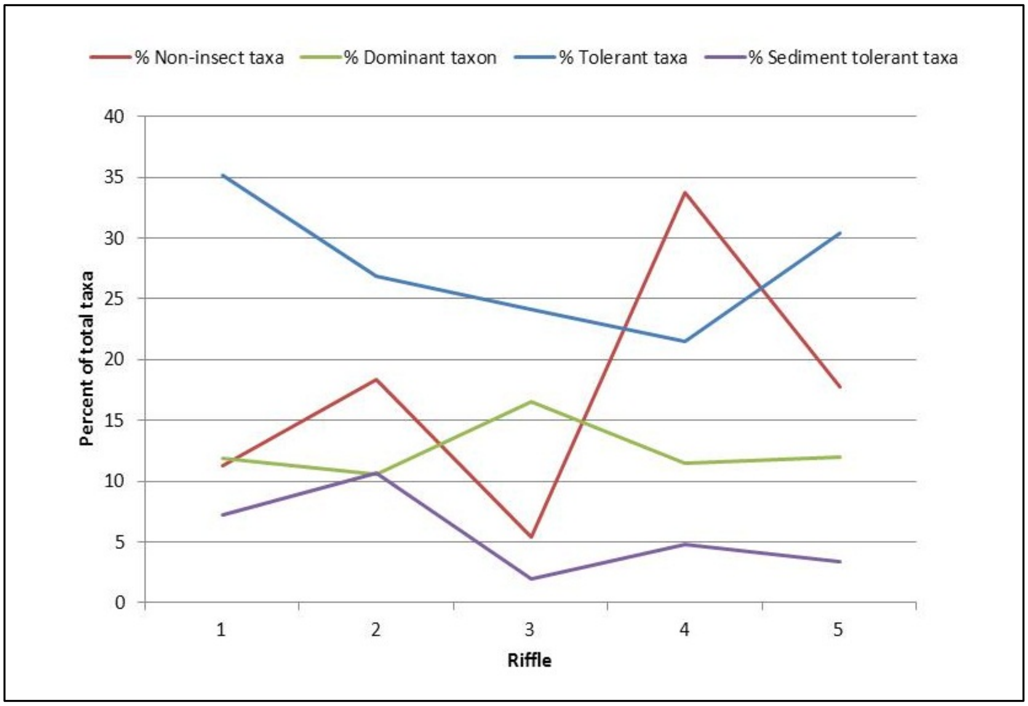

Figure 5-21. Mean values at each of the riffles of several metrics expected to increase with increasing environmental degradation

An additional method of comparing sites, is to calculate an Index of Biotic Integrity (IBI) for each of the riffles. The *Oregon Plan for Salmon and Watersheds* (*Oregon Plan*) (WQIW, 1999), established an IBI for assessing the degree of impairment of Oregon Rivers. It uses ten metrics and assigns a given site a score of 1, 3, or 5 on each metric. The IBI is no longer widely used, but can provide useful information to rank sites on their degree of environmental impairment. Table 5-6 provides the metrics and scoring criteria. Following are the metrics not previously discussed:

- Sediment Sensitive Taxa: Some taxa are known to be very sensitive to inputs of fine sediment. The presence of one or more of these taxa indicate that fine sediments are probably not a major concern. Taxa designations are included in Appendix K.
- Hilsenhof Biotic Index (HBI): This is an index of a taxon’s sensitivity to organic enrichment that typically occurs as a result of excessive nutrient inputs. Index values for individual taxa range from 1 to 10. Low scores indicate high sensitivity (found only in waters with low organic enrichment). High scores indicate low sensitivity (tolerant of waters with high organic enrichment). The *Oregon Plan* methods call for a modified HBI, and Aquatic Biological Associates (ABA) provides an HBI developed for Wyoming. However, according to ABA, the two indices track each other very closely, and therefore, the lab-reported HBI value was used. Taxa designations are included in Appendix K.
- Percent Sediment Tolerant Taxa: This is the percent of the invertebrate community made up of taxa tolerant to fine sediments (see Appendix K).

Table 5-6. Oregon Plan IBI criteria			
	Scoring criteria		
	5	3	1
Taxa richness	>35	19-35	<19
Mayfly richness	>8	4-8	<4
Stonefly richness	>5	3-5	3
Caddisfly richness	>8	4-8	<4
Sensitive taxa	>4	2-4	<2
Sediment sensitive taxa	>2	1-2	0
Modified HBI	<4.0	4-5	>5.0
Percent tolerant taxa	<15	15-45	>45
Percent sediment tolerant taxa	<10	10-25	>25
Percent dominant (single species)	<20	20-40	>40
Total score range	Stream condition		
>39	No impairment. Indicates good diversity of invertebrates and stream conditions with little or no disturbance		
30-39	Slight impairment		
20-29	Moderate impairment: clear evidence of disturbance exists		
<20	Sever impairment. Conditions indicate a high level of disturbance		

The rankings on each metric for each replicate are included in Table 5-7, and the scores are included in Table 5-8.

Table 5-7. IBI Metric Values										
IBI metrics	Riffles									
	1	1(dup)	2	2(dup)	3	3(dup)	4	4(dup)	5	5(dup)
Taxa richness	47	45	45	41	40	42	34	33	40	42
Mayfly richness	8	7	6	7	4	4	4	4	6	5
Stonefly richness	6	5	8	7	5	5	1	2	3	2
Caddisfly richness	7	7	7	7	6	6	4	3	5	7
sensitive taxa	2	3	2	1	2	2	1	1	2	2
sediment sensitive taxa	1	2	1	1	0	0	0	0	0	0
HBI	4.1	3.7	3.8	3.8	4.0	4.0	6.0	5.4	4.4	5.1
Percent tolerant taxa	34.5	35.7	25.3	28.4	24.7	23.5	17.5	25.5	23.8	36.9
Percent sediment tolerant taxa	7.5	6.9	10.7	10.7	1.5	2.3	6.2	3.4	4.1	2.8
Percent dominant (single species)	12.8	17.0	10.3	10.7	17.5	15.9	16.5	10.4	12.8	20.5

Table 5-8. IBI Metric Scores

IBI Metrics	Riffles									
	1	1(dup)	2	2(dup)	3	3(dup)	4	4(dup)	5	5(dup)
Taxa richness	5	5	5	5	5	5	3	3	5	5
Mayfly richness	3	3	3	3	3	3	3	3	3	3
Stonefly richness	5	3	5	5	3	3	1	1	3	1
Caddisfly richness	3	3	3	3	3	3	3	1	3	3
sensitive taxa	3	3	3	1	3	3	1	1	3	3
sediment sensitive taxa	3	3	3	3	1	1	1	1	1	1
Modified HBI	3	5	5	5	3	3	1	1	5	1
Percent tolerant taxa	3	3	3	3	3	3	3	3	3	3
Percent sediment tolerant taxa	5	5	3	3	5	5	5	5	5	5
Percent dominant (single species)	5	5	5	5	5	5	5	5	5	3
Total score	38	38	38	36	34	34	26	24	36	28
Degree of impairment	slight	slight	slight	slight	slight	slight	moderate	moderate	slight	moderate

Based on this analysis, Riffle 4 appears to have the least favorable conditions for macroinvertebrates, being moderately impaired along with one of the replicates at Riffle 5, while all other sample sites/riffles (including the upstream sites) are slightly impaired.

But the question of how significant that impairment is, remains. Because two replicates were done at each riffle, comparisons can be made to see if the differences observed between riffles are more significant (statistically significant) than the differences within riffles. First, an analysis of variance was run on each of the above metrics (considering each riffle as a separate treatment). Then, Tukey's Comparison of Means test was used to determine if there were significant differences between all pair-wise samples. The probability that the differences observed are the result of natural, random variation is termed the p-value. For instance, a p-value of 0.05 (which was considered statistically significant for this study) indicates that there is a 5 percent chance that the observed differences between two samples are the result of random chance, rather than actual differences due to some treatment effect. In this case, the assumed treatment effect is the wastewater outfall, although other sources of environmental impact also may be present. Analytical details are included in Appendix L.

Table 5-9 illustrates the metrics and riffles where significant differences were observed.

Table 5-9. Metrics and Riffles with Significant Differences				
Riffles being compared	Total taxa richness	EPT taxa richness	Percent intolerant taxa	Percent clingers
1 to 2				
1 to 3		X		
1 to 4	X	X		X
1 to 5		X		
2 to 3		X	X	
2 to 4	X	X	X	
2 to 5		X	X	
3 to 4	X	X		
3 to 5				
4 to 5	X	X		

All pairwise riffle comparisons show significant differences on the individual metrics. Metrics/pairs where significant differences ($p \leq 0.05$) were observed are marked with an X.

There were relatively few significant differences between the riffles, partly because a lot of variability was seen between the replicates within given riffles, and partly because the differences between riffles observed were not nearly as great as those observed by Hafele (2013). No significant differences were observed between sites on the total abundance, EPT abundance, percent Oligochaetes, percent non-insect taxa, percent shredders or percent dominant taxon.

Riffle 4 was different from the other riffles (including other downstream riffles) in the total taxa richness, and percent intolerant taxa. Riffles 1 and 2 were different from the downstream riffles on the EPT taxa richness, and Riffle 4 was different than both Riffles 3 and 5 on the same metric.

5.9.4 Benthic Macroinvertebrate Discussion

Table 5-10 illustrates the mean results for each of the reported Hafele metrics compared to the mean results from this study. Hafele also reported percent sensitive EPT taxa and percent intolerant taxa (both as defined by the state of California). Those metrics are not included herein, because ABA does not consider them to be good indicators in Pacific Northwest streams.

Table 5-10. Mean of the Two Replicates at Each Riffle (comparing 2013 results to those reported for 2012 in Hafele, 2013)								
Macroinvertebrate metrics	Riffles							
	1	2	2 – 2012 (Hafele US)	3	3- 2012 (Hafele LS1)	4	4- 2012 (Hafele LS2)	5
Total abundance	9749	7194	21,852	3279	4,646	9724	7,293	9909
EPT abundance	4489	2975	8,476	1472	268	1089	1,442	3320
Total taxa richness	54	51	44	51	32	40	38	50
EPT taxa richness	24	24	22	20	8	11	14	18
Percent *Oligochaeta*	2.921	6.438	7	0.4526	25	15.62	12	2.901
Percent non-insect taxa	4.844	7.689	14	5.384	58	33.78	29	17.72

Figure 5-22 further illustrates the results for total abundance, and Figure 5-23 illustrates the results for EPT abundance.

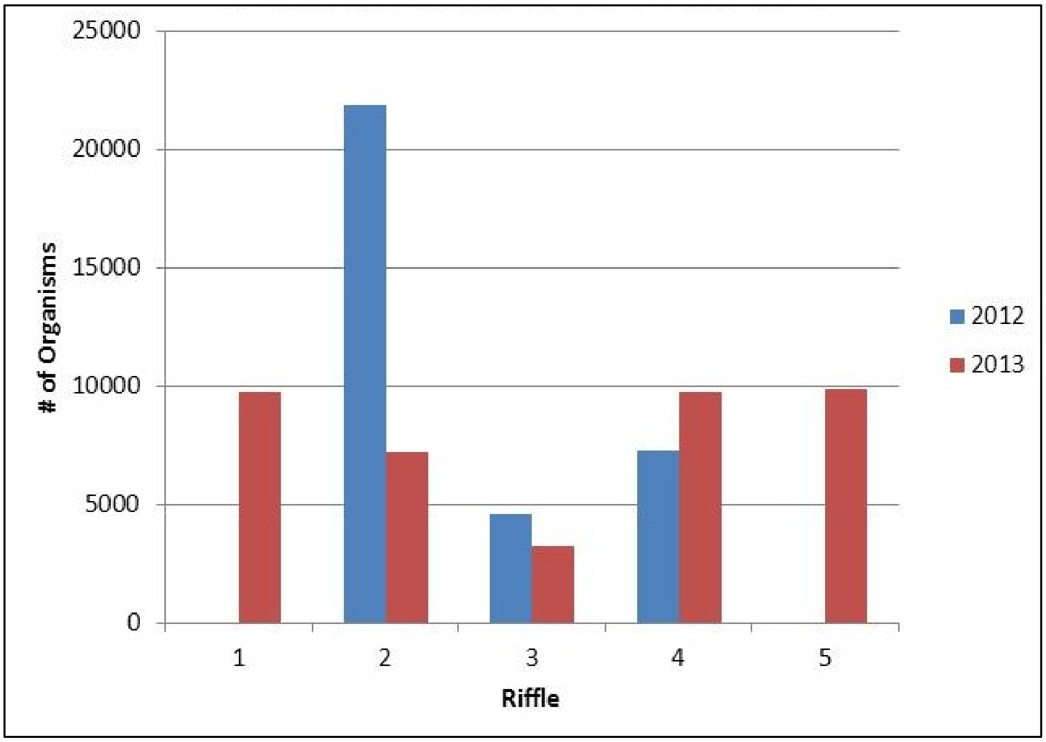

Figure 5-22. Total abundance 2012 versus 2013

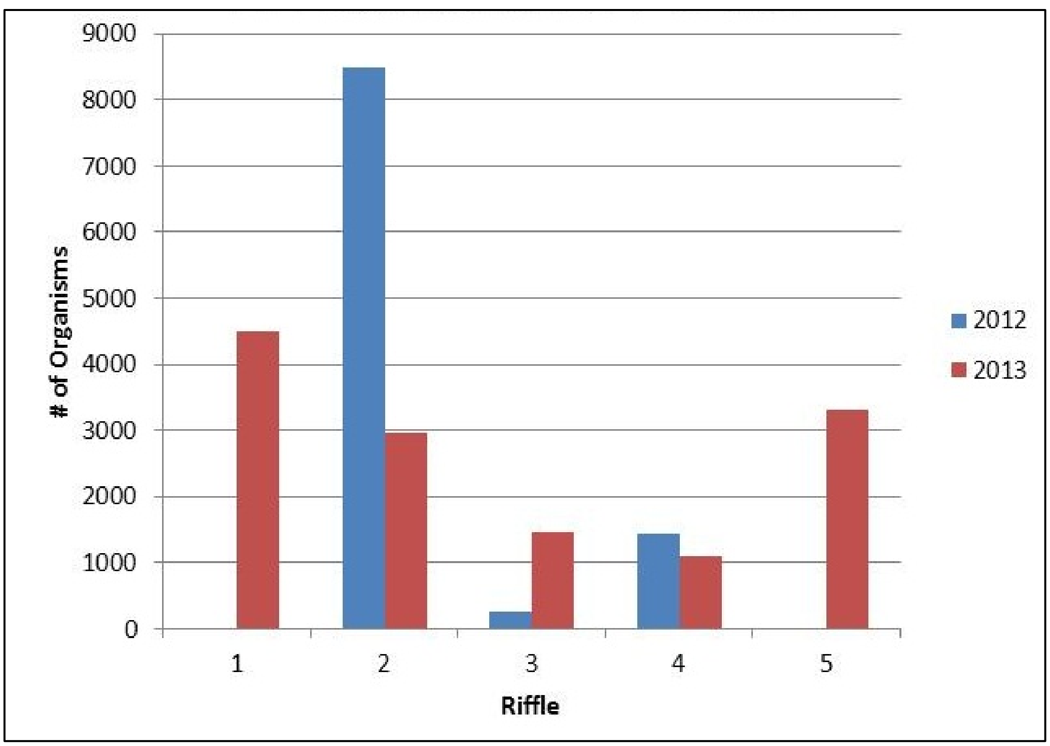

Figure 5-23. EPT abundance 2012 versus 2013

These figures illustrate that the total and EPT abundance at Riffle 2 was much higher in 2012 than in 2013. At Riffle 3, total abundance was higher in 2012, but EPT abundance was much higher in 2013, possibly indicating higher water quality in 2013. The opposite effect was seen at Riffle 4. Total abundance was lower in 2012, but EPT abundance was somewhat higher. The number of EPT taxa was higher at Riffles 2 and 3 in 2013 than it was in 2012, but lower at Riffle 4 (Figure 5-24).

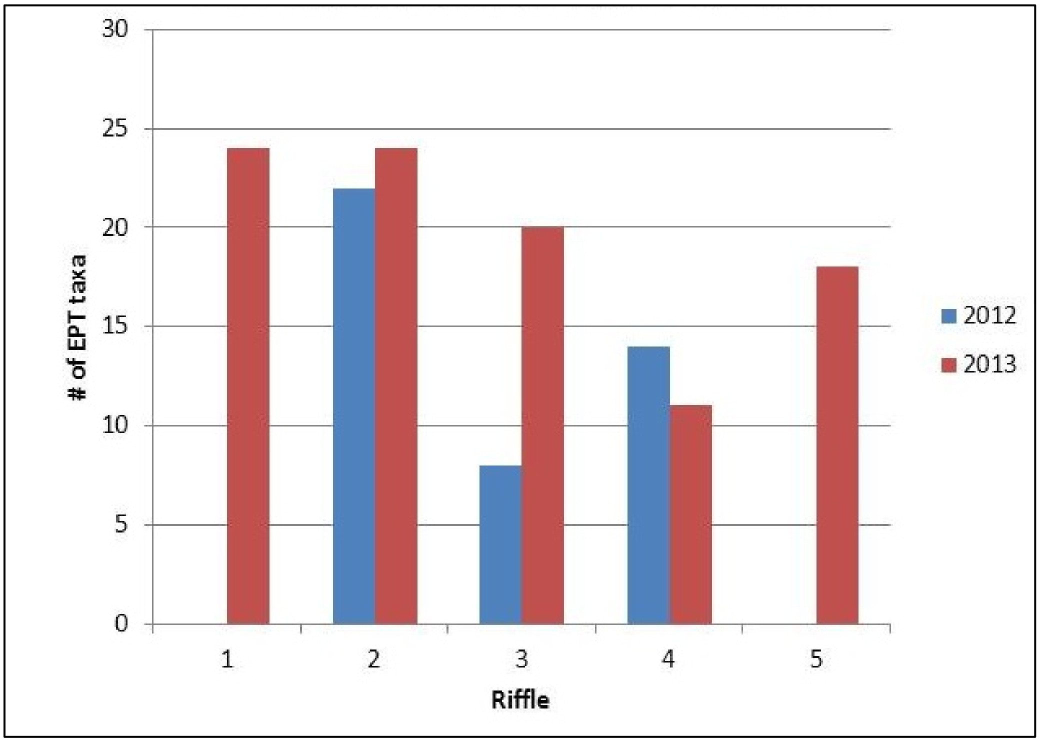

Figure 5-24. EPT taxa richness, 2012 versus 2013

Taken together, the macroinvertebrate data indicate environmental impairment downstream of the outfall, with the most impairment at Riffle 4, the second riffle downstream. River conditions have essentially returned to background (similar to upstream sites) by Riffle 5, with Riffle 5 being significantly different than both upstream riffles only on EPT abundance; and different from Riffle 2 on percent intolerant taxa.

The observed degradation between upstream and downstream riffles does not appear to be as severe as indicated by Hafele (2012). Hafele (2012) found that the first riffle downstream (Riffle 3), was significantly different from the upstream riffle (Riffle 2) on all of the metrics. In contrast, the 2013 data indicate that the first riffle downstream of the outfall (Riffle 3) is little different than the upstream sites, showing significant differences to the upstream riffles only on EPT taxa richness. In addition, the 2013 data indicate that Riffle 4 has the greatest environmental degradation, while Hafele (2013) showed conditions nearer background by Riffle 4. Hafele found that Riffle 4 was significantly different from Riffle 2 only for EPT abundance and EPT taxa richness. One possible explanation for the differences observed between 2012 and 2013 is the different sampling gear that was employed. Hafele (2013) used a D-frame net, which is a *qualitative* sampling method. The d-frame net can become clogged with algae, causing organisms to back-flow out of the net, and sampling an area smaller or larger than prescribed by the *Study Plan* can easily occur with a D-frame net if the sampling location is not carefully delineated. In contrast, the PIBS used for this study is a *quantitative* sampling method. The PIBS completely encloses a 0.1 square meter area to be sampled and does not allow back-flow even in areas with heavy algae growth.

There is no obvious reason why Riffle 3 would show relatively little impairment, while Riffle 4 is more significantly impaired. The dye study indicated that the effluent plume extended across the entirety of Riffle 3; however, the plume was more concentrated on the south bank at Riffle 3, where sampling was not conducted. Possibly, differences in the across-channel dilution between Riffles 3 and 4 could have accounted for the apparent reversal in the downstream effect of the effluent in the 2013 results.

Section 6

Dilution Model Analysis

This section presents a hydrodynamic model analysis of the Medford RWRF outfall. Data collected during the field study (see Section 5) were used to calibrate model results to observed plume characteristics. The calibrated model is then used to predict dilution at Oregon DEQ defined critical ambient and effluent conditions.

6.1 Methodology

Two USEPA and DEQ-approved dilution models were evaluated for their applicability to the Medford RWRF outfall: the Cornell Mixing Zone Expert System (CORMIX, v8.0) (Jirka, et al., 1996) and Visual Plumes (Frick, et al., 2002).

The Visual Plumes suite of dilution models were developed to model dilution within large bodies of water where plume interaction with boundaries (river banks, water surface, etc.) is negligible and dilution is driven primarily by buoyancy effects within a density-stratified water column. Therefore, Visual Plumes is not appropriate for the City's outfall due to boundary conditions defined by the outfall discharge and the physical dimensions of the Rogue River.

CORMIX is well suited for the receiving water conditions in the vicinity of the City's outfall because it was developed for steady-state riverine conditions and places an emphasis on effluent plume interaction with boundary conditions and their affect on mixing. CORMIX accounts for both vertical and lateral boundaries such as the river bottom, river surface, and river banks.

All dilution modeling performed utilizes the CORMIX model as supported by the CORMIX *User's Manual* and is calibrated with data collected during the field study. Section 6.2 provides a basic CORMIX model description.

6.2 Model Description

Subsystem 2 of the CORMIX model predicts the geometry and dilution characteristics of an effluent plume resulting from submerged multiport diffusers. A submerged river outfall is characterized by two distinct mixing regions: near-field and far-field. Mixing in the near field is vigorous as effluent momentum dissipates quickly. Near-field mixing is a function of diffuser port size/shape, outlet velocity, plume buoyancy effects, lateral extent of the diffuser, and vertical extent of the water column over the diffuser. Dispersion of the effluent in the far field is driven by turbulent transport in the receiving water. Receiving water turbulence is a function of current speed and channel characteristics, such as river depth, bottom roughness, and presence of river bends and eddies. Far-field mixing rates are typically less than near-field mixing rates.

6.3 Model Input Data and Calibration

CORMIX model input data include parameters related to the outfall design, effluent flow rate and temperature, and ambient parameters that define the river dimensions and other more subjective conditions such as river bed roughness and the uniformity of the river channel. This section summarizes model input parameters and calibration based upon data collected during the field study.

6.3.1 Effluent Parameters

- Effluent Flow Rate: Average effluent flow rate during plume mapping activities was 18.2 mgd.
- Effluent Temperature: Average effluent temperature during plume mapping activities was 68.3 degrees F.

6.3.2 Ambient Parameters

- River Width: River width measurements are provided in Table 5-1. The average of river widths measured at the 36-foot upstream and 411-foot downstream transects is approximately 200 feet.
- Depth at Discharge: Measured river depth just downstream of the midpoint of the diffuser was approximately 8 feet.
- Average Depth: CORMIX requires that the actual river cross-section be described by a rectangular channel. Furthermore, the average depth cannot vary from the depth at discharge by more than 30 percent. Average depth for model input was selected using the upstream transect (rather than the downstream transect or a combination of the two) because river depth has the greatest affect on dilution in the near field, immediately upon discharge from the outfall. The river, on average, is 4.85 feet deep across the entire upstream transect, but approximately 6 feet deep on average for the southern most half of the river where the effluent plume is located. An average depth of 6.2 feet was selected for model input to be consistent with model assumptions related to depth at discharge and average depth (6.2 feet x 1.3 = 8 feet).
- Ambient Flow Rate: River flow calculated from Acoustic Doppler Current Profile measurements is provided in Table 5-1. The average of river flows calculated for the 36-foot upstream and 411-foot downstream transects is approximately 1,600 cfs.
- Ambient Temperature: The average ambient temperature, as recorded by the upstream continuous monitoring probe, during plume mapping activities, was 44.4 degrees F.
- Manning's n Coefficient: The Manning's n coefficient is a measure of the roughness characteristics of the river bed. Higher values indicate a rougher surface, which would create greater mixing. An initial Manning's coefficient of 0.035 was selected for the area of the river within the mixing zone based on general guidelines for a "winding channel, with pools and shoals" as provided in the CORMIX *User's Manual*. This initial value was later evaluated as described in Section 6.3.4 to calibrate model predictions to plume dimensions observed in the field.
- Channel Appearance: CORMIX allows selection from one of three channel appearance categories: 1) straight and uniform; 2) moderate downstream meander with non-uniform channel; or 3) strongly winding and highly irregular channel. Channel appearance category 2 was selected based on the appearance of the Rogue River in the vicinity of the outfall.
- Wind Speed: Wind speed has a negligible effect on dilution within the mixing zone. An input value of 2 meters per second was assumed based on CORMIX *User's Manual* guidelines for a breeze.

6.3.3 Outfall Parameters

- Nearest Bank Location: Distance to the nearest bank (left bank looking downstream) is approximately 30 feet from the first inshore diffuser port. The outfall drawing in Appendix C shows this distance to be approximately 20 feet at low water conditions, but river flow during the field study was significantly greater than the reference flow cited in the drawings.
- Diffuser Length: Total diffuser length is 12 feet.
- Number of Diffuser Ports: 3

- Diffuser Port Configuration: Consistent with the previous DEQ model analysis presented in the NPDES permit fact sheet, the model assumes a fanned diffuser port configuration at an angle of 15 degrees to the Rogue River flow.
- Diffuser Port Diameter: The elastomeric check valves at the end of each diffuser port are variable orifice devices which change the effective port area with respect to internal pressure/flow rate. Calculated effective port area for the effluent flow rate observed during the field study and critical effluent flow rates (see Table 3-1) are provided in Appendix M based on manufacturer area versus flow curves.
- Diffuser Port Height: Diffuser port height varies for each of the three ports (see drawing in Appendix C). Average diffuser port height is approximately 2 feet from the river bottom.

6.3.4 Model Calibration

An initial model run was performed using the model input parameters described in Section 6.3.3. The model predicted plume width (70 feet) at the RMZ boundary was less than the plume width observed in the field, approximately 100 feet. However, the offshore plume boundary observed during plume mapping closely matched the offshore plume edge predicted by CORMIX. Another difference between the CORMIX predictions and the observed plume mapping was how quickly the dye was observed to reach the river bank downstream of the outfall. Entrained air in the RWRF effluent likely results in back eddies and dispersion that quickly dispersed the dye to the river bank.

The inability of CORMIX to model certain aspects of the actual plume is likely due to the physical configuration of the river bank, the effects of entrained air on the effluent dispersion into the mixing zone and the limitations of the model itself. CORMIX assumes a straight river bank, projected perpendicularly from the defined point where the outfall intersects the bank. As shown in the aerial photos and plume mapping (see Figure 5-1), the river bank curves away (to the south) from this projection. The difference between the CORMIX assumption and actual conditions is shown schematically in Figure 6-1. The approximate 20- to 30-foot gap that CORMIX cannot model accurately is consistent with the difference between the model-predicted plume width and the actual observed plume width at the RMZ boundary.

Additional modeling and analysis were performed to consider other various scenarios that might address the differences between the model and observed field conditions. Various values of the Manning's n coefficient within the range for a "winding channel, with pools and shoals" (0.033 to 0.040) were evaluated and had no impact on the model-predicted plume width at the RMZ boundary. Modification of other potential calibrating parameters, such as port configuration angle and port height from that described in Section 6.3.3 also had no significant affect on predicted plume width. Other CORMIX model scenarios were evaluated including one-third of the RWRF flow discharged through only the offshore diffuser port rotated toward the center of the river at a 45-degree angle to match the as-built conditions (see Appendix C) and a scenario that combined results from two CORMIX model runs that attempted to represent the outer and inner diffuser port as-built conditions. All considered scenarios resulted in similar dilutions and seemed to be representative of observed field conditions. Based on the various scenarios considered, and considering the limitations associated with the CORMIX model, the predicted results were found to be as representative of observed field conditions as was possible within the scope of this study.

Critical model runs discussed in Section 6.4 were performed using the model input parameters discussed in Section 6.3.3, as modified for critical ambient and effluent flow and temperature conditions.

6.4 Model Results at Critical Conditions

The calibrated model, using model input values established as discussed in Section 6.3, was re-run using input values specific to critical ambient and effluent conditions defined in the IMD and presented in Section 3. Model input parameters that were modified from those established in Section 6.3 are summarized in Table 6-1 for each of four critical condition model runs.

Table 6-1. Critical Model Run Input Parameters

Model input parameter	Aquatic life critical conditions		Human health critical conditions	
	Acute	Chronic	Non-carcinogen	Carcinogen
Effluent flow, mgd	26.0	18.2	18.2	18.2
Effluent temperature, degrees F	74.4	70.9	65.6	65.6
Ambient flow, cfs	848	882	998	1898
Ambient temperature, degrees F)	63.7	63.7	48.4	48.4
Port diameter, feet	1.6	1.5	1.5	1.5

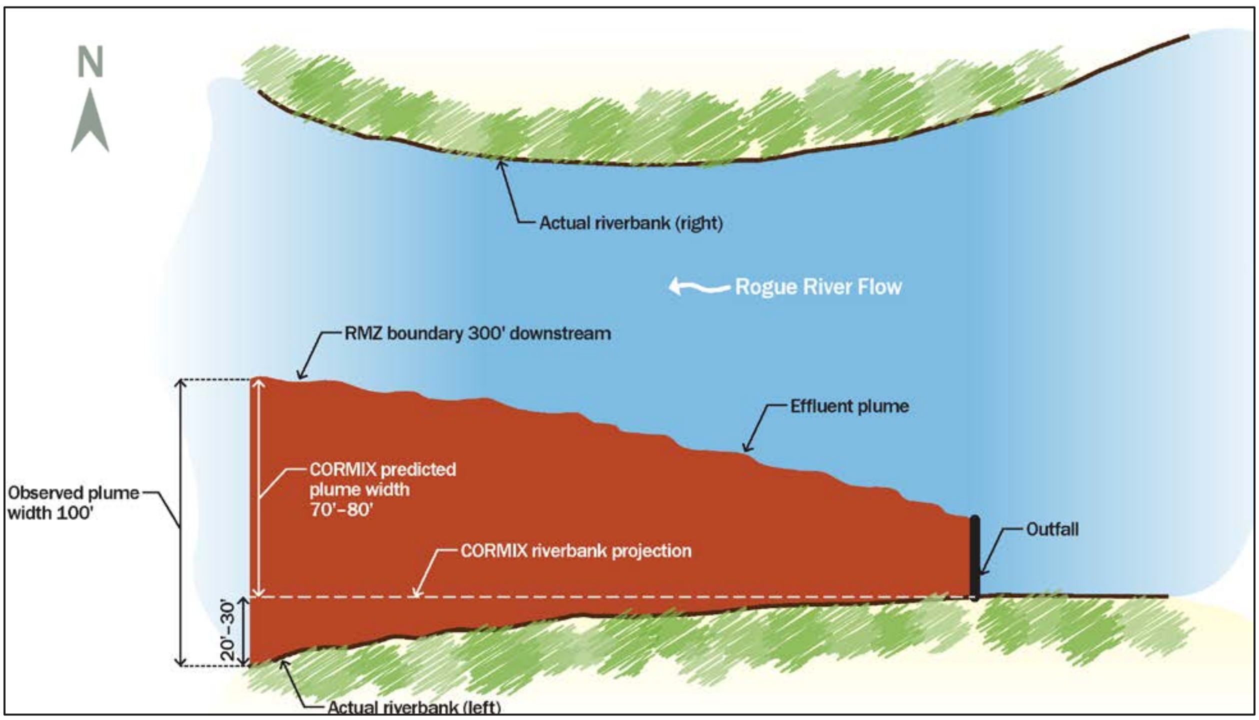

Figure 6-1. Model calibration – CORMIX predicted plume width

The rating curve for USGS Gauging Station No. 14339000 indicates a difference in gauge height between USGS-measured flows during the field study and the 1Q10/7Q10 flows of approximately 0.5 foot. However, the river depth input values were not adjusted for critical model runs due to the following:

- Changes to the average river depth would be outside the allowable model depth assumptions (see Section 6.3.2).
- The difference in river depth between locations upstream of the outfall and the downstream mixing zone boundary (1.4 feet, see Section 5.5) exceeds by a factor of three the river depth modifications due to extrapolation to critical conditions. Because the model can use depth at a single location only, any changes in river depth due to changes in flow are within model accuracy limits.
- Based on model calibration analysis, minor changes in river width and depth had nominal impact on model predicted dilution.

Table 6-2 summarizes the model predicted dilution at the critical conditions and compares these values to DEQ modeled values contained in the NPDES permit fact sheet. Model output files, including effluent plume plan and profile graphics generated by CORMIX, are provided for the four critical model runs in Appendix N.

Table 6-2. Predicted Effluent Dilution at Critical Conditions, Including Prior DEQ Model Analysis

Critical condition	Mixing zone study model analysis	DEQ model analysis (DEQ, 2011)
Aquatic life acute condition	4.9	8.8
Aquatic life chronic condition	10.2	14.0
Human health non-carcinogen	10.9	16.4
Human health carcinogen	15.5	30.4

As shown in Table 6-2, the model predicted critical dilution factors for the present analysis are lower than predicted by the prior DEQ analysis. The lower predicted dilutions are due primarily to the difference in river width and depth measured in the field versus values assumed by DEQ in its analysis. DEQ used an average river depth (and depth at discharge) of 12 feet and a river width of 75 feet. As discussed in Section 5.5, the Rogue River in the vicinity of the outfall is shallower and wider during critical conditions than assumed by DEQ. The DEQ-assumed river depth results in an over-prediction of actual dilution because the CORMIX model assumes rapid vertical mixing of the effluent within the water column. Additional model input differences that impact predicted dilution include the port diameter and critical effluent flow rates. DEQ assumed a port diameter of 1.2 feet, rather than the values calculated using manufacturer area versus flow curves. DEQ model runs also used maximum plant flows of 20 mgd. Acute condition model runs for the present analysis were based on a maximum plant flow of 26 mgd calculated from actual RWRF data (2010 through 2013) consistent with IMD guidance. Acute condition dilutions are reported as centerline dilutions and chronic condition dilutions are reported as flux average dilutions by CORMIX.

Section 7

Reasonable Potential Analysis

The reasonable potential to exceed water quality standards is a standard statistical test developed by the USEPA to establish the need for effluent limitations in NPDES permits. Reasonable potential analysis (RPA) procedures are outlined in the *Technical Support Document for Water Quality-Based Toxics Control* (USEPA 505/2-90-001, 1991) and *Reasonable Potential Analysis for Toxic Pollutants Internal Management Directive*, Version 3.1 (DEQ, 2012).

The RPA was performed for metals and priority pollutants parameters. New criteria, taking into account the sensitivity of freshwater snails and mussels to acute and chronic ammonia toxicity were published by the USEPA in April 2013, but have not yet been adopted by DEQ. The ammonia RPA completed by DEQ and the City in the last permit reissuance will be updated during the next NPDES permit cycle using current (at that time) ammonia water quality criteria. As was performed under the last permit reissuance, the RPA analysis for ammonia will be updated using monthly data for variables of river flow, ambient temperature, pH, alkalinity and background ammonia concentration, and modeled monthly dilution ratios.

7.1 Input Data

The RPA for effluent discharge from the Medford RWRF outfall was performed using the predicted critical dilution factors from the dilution modeling presented in Section 6 and effluent metals and priority pollutant water quality data collected between 2009 and 2013 as part of scheduled NPDES permit sampling. Effluent metals data collected prior to May 2011 were not used for the RPA because the results of February 2011 sampling indicated anomalously high concentration values for several parameters, including chromium, copper, lead, silver, and zinc. The City subsequently began implementing more rigorous clean sampling procedures (USEPA Method 1669) to minimize potential sample contamination concerns. Minimum sampling frequencies for the parameters evaluated in the RPA are as follows:

- Metals: Quarterly: 4 times per year
- Priority Pollutants: 2 times per year

Ambient water quality data for toxic parameters in the vicinity of the RWRF are not available through the Oregon DEQ's LASAR database. Therefore, ambient values used in the RPA herein are made consistent with the values used by DEQ in the RPA analysis performed to support the most recent NPDES permit renewal, as documented in the NPDES permit fact sheet (DEQ, 2011).

Table 7-1 presents a summary of the effluent water quality data used as input data for the RPA. Bis (2-ethylhexyl) phthalate, di-n-butyl phthalate, and chloroform were detected in three or more of the six priority pollutant scans performed between 2009 and 2013. The remaining priority pollutant scan parameters (toluene, methylene chloride, butyl benzyl phthalate, diethyl phthalate, and dimethyl phthalate were detected in only one of six priority pollutant scans. The effluent ammonia dataset is based on over 200 samples collected during the critical period (June through October) between 2010 and 2013. All measurements of metals and priority pollutant effluent water quality data are provided in Appendix D, including statistical computations.

Table 7-1. Effluent Water Quality Data Summary			
Parameter	No. of samples	Maximum effluent concentration	Coefficient of variation (CV)
Antimony, micrograms per liter (µg/L)	3	0.42	0.60[a]
Arsenic, µg/L	9	1.65	0.21
Cyanide, µg/L	9	3.07	0.26
Beryllium, µg/L	3	0.02	0.60[a]
Bis(2-ethylhexyl) phthalate, µg/L[b,c]	6	1.4	0.60[a]
Butyl benzyl phthalate, µg/L	6	2.6	0.60[a]
Cadmium, µg/L	9	0.11	0.23
Chloroform, µg/L	6	1.0	0.60[a]
Chromium, µg/L	9	1.87	0.36
Copper, µg/L	9	25.53	0.20
Diethyl phthalate, µg/L	6	0.7	0.60[a]
Dimethyl phthalate, µg/L	6	0.6	0.60[a]
Di-n-butyl phthalate, µg/L	6	1.0	0.60[a]
Iron, µg/L	3	41.8	0.60[a]
Lead, µg/L	9	0.66	0.16
Mercury, µg/L	9	0.06	0.48
Methylene chloride, µg/L[c]	6	0.2	0.60[a]
Molybdenum, µg/L	3	3.48	0.60[a]
Nickel, µg/L	9	5.04	0.30
Selenium, µg/L	6	2.58	0.60[a]
Silver, µg/L	9	0.16	0.27
Thallium, µg/L	3	0.07	0.60[a]
Toluene, µg/L	6	0.2	0.60[a]
Total Phenolics, µg/L	6	70.9	0.60[a]
Zinc, µg/L	9	46.83	0.16

[a]Assumed CV value of 0.6 used for sample sets with less than 9 values.

[b]Data excludes anomalously high value of 22 µg/L (ten times higher than all other detected concentrations) recorded in June 2010.

[c]Per DEQ guidelines in the IMD for suspected carcinogenic parameters, effluent concentration reported is geometric mean concentration.

7.2 Results

The RPA was performed using the domestic RPA spreadsheet (Revision 3.4) developed by DEQ. The domestic RPA spreadsheets are provided in Appendix O. Tables 7-2 and 7-3 summarize the RPA results which indicate that there is no reasonable potential to exceed water quality standards for all parameters evaluated. Tables 7-2 and 7-3 also present an RPA ratio for each effluent parameter. The RPA ratio is the ratio of the predicted constituent concentration at the mixing zone boundary to the regulatory standard. The higher the RPA ratio, the closer the predicted constituent concentration is to the standard. For most parameters, the applicable standard is met with a safety factor of at least 10 (RPA ratio of less than

0.10). Several metals parameters have RPA ratios approaching 1.0, but the acute and chronic water quality standards are still met assuming worst case conditions and maximum effluent concentrations in accordance with IMD and RPA procedures.

Table 7-2. RPA Results – Aquatic Life

Parameter	Aquatic life water quality standard		Constituent concentration at mixing zone		Limit required	RPA ratio	
	Acute	Chronic	Acute	Chronic		Acute	Chronic
Arsenic, µg/L	360	190	0.4	0.2	No	0.00	0.00
Cadmium[a], µg/L	1.5	0.12	0.03	0.02	No	0.02	0.17
Chromium[a] , µg/L	15.7	10.6	0.6	0.3	No	0.04	0.03
Copper[a] , µg/L	8.1	4.7	7.6	4.2	No	0.94	0.89
Cyanide, µg/L	22.0	5.2	2.1	1.8	No	0.10	0.35
Iron, µg/L	N/A	1,000	33.3	16.0	No	N/A	0.02
Lead[a], µg/L	25.7	0.76	0.6	0.6	No	0.02	0.79
Mercury , µg/L	2.4	0.01	0.02	0.01	No	0.01	0.83
Nickel, µg/L[a]	231	20.8	1.5	0.7	No	0.01	0.03
Selenium, µg/L	260	35.0	1.4	0.7	No	0.01	0.02
Silver, µg/L[a]	0.77	0.09	0.07	0.05	No	0.09	0.56
Zinc, µg/L[a]	57.8	47.2	15.5	10.0	No	0.27	0.21

[a]*Water quality standards are calculated based on mixed hardness at modeled critical dilution factors, where average effluent hardness concentration is 115.1 mg/L $CaCO_3$ (see metals sampling data in Appendix D) and ambient hardness concentration is assumed to be 25 mg/L $CaCO_3$. Ambient hardness data are not available. Selected value is within the range provided by DEQ in Domestic RPA spreadsheet.*

Table 7-3. RPA Results – Human Health							
Parameter	Human health water quality standard, µg/L		Carcinogen status	Constituent concentration at mixing zone, µg/L	Limit required	RPA ratio	
	Water + fish	Fish only				Water + fish	Fish only
Metals and cyanide							
Antimony	5.1	64.0	No	0.1	No	0.02	0.00
Arsenic	2.1	2.1	Yes	0.7	No	0.33	0.33
Copper	1,300	-	No	3.8	No	0.00	-
Cyanide	130	130	No	1.7	No	0.01	0.01
Nickel	140	170	No	0.7	No	0.01	0.00
Selenium	120	420	No	0.5	No	0.00	0.00
Thallium	0.04	0.05	No	0.02	No	0.50	0.40
Zinc	2,100	2,600	No	9.6	No	0.00	0.00
Volatile organic compounds and base-neutral compounds							
Chloroform	260	1,100	No	0.3	No	0.00	0.00
Methylene Chloride	4.3	59.0	Yes	0.03	No	0.01	0.00
Toluene	720	1,500	No	0.04	No	0.00	0.00
Bis (2-ethylhexyl) phthalate	0.20	0.22	Yes	0.19	No	0.95	0.86
Butyl benzyl phthalate	190	190	No	0.5	No	0.00	0.00
di-n-butyl phthalate	400	450	No	0.2	No	0.00	0.00
Diethyl phthalate	3,800	4,400	No	0.1	No	0.00	0.00
Dimethyl phthalate	84,000	111,000	No	0.1	No	0.00	0.00

As identified previously, the present RPA is based on limited ambient water quality data and is consistent with values used by DEQ in the NPDES permit fact sheet (DEQ, 2011). Therefore, the RPA presented herein includes a level of uncertainty with respect to ambient data..

Section 8

Limitations

This document was prepared solely for the City of Medford in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Medford and Brown and Caldwell dated August 20, 2013. This document is governed by the specific scope of work authorized by City of Medford; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Medford and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Section 9

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Appendix A: DEQ Mixing Zone Study Correspondence

Oregon
John A Kitzhaber, M.D., Governor

Department of Environmental Quality
Western Region Salem Office
750 Front Street NE, Suite 120
Salem, OR 97301-1039
(503) 378-8240
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May 28, 2013

Dennis Baker
City of Medford
1100 Kirtland Rd
Central Point, OR 97502-9439

RE: <u>**Mixing Zone Study**</u>
File No. 36335
County: Jackson

Dear Dennis:

DEQ appreciates meeting with you on May 23, 2013, to discuss the City's mixing zone study scheduled for 2013. At the meeting we discussed what DEQ would expect in the mixing zone study as required in your permit and also to address concerns raised by the Haefle study on the Rogue River. Our requirements and recommendations are summarized below.

- A level 2 mixing zone study is required. DEQ has a mixing zone internal management directive (IMD) that can provide direction to your consultant regarding the details of what a level 2 mixing zone study encompasses (http://www.deq.state.or.us/wq/pubs/imds/rmz/RMZIMDpart2.pdf). In summary, a level 2 mixing zone study requires that field data be collected at or near critical flow conditions that would then be used to simulate the discharge using a mixing zone computer model. A field dye study is not needed.

- The study should be conducted in late summer to early fall when stream flows are nearest to low flow 7Q10 conditions.

- Dye should be placed in the effluent to track the plume as it moves downstream. This should be documented with photos. This would be used to determine water column sample locations as discussed below. No dye concentration measurements are necessary.

- Collect nutrient samples upstream and downstream of the outfall. Nutrients should include ammonia, total kjeldahl nitrogen, nitrate/nitrite, total phosphorus and ortho-phosphorus. Data collection should occur at approximately 5 transects with a minimum of 3 samples across each transect. The transect locations should be upstream of the outfall, at the edge of the mixing zone, and then 2-3 more downstream with one of them being where the plume is completely mixed with the stream.

- Place continuous monitors at three locations in the stream to measure dissolved oxygen, pH, conductivity and temperature. These should be placed upstream of the outfall, at the edge of the mixing zone and downstream where the plume is completely mixed. Monitoring should occur for three days if possible.

- You may also want to consider collecting algae biomass samples at the same locations where the nutrient samples are collected.

DEQ recommends you put together a mixing zone study plan and submit it to DEQ for review. We will review the plan and provide any comments to ensure you are meeting the requirements of our mixing zone IMD and conducting additional monitoring to better understand the causes of the water quality concerns raised in the Haefle report. We also want to ensure the plan does not include extraneous monitoring with little to no value – we want this study to make the best use of your resources. I will forward standard operating procedures for the continuous monitors and algae sampling once I receive those from our lab.

Please let me know if you have additional questions or concerns.

Sincerely,

Steve Schnurbusch
Acting Manager - Water Quality
Western Region

DEQ-DC1

Appendix B: Mixing Zone Study Checklist

Appendix A: Mixing Zone Study Checklist

Oregon DEQ Mixing Zone Study Checklist
(to be submitted to DEQ with Report on Mixing Zone Study) (v. 2.0, May 2012)

Legal Name: **Common Name:** **Facility ID#:** **Application #:**	**Date Submitted:** **Conducted by:**

Study Level (*to be filled out by DEQ*): ☐ **Level 1 - Simple** ☐ **Level 2 - Moderate** ☐ **Level 3 – Complex** **(See Part 2 of RMZ, Section 3.1, p.8)**	**Information:** **X** = required **E** = estimate is acceptable **M** = measurement (field or engineering plans) **D** = desirable	**Check if Complete** (or note deficiencies) *To be filled out by DEQ.*

1	2	3	1. **Environmental Mapping** (RMZ IMD Part 2, Section 4.1, p. 19)	
X	X	X	A. Attach plan view map showing outfall and a segment of river that extends at least 1/2 mile upstream and downstream of outfall. Map should indicate the following features downstream of outfall unless otherwise noted. By checking whether the specific feature is present or not, the permittee is certifying they have researched the information resources listed in Section 4.1 (Environmental Mapping) of the RMZ IMD.	

Feature	Present	Not present
Known commercial or recreational shellfish areas		✓
Fish spawning/rearing habitat	✓	
Cold water refugia for fish		✓
Areas identified as having species (fish or non-fish) that may be sensitive to impact of discharge*		✓
Physical structures expected to attract fish (e.g., piers, large woody debris, outfalls)	✓	
Public access areas such as boat ramps, docks or public beaches	✓	
Drinking water intakes within the vicinity of the outfall and ½ mile downstream (to be identified by DEQ. Link to internal webpage is http://deq05/wqoutfalls/EOPbasics.aspx	To be determined by DEQ	
Other NPDES discharges upstream and downstream within ½ mile of outfall (to be identified by DEQ. Link to internal webpage is http://deq05/wqoutfalls/EOPbasics.aspx)	To be determined by DEQ	

*If such species are found to be present, report should include a description of such species.
Page number(s) SEE FIGURE 2-2 , SECTION 2-3

1	2	3		
X	X	X	B. Are there threatened and endangered species in the RMZ? ☑ Yes ☐ No If yes, report should include a description of threatened and endangered species present, habitat, and migration pathways as well as source(s) of information. Page number(s) SECTION 2-3	

Oregon DEQ Mixing Zone Study Checklist
(to be submitted to DEQ with Report on Mixing Zone Study) (v. 2.0, May 2012)

		D	C. Other information as appropriate.	

Type of Information (check all that apply)	Page Number(s)
☐ Detailed salmonid use	
☐ Bioassessment.	
☐ Fish migration study	
☐ Thermal imagery	
☐ Map or measurements of channel width/depth	
☐ Published information supporting environmental mapping	
☐ Other. Describe:	

			2. Outfall Location and Mixing Description (RMZ IMD Part 2, Section 4.2, p.24)	
E	M	M	A. Outfall Measurements:	

Measurement	Page Number(s)
Distance from bank (ft): 20-32 ft @ low flow	Sections 2-1 & 6.3, APP C
Height above bottom (ft): 2 ft	Section 6.3 and APP C

E	M	M	B. If present, diffuser and port dimensions, orientation angle and configuration (include drawings, if available) ☐ N/A ☑ Description on page number(s) SECTION 6.3 ☑ Drawing on page number(s): APP C	
X	M	M	C. Outfall Location: Latitude: -122.9046 Longitude: 42.4379 *This information may be available on the following internal webpage:* http://deq05/wqoutfalls/EOPbasics.aspx	
E	E	E	D. River mile of outfall: 130.5 *This information may be available on the following internal webpage:* http://deq05/wqoutfalls/EOPbasics.aspx	
D	D	D	E. Photographs of the outfall vicinity ☐ N/A ☑ See attached on page number(s): APPENDIX F	
X	X	X	F. Description and plan view of current RMZ and ZID as described in permit: ☑ See attached on page number(s): SECTION 2.2 & FIGURE 2-1	

			Part 3. Ambient Receiving Water Conditions (RMZ IMD Part 2, Section 4.3, p.26)	
E	E	E	A. Parameter: Dates of Critical Period: *(Note: may vary with parameter. See Section 4.3, p.26)* ☑ See attached on page number(s) SECTION 3 Justification for Critical Period: ☑ See attached on page number(s) SECTION 3. For Riverine Systems: Flow statistics and dilutions corresponding to critical period:	

Flow Statistic	Stream Flow (cfs)	Velocity (ft/sec)*	Dilution at edge of ZID	Dilution at edge of RMZ	Page Number(s)
1Q10	848 cfs	SEE BELOW	4.9	–	SEE SECTION 6.4
7Q10	882 cfs		–	10.2	
30Q5	998 cfs		–	10.9	
Harmonic Mean	1,898 cfs		–	15.5	

E	E	E	*For systems where velocity can be approximated by a single value. If velocity profile is needed, go to next section B. Describe source (USGS, other) and extent of flow data on which critical flow statistics are based. ☐ N/A ☑ See attached on page number(s) SECTION 3.1 For Marine/Estuarine Systems: Refer to Table 4-2 on p. 30 for appropriate statistics and describe in an attachment. ☑ N/A ☐ See attached on page number(s) ______	
E	E/M	E/M	B. Velocity profile* for each critical flow condition ☐ N/A ☑ See attached on page number(s) FIGURE 5-2 *for systems that where velocity cannot be approximated by a single value. VELOCITY PROFILE RECORDED FOR FIELD CONDITIONS, BUT NOT EXTRAPOLATED TO CRITICAL CONDITIONS.	
E	E/M	M	C. Cross sectional area (width and depth) for each critical flow. ☑ See attached on page number(s) TABLE 5-1 CROSS-SECTION RECORDED FOR FIELD CONDITIONS, BUT NOT EXTRAPOLATED TO CRITICAL CONDITIONS	
E	E/M	M	D. Temperature and salinity profiles ☑ N/A (no stratification) ☐ See attached on page number(s) ______	
E	E	E	E. Manning's roughness coefficient: Page number 0.035 SECTION 6.3	

			Part 4. Discharge Characteristics (RMZ IMD Part 2, Section 4.4, Table 4-3, p. 31)		
E	X	X	C. Discharge flow rates for critical flow scenarios:		
				☑ Domestic	☐ Industrial
			Aquatic Life: Acute	☑ For plants operating at <85% DWDF[1] during the critical period: Use maximum daily average flow for the past 3 years during the period when the critical receiving water flow is most likely to occur. ☐ For plants operating at 85-100% of DWDF: Use DWDF x PF[2]	☐ Use maximum daily average flow for the past 3 years during the period when the critical receiving water flow is most likely to occur. ☐ If flows are expected to increase over the life of the permit, estimate highest daily maximum flow.
				Applicable Effluent Flow : 26.0 MGD	Page No.: SECTION 3.2
			Aquatic Life: Chronic	☑ For plants operating at 85-100% of DWDF during the critical period: Use DWDF. ☐ For plants operating at <85% DWDF: Use highest monthly average flow for the past 3 years during the critical period or during the period when the critical condition is likely to occur.	☐ Use highest monthly average flow for the past 3 years during the period when the critical receiving water flow is most likely to occur. ☐ If flow is expected to increase, estimate highest monthly average maximum flow.
				Applicable Effluent Flow : 18.2 MGD	Page No.: SECTION 3.2
			Human Health	☑ Carcinogens: Use the annual average design flow as specified in the engineering report or permit application, or use the annual average flow based on DMR analysis. ☑ Non-carcinogens: ☐ For plants operating at 85-100% of design capacity: Use the dry weather design flow. ☑ For plants operating at <85% of design flow: Use highest monthly average flow for the past 3 years during the period when the critical receiving water flow is most likely to occur.	☐ Carcinogens: Use the annual average flow based on the permit application or DMR analysis. ☐ Non-carcinogens: Use highest monthly average flow for the past 3 years during the period when the critical receiving water flow is most likely to occur. If flows are expected to increase over the life of the permit, estimate highest average monthly flow.
				Applicable Effluent Flow : 18.2 MGD	Page No.: SECTION 3.2

Notes:
[1]DWDF - Dry Weather Design Flow
[2]PF – Peaking Factor

	E/M	M	D. Discharge chemistry data:				
			Check if N/A	**Parameter**	**Value**	**Page Number(s)**	
			✓	Temperature (F)	SEE TABLE 3-1		
				Conductivity (µmhos)			
				Salinity (ppt)			

			Part 5. Mixing Zone Modeling* (RMZ IMD Part 2, Section 4.5, p. 32)	
	D	M	A. Field mixing measurements (e.g., dye studies) ☐ N/A ☑ See attached on page number(s) SECTION 5	
X	X	X	B. Model selection and application discussion ☐ N/A ☑ See attached on page number(s) SECTION 6.1	
X	X	X	C. Description of mixing and plume dynamics (near-field and far-field) ☐ N/A ☑ See attached on page number(s) SECTION 6.2	
X	X	X	D. Sensitivity analysis ☐ N/A ☑ See attached on page number(s) SECTION 6.3	
X	X	X	E. Model results table (see Table 4-4 on page 34 of Section 4.5 of Part 2 of the RMZ IMD for an example) ☐ N/A ☑ See attached on page number(s) TABLE 6.2	

*Note: In some cases (e.g., shallow streams with non-uniform flow and tidally-influence waterbodies), modeling is not appropriate. See RMZ IMD Part 2, Section 2.2, p. 6.

DEQ Reviewer Comments

Name of DEQ Reviewer:

Date:

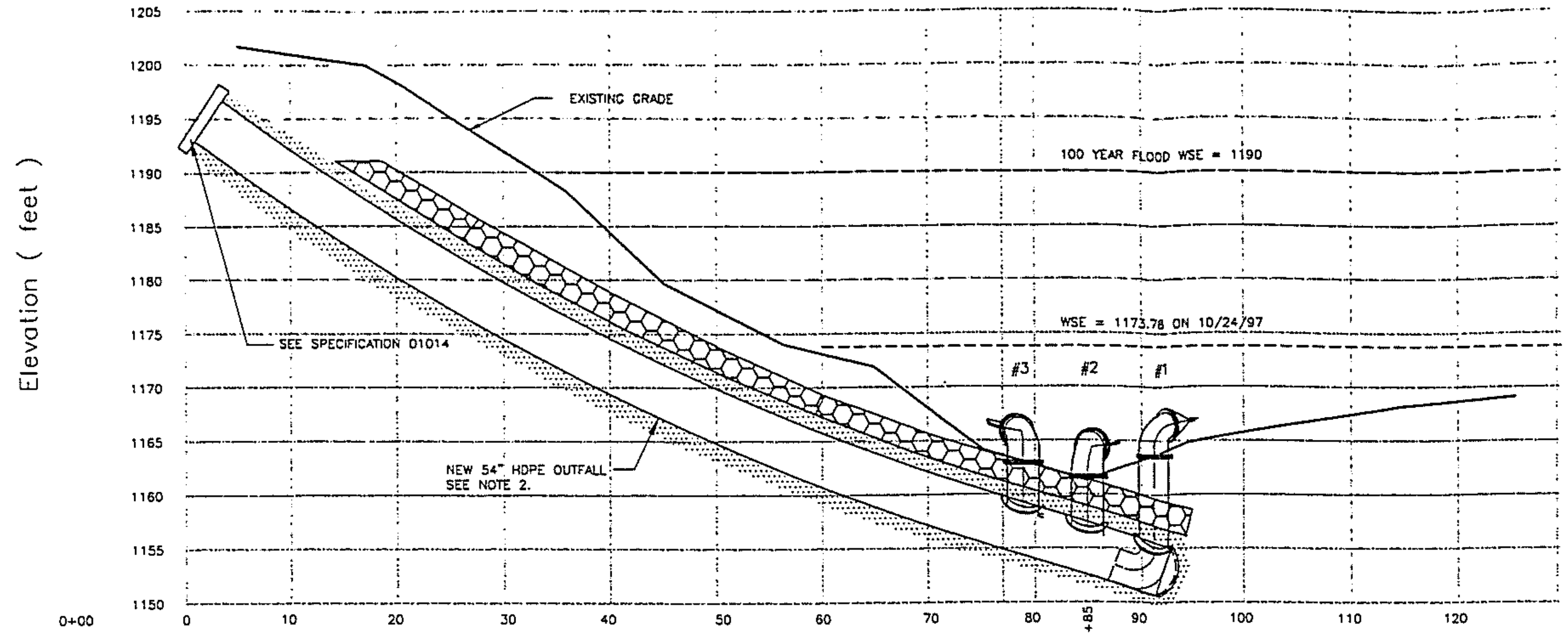
4. Describe deficiencies, if any.

5. Which if any need to be addressed before the permit can be issued?

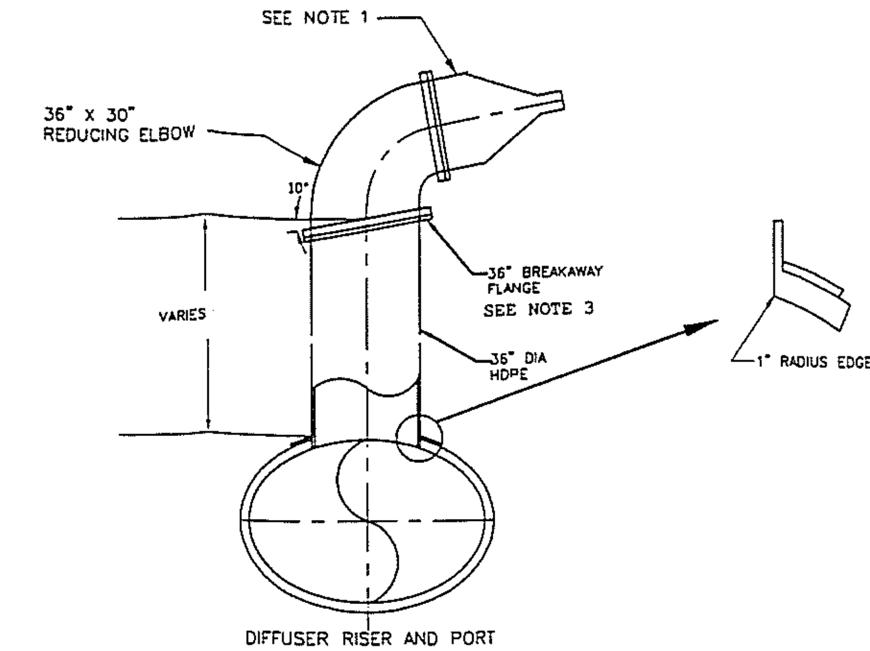
6. Which if any may be addressed through permit conditions?

The checklist and reviewer comments should be attached to the permit evaluation report.

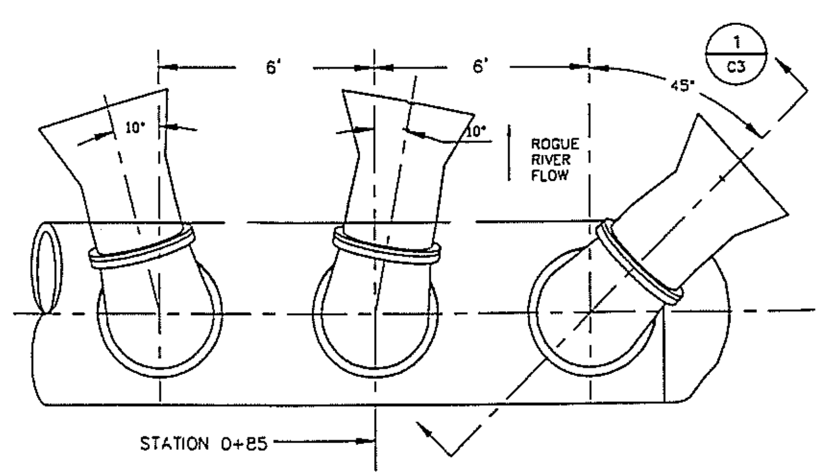
Appendix C: Outfall Drawing



Profile (A/C3)
SCALE: 1/8" = 1'-0"

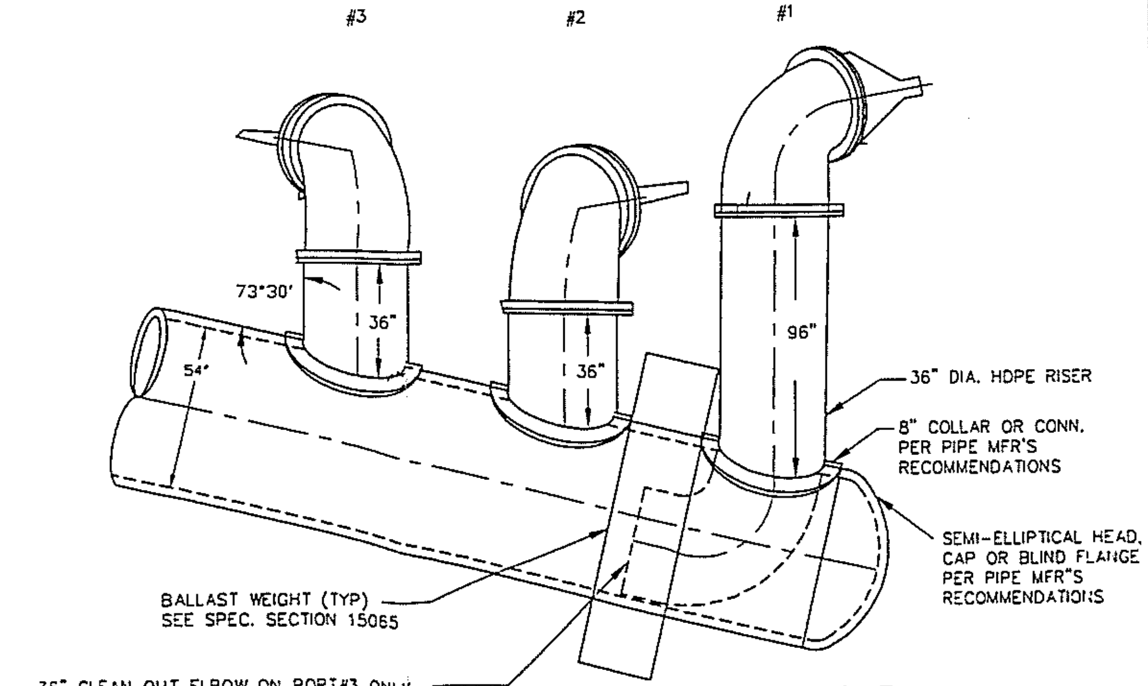


Section (1/C3)
SCALE: 3/8" =1'



Detail (A/C3)
SCALE: 3/8" =1'

NOTES:
1. CHECK VALVES SHALL BE TIDEFLEX VALVES AS MANUFACTURED BY RED VALVE OR EQUAL.
2. MINIMUM CURVE RADIUS FOR OUTFALL PIPE IS 250 FEET.
3. PROVIDE OVERSIZED FLANGE AS NECESSARY FOR BOLT INSTALLATION



Detail (B/C3)
SCALE: 3/8" =1'

WEST YOST & ASSOCIATES
Consulting Engineers
132 East Broadway, Suite 431
Eugene, Oregon 97401
(541) 431-1280
FAX (541) 431-1290

BROWN AND CALDWELL
EUGENE, OREGON

SUBMITTED: ______ PROJECT MANAGER DATE: ______
APPROVED: ______ BROWN AND CALDWELL DATE: ______
APPROVED ______ DATE: ______

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"-SCALE ACCORDINGLY)
FILE 500-97-03
DRAWN DL
DESIGNED MWJ
CHECKED WJM
CHECKED ______

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

REVISIONS

CITY OF MEDFORD OREGON

CITY OF MEDFORD
REGIONAL WATER
RECLAMATION FACILITY

OUTFALL DIFFUSER

OUTFALL DIFFUSER–
PROFILE, SECTION AND DETAILS

SCALE AS NOTED
DRAWING NUMBER C3
SHEET NUMBER 3 OF 3
REVISION

500A-03 4-15-.. DL

Appendix D: RWRF Effluent Data

RWRF Effluent Summary Stats
Data collected October 2010 through October 2013
Critical Period: June - October

Critical Period Max Day Flow	26.0 mgd
Critical Period Max Month Flow	18.2 mgd
Annual Average Flow	18.2 mgd
Critical Period 90th Percentile Max Temp	74.4 deg F
Critical Period Average Temp	70.9 deg F
Average Annual Temp	65.6 deg F

Ammonia Stats - All Data

Count	338
Average	11.6 mg/L
St Dev	3.55 mg/L
CV	0.31
Max	25.7 mg/L
90th Percentile	16.1 mg/L

Total Effluent Metals Concentration

Non-detect: Concentration listed as Method Detection Limit (MDL)

Data removed from statistical analysis due to anomolously high concentrations

Date	Silver ug/L	Arsenic ug/L	Cadmium ug/L	Chromium ug/L	Copper ug/L	Mercury ug/L	Nickel ug/L	Lead ug/L	Zinc ug/L	Cyanide ug/L	Molybdenum ug/L	Selenium ug/L	Antimony ug/L	Beryllium ug/L	Iron ug/L	Thallium ug/L	Total Hardness mg/L	Total Phenolics ug/L
Feb 2011	0.499	1.220	0.147	2.160	49.10	0.007	3.21	1.697	125.67	2.53	3.61	1.77						
May 2011	0.136	1.653	0.112	1.223	23.00	0.033	3.54	0.484	45.37	2.40	1.86	2.29						
Aug 2011	0.112	1.423	0.065	1.867	20.03	0.030	3.93	0.646	34.27	2.50	2.58	1.61						
Nov 2011	0.120	1.140	0.082	1.797	22.67	0.062	3.11	0.471	36.97	3.07	3.48	1.24						
Feb 2012	0.065	1.173	0.107	0.916	12.97	0.027	2.27	0.372	35.43	2.40							126.0	49.0
Feb 2012 (PP)												1.4	0.423	0.015	4.7	0.0384		
May 2012	0.159	1.343	0.092	1.233	25.53	0.021	3.09	0.580	46.83	2.40							118.3	33.5
Aug 2012	0.077	1.044	0.092	1.037	15.00	0.014	2.52	0.493	26.97	2.40							101.0	33.5
Aug 2012 (PP)												2.58	0.293	0.0126	41.8	0.0747		
Nov 2012	0.141	0.990	0.109	1.490	21.77	0.017	3.97	0.657	37.37	1.50							106.0	47.6
Feb 2013	0.097	1.487	0.077	1.053	23.97	0.030	1.95	0.386	39.73	1.66							129.0	33.5
Feb 2013 (PP)												0.911	0.266	0.0126	3.32	0.0747		
May 2013	0.101	0.845	0.052	0.437	21.03	0.027	5.04	0.472	35.60	1.29							110.3	70.9
Count	9	9	9	9	9	9	9	9	9	9	3	6	3	3	3	3	6	6
Min	0.065	0.845	0.052	0.437	12.97	0.014	1.95	0.372	26.97	1.29	1.86	0.91	0.27	0.01	3.32	0.04	101.0	33.5
Average	0.112	1.233	0.088	1.228	20.66	0.029	3.27	0.626	37.61	2.18	2.64	1.69	0.33	0.01	16.61	0.06	115.1	44.7
Max	0.159	1.653	0.112	1.867	25.53	0.062	5.04	0.657	46.83	3.07	3.48	2.58	0.42	0.02	41.80	0.07	129.0	70.9
Std. Dev	0.03	0.26	0.02	0.45	4.14	0.01	0.97	0.10	5.95	0.57	0.81	0.59	0.08	0.00	21.83	0.02	11.21	14.76
CV*	0.27	0.21	0.23	0.36	0.20	0.48	0.30	0.16	0.16	0.26	0.31	0.35	0.26	0.10	1.31	0.33	0.10	0.33

* The Coefficient of Variation (CV) shows the extent of variability in relation to the average value for a data set. CV is calculated at the ratio of the standard deviation to the average

Effluent Priority Pollutant Scan Data with Detection Limit Above MDL
All other parameters Non-Detect for all samples

Date	Bis(2-ethylhexyl) phthalate ug/L	Di-n-butyl phthalate ug/L	Chloroform ug/L	Toluene ug/L	Methylene Choride ug/L	Butyl benzyl phthalate	Diethyl phthalate	Dimethyl phthalate
May 2009	2.7	1.0	1.0					
May 2010			0.3	0.2				
Jun 2010	2.2							
May 2011	1.2		0.2		0.2			
Feb 2012	1.2	1.2						
Aug 2012	0.9		0.52					
Feb 2013	1.2	0.8	0.5			2.6	0.7	0.6
max	2.7	1.2	1.0	0.2	0.2	2.6	0.7	0.6
geo mean	1.4	1.0	0.4	0.2	0.2	2.6	0.7	0.6

Appendix E: Dive Inspection Report

FDS Marine International, LLC
PO Box 2146
Fairview, OR 97024
503-250-1633

September 26, 2013

Timothy Mills
Brown and Caldwell
Portland, OR

Re: Medford Outfall Inspection Report and DVD

Dear Timothy Mills,

This is the report on the underwater video inspection that we performed for the City of Medford, RWRF Mixing Zone Study project on 09/13/13 and 09/19/13.

Upon arrival we observed a very low water level. Using a pin point camera we were able to identify (3) approximately class 400 or larger rocks and one log obstructing the outfall. The decision was made to remove the debris in order to verify the nozzle flows and condition of rubber duck bills and outfall pipe. Per discussion with you and Tom Suttle, our plan was to provide a DVD video of the debris removal operation and then a final inspection from a wider view.

Upon our arrival on 09/19/13, the river was so low that we could not access the job site from the down river launch and had to streamline our work platform and gear. We went up river and removed the boat motor and then drifted down-stream back to the job site. The removal of the debris went well. The total video recording time is just over four hours. Due to the wide angle lens, it is unfortunately not a very high quality video. We edited this video and made a DVD with the best views of the actual debris removal and a final inspection of the outfall. The DVD is coming to you by mail.

We appreciate the opportunity to work for you. If you have any questions or need clarification upon viewing the DVD, please contact me at 503-250-1633. If you have any questions about the invoices please contact Charles Parks at fdsmarinedives@aol.com.

Sincerely,

Fred Stambaugh
FDS Marine International, LLC, fdsmarinedives@aol.com

Appendix F: Aerial Photos

Brown AND Caldwell

PHOTO #

0' 1,000' 3,000'

N

PHOTO 1

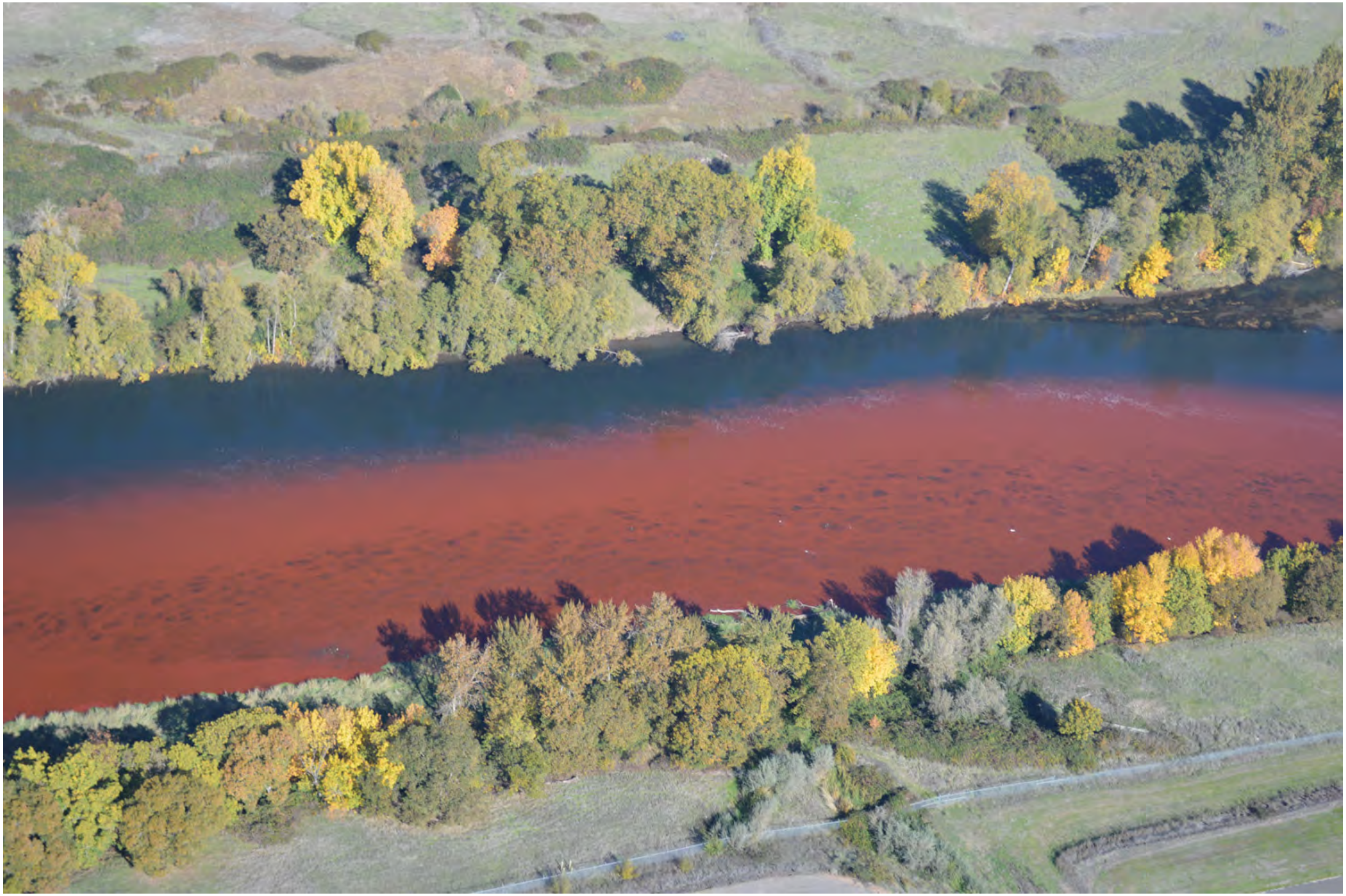


PHOTO 2

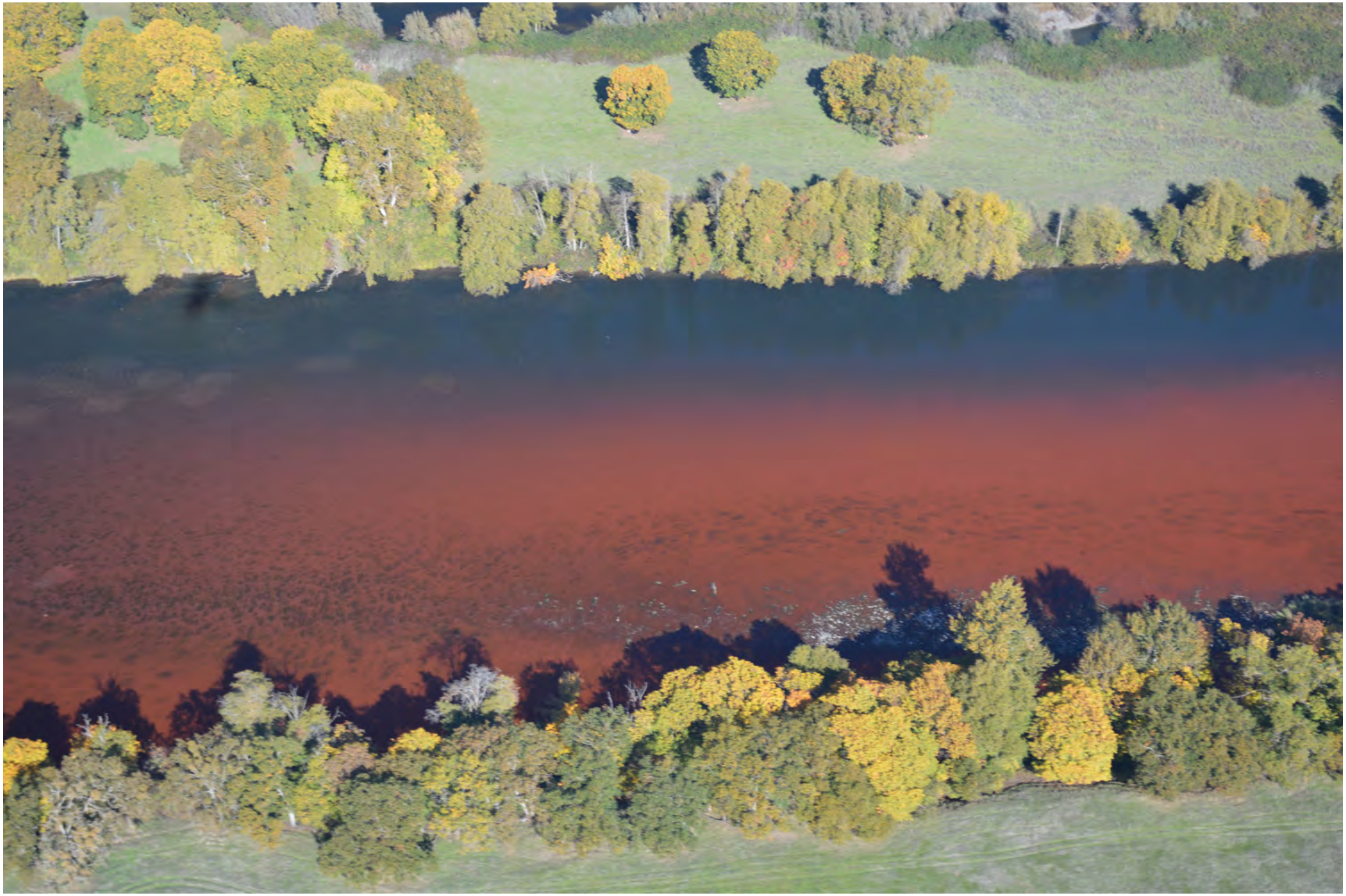


PHOTO 3

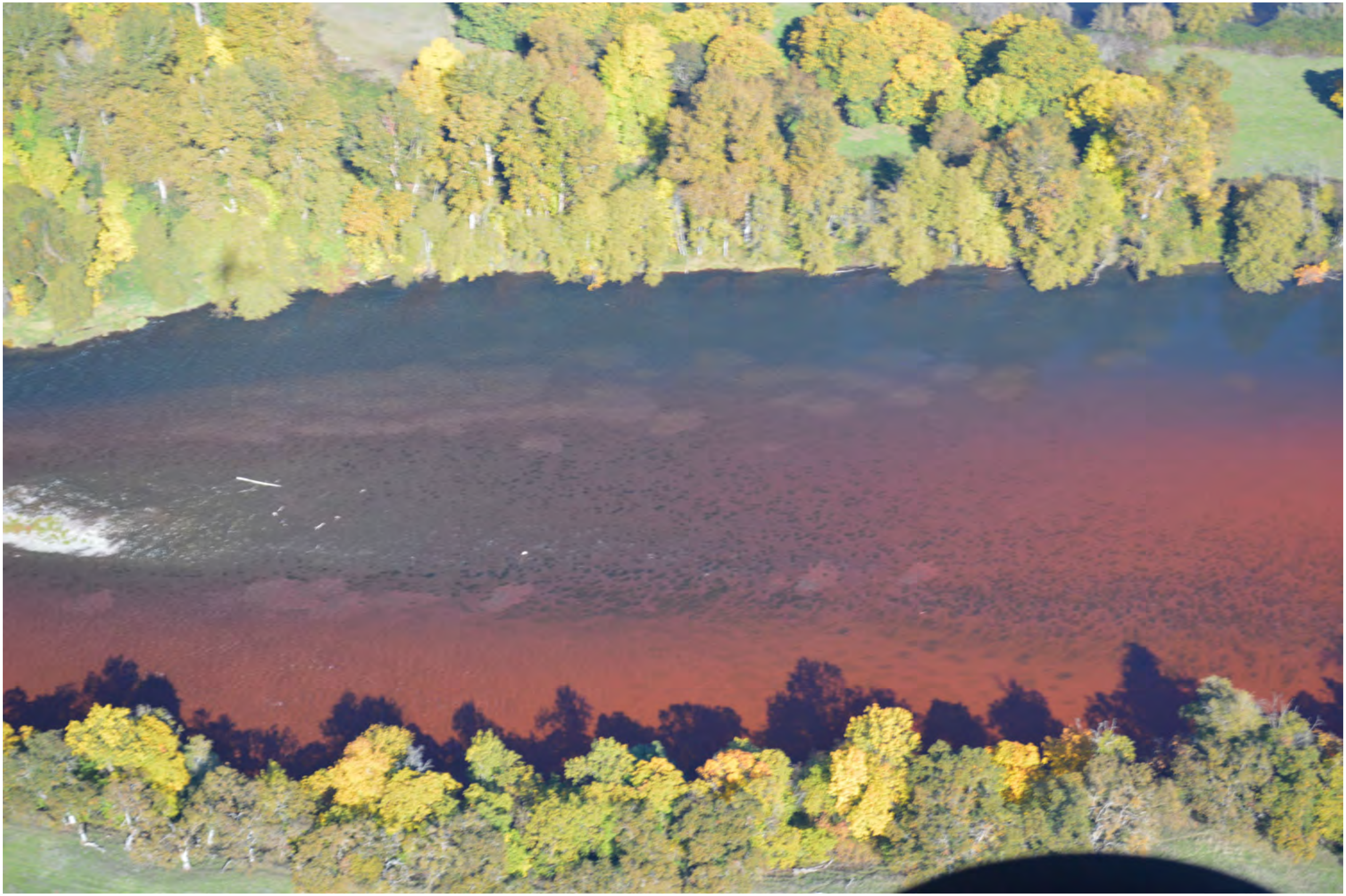


PHOTO 4

PHOTO 5

PHOTO 6

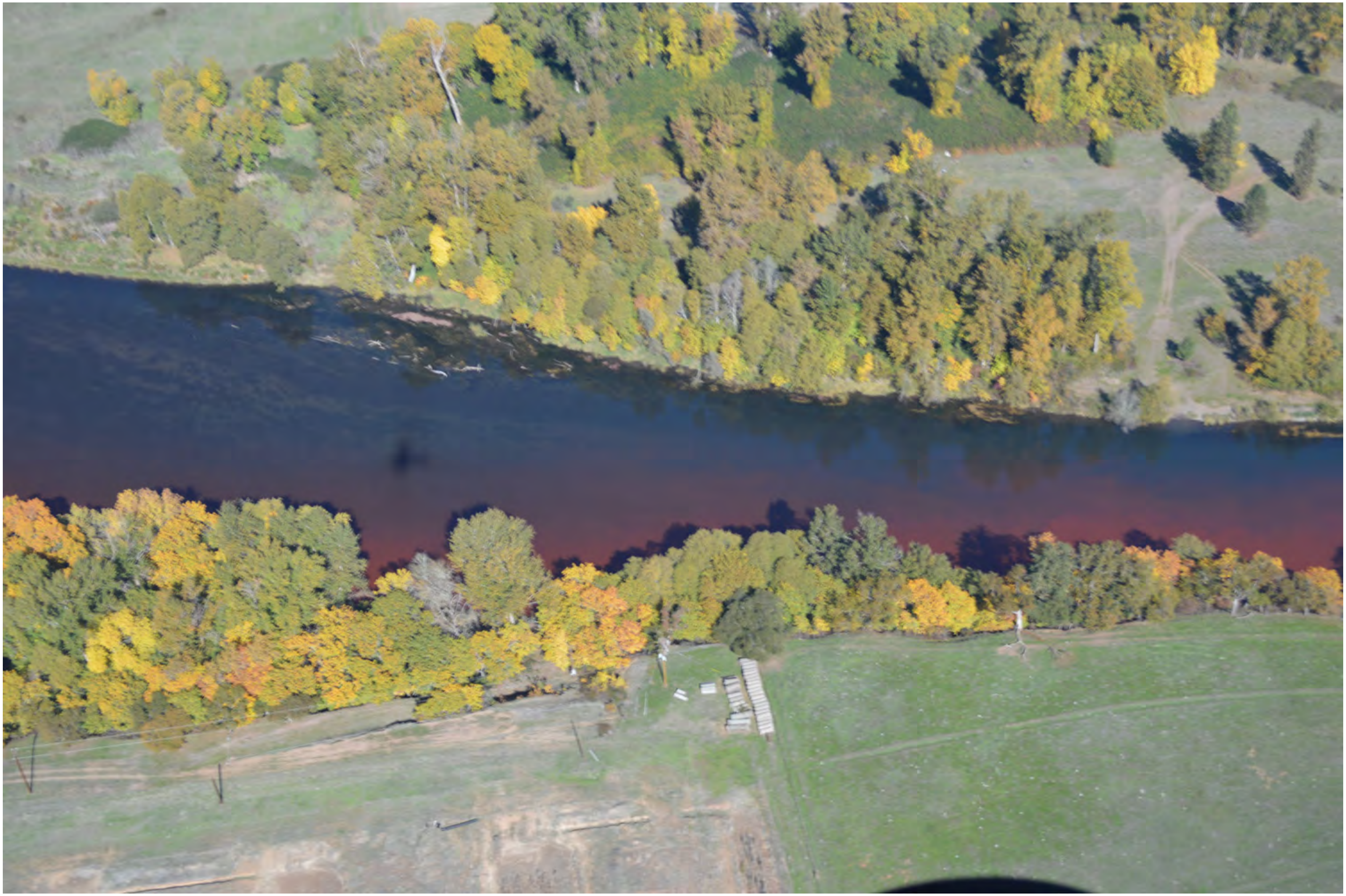


PHOTO 7

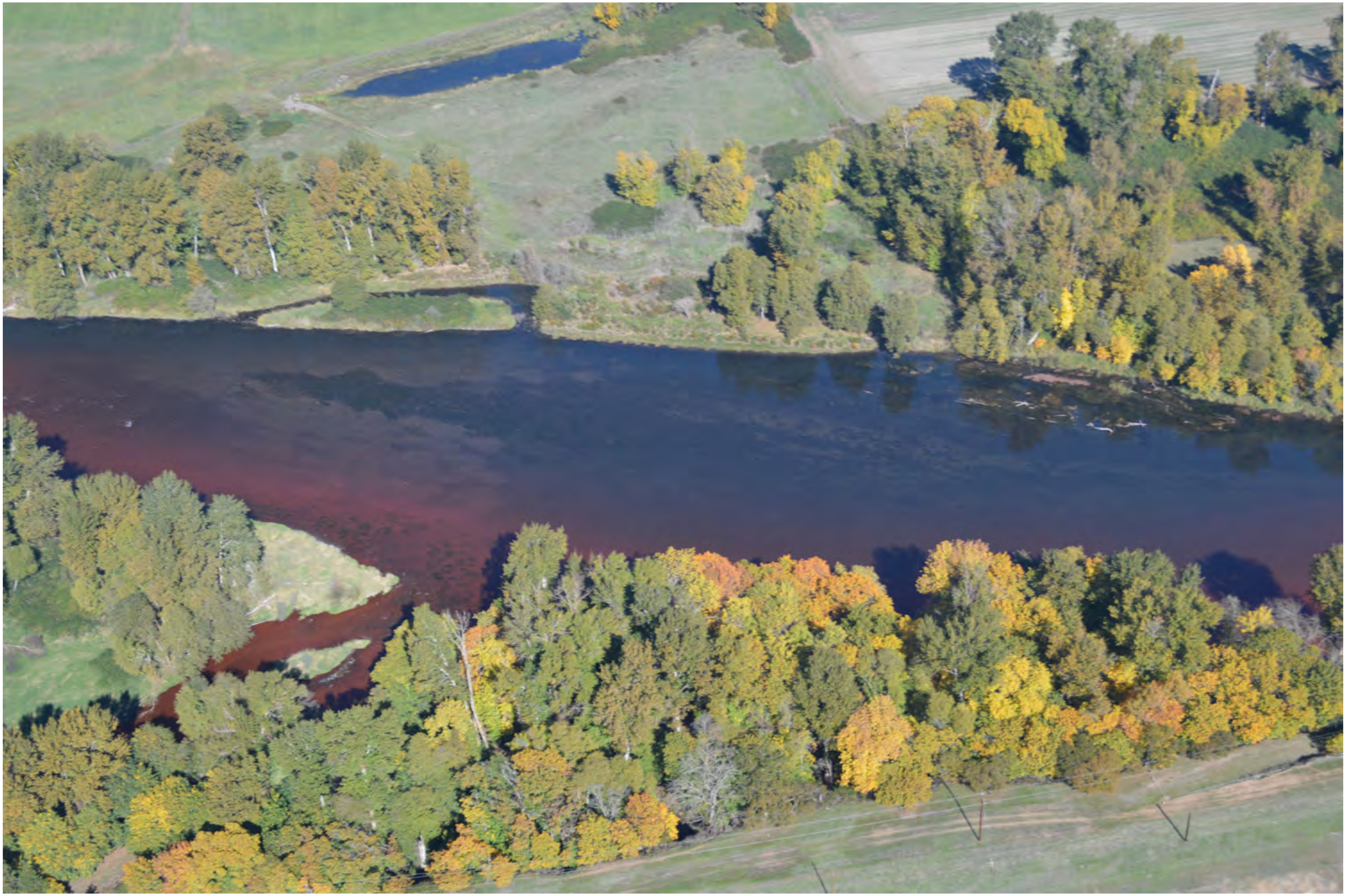


PHOTO 8

PHOTO 9

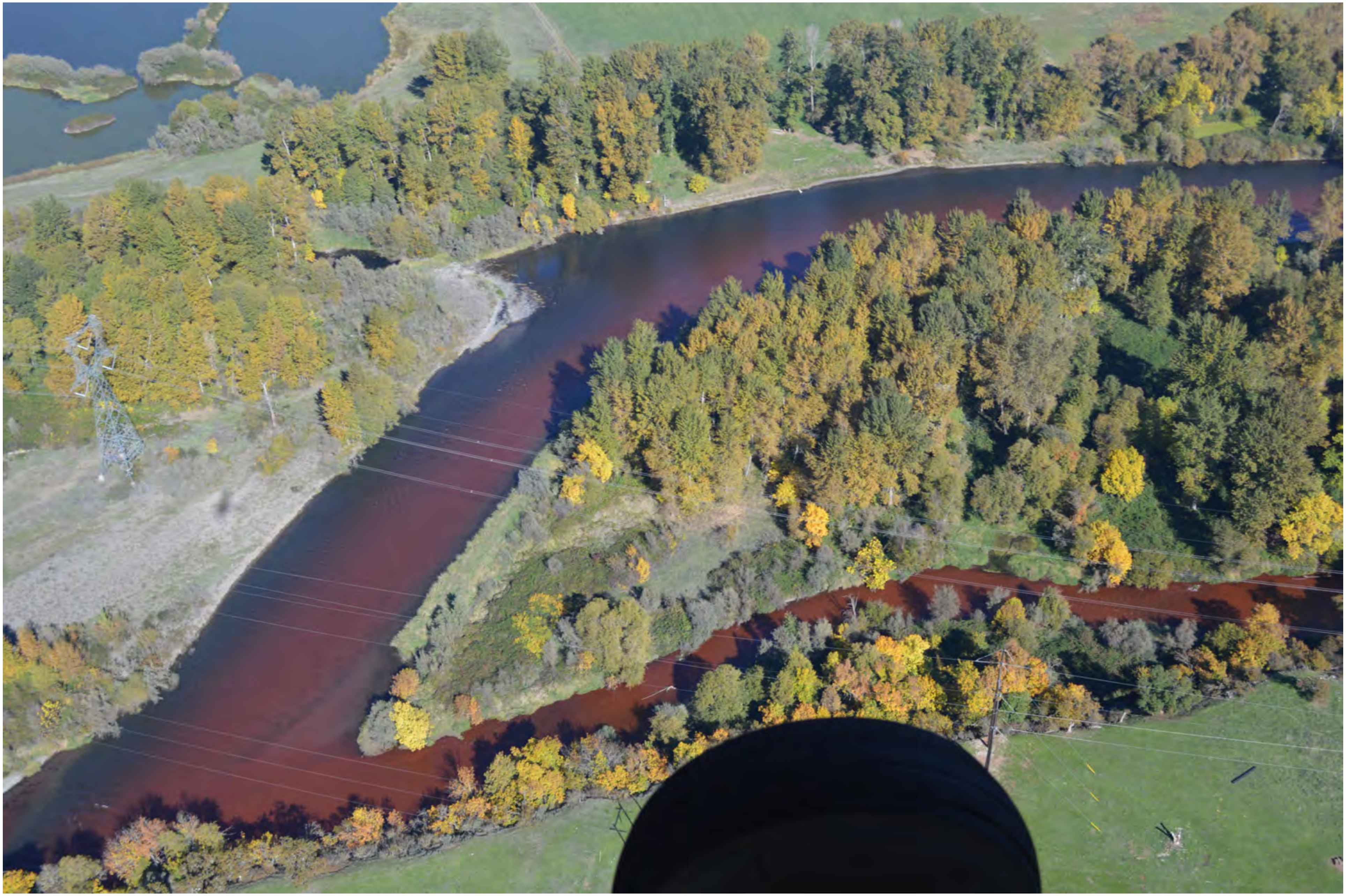


PHOTO 10

PHOTO 11

PHOTO 12

PHOTO 13

Appendix G: Effluent Flow and Temperature During Dye Injection

RWRF Effluent Data		
October 16, 2013		
Time	**Flow MGD**	**Temp ^{0}F**
8:00	10.0	68.1
8:15	10.7	68.1
8:30	11.4	68.1
8:45	13.3	68.1
9:00	13.5	68.1
9:15	14.2	68.1
9:30	15.2	68.1
9:45	16.8	68.1
10:00	22.3	68.1
10:15	20.3	68.1
10:30	18.6	68.1
10:45	18.0	68.2
11:00	17.9	68.2
11:15	18.9	68.2
11:30	18.5	68.2
11:45	18.7	68.2
12:00	18.8	68.2
12:15	15.8	68.3
12:30	17.9	68.4
12:45	18.7	68.5
13:00	18.6	68.6
13:15	18.6	68.7
13:30	18.2	68.8
13:45	18.1	68.8
14:00	18.8	68.9
14:15	18.0	68.9
14:30	17.9	69.0
14:45	17.6	69.0
15:00	17.1	69.0
15:15	16.6	69.1
15:30	17.3	69.1
15:45	18.2	69.1
16:00	17.3	69.1

Note: The Q spike at 10:00 was from shutting off the Trickling Filter pump. The dip at 12:15 was from turning it back on. Maintenance was servicing the Trickling Filter

Appendix H: Continuous Monitoring Probe Data

========		========		=====	======	=====	======	=====	=======	=====	======	=====	======	=====	=======	=====	======	=====
Date m/d/y		Time hh:mm:ss		Temp C	SpCond uS/cm	DOsat %	DO mg/L	pH	Turbid+ NTU	Temp C	SpCond uS/cm	DOsat %	DO mg/L	pH	Turbid+ NTU	Temp C	SpCond mS/cm	DOsat %
--------		--------		-----	------	-----	------	-----	-------	-----	------	-----	------	-----	-------	-----	------	-----
Date		Time	Date/Time	Riffle 2	Riffle 2	Riffle 2	Riffle 2	Riffle 2	Riffle 2	Riffle 3	Riffle 3	Riffle 3	Riffle 3	Riffle 3	Riffle 3	Riffle 4	Riffle 4	Riffle 4
date		time	date/time	TempRiffle 2	SpCondRiffle	DOsatRiffle	DORiffle	pHRiffle 2	Turbid+Riff	TempRiffle	SpCondRiff	DOsatRiffle	DORiffle	pHRiffle 3	Turbid+Riff	TempRiffle	SpCondRiff	DOsatRiffle
	10/14/2013	16:16:00	10/14/13 16:16	9.36	76	124.5	14.26	8.23	2.9	9.55	85	108.2	12.34	8.56	1.4	9.52	0.074	123.2
	10/14/2013	16:31:00	10/14/13 16:31	9.43	76	123.7	14.15	8.3	1.6	9.6	85	107.9	12.29	8.58	1.4	9.57	0.074	122.6
	10/14/2013	16:46:00	10/14/13 16:46	9.48	76	123	14.06	8.34	2.2	9.64	85	107.4	12.22	8.58	1.4	9.61	0.074	122
	10/14/2013	17:01:00	10/14/13 17:01	9.53	76	122.5	13.98	8.37	1.6	9.65	85	107	12.17	8.59	1.4	9.62	0.074	121.3
	10/14/2013	17:16:00	10/14/13 17:16	9.55	76	122	13.91	8.39	1.4	9.65	85	106.3	12.1	8.59	1.4	9.62	0.074	120.4
	10/14/2013	17:31:00	10/14/13 17:31	9.57	76	121.3	13.84	8.41	1.5	9.64	85	105.6	12.01	8.59	1.5	9.62	0.074	119.2
	10/14/2013	17:46:00	10/14/13 17:46	9.56	76	120.6	13.75	8.4	1.4	9.62	85	104.8	11.93	8.57	1.3	9.61	0.074	118
	10/14/2013	18:01:00	10/14/13 18:01	9.55	76	119.6	13.65	8.39	1.4	9.58	85	103.7	11.82	8.55	1.8	9.6	0.074	116.9
	10/14/2013	18:16:00	10/14/13 18:16	9.52	76	118.4	13.52	8.37	1.4	9.54	85	102.6	11.71	8.52	1.3	9.57	0.074	115.6
	10/14/2013	18:31:00	10/14/13 18:31	9.48	76	117.1	13.38	8.34	1.5	9.49	85	101.4	11.58	8.48	1.2	9.54	0.074	114.3
	10/14/2013	18:46:00	10/14/13 18:46	9.44	76	116	13.27	8.31	1.4	9.45	85	100	11.44	8.44	1.3	9.51	0.074	113
	10/14/2013	19:01:00	10/14/13 19:01	9.4	76	115	13.16	8.28	1.4	9.4	85	98.9	11.32	8.38	1.2	9.47	0.074	111.7
	10/14/2013	19:16:00	10/14/13 19:16	9.36	76	114	13.07	8.24	1.4	9.36	85	97.8	11.21	8.33	1.3	9.43	0.074	110.5
	10/14/2013	19:31:00	10/14/13 19:31	9.31	76	113.2	12.98	8.21	1.4	9.32	85	96.9	11.12	8.29	1.2	9.39	0.074	109.4
	10/14/2013	19:46:00	10/14/13 19:46	9.27	76	112.4	12.91	8.17	1.5	9.29	85	96.1	11.03	8.24	1.7	9.36	0.074	108.2
	10/14/2013	20:01:00	10/14/13 20:01	9.22	76	111.7	12.84	8.13	1.4	9.24	85	95.4	10.96	8.2	1.2	9.31	0.074	107.3
	10/14/2013	20:16:00	10/14/13 20:16	9.18	76	111.1	12.79	8.1	1.4	9.2	85	94.8	10.9	8.14	1.2	9.27	0.074	106.3
	10/14/2013	20:31:00	10/14/13 20:31	9.13	76	110.5	12.73	8.07	1.4	9.15	85	94.2	10.85	8.1	1.2	9.22	0.074	105.6
	10/14/2013	20:46:00	10/14/13 20:46	9.1	76	110.2	12.71	8.04	1.6	9.11	85	93.7	10.81	8.06	1.2	9.18	0.074	104.8
	10/14/2013	21:01:00	10/14/13 21:01	9.06	76	109.7	12.66	8.01	1.5	9.06	85	93.2	10.76	8.03	1.2	9.13	0.074	104.2
	10/14/2013	21:16:00	10/14/13 21:16	9.03	76	109.3	12.63	7.99	1.4	9.03	85	92.8	10.72	8	1.2	9.08	0.074	103.6
	10/14/2013	21:31:00	10/14/13 21:31	8.99	76	109	12.6	7.96	1.4	8.99	85	92.5	10.69	7.97	1.3	9.04	0.074	103.1
	10/14/2013	21:46:00	10/14/13 21:46	8.95	76	108.7	12.58	7.94	1.6	8.96	85	92.2	10.67	7.95	1.3	9	0.074	102.6
	10/14/2013	22:01:00	10/14/13 22:01	8.92	76	108.4	12.56	7.91	1.4	8.92	85	91.9	10.64	7.92	1.2	8.97	0.074	102.2
	10/14/2013	22:16:00	10/14/13 22:16	8.89	76	108.2	12.54	7.88	1.4	8.89	85	91.8	10.64	7.89	1.3	8.93	0.074	101.9
	10/14/2013	22:31:00	10/14/13 22:31	8.85	76	108	12.53	7.85	1.4	8.86	85	91.5	10.61	7.87	1.3	8.89	0.074	101.6
	10/14/2013	22:46:00	10/14/13 22:46	8.82	76	107.9	12.53	7.83	1.5	8.83	85	91.4	10.6	7.84	1.4	8.86	0.074	101.3
	10/14/2013	23:01:00	10/14/13 23:01	8.79	76	107.6	12.5	7.81	1.4	8.79	85	91.3	10.6	7.81	1.4	8.82	0.074	101.1
	10/14/2013	23:16:00	10/14/13 23:16	8.75	76	107.5	12.5	7.78	1.5	8.76	85	91.2	10.6	7.79	1.7	8.79	0.074	100.8
	10/14/2013	23:31:00	10/14/13 23:31	8.72	76	107.3	12.49	7.76	1.4	8.72	85	91.1	10.6	7.77	1.2	8.75	0.074	100.6
	10/14/2013	23:46:00	10/14/13 23:46	8.68	76	107.3	12.5	7.74	1.5	8.69	85	91	10.6	7.74	1.2	8.72	0.074	100.4
	10/15/2013	0:01:00	10/15/13 0:01	8.63	76	107.2	12.5	7.72	1.6	8.65	85	91	10.61	7.73	1.4	8.67	0.074	100.3
	10/15/2013	0:16:00	10/15/13 0:16	8.59	76	107.1	12.5	7.7	1.4	8.62	85	90.8	10.59	7.71	1.2	8.64	0.074	100.1
	10/15/2013	0:31:00	10/15/13 0:31	8.54	76	106.9	12.5	7.68	1.4	8.58	85	90.8	10.61	7.69	1.2	8.6	0.074	100
	10/15/2013	0:46:00	10/15/13 0:46	8.48	76	106.9	12.52	7.66	1.4	8.53	85	90.9	10.63	7.67	1.3	8.57	0.074	99.9
	10/15/2013	1:01:00	10/15/13 1:01	8.42	76	107	12.55	7.65	1.5	8.49	85	91	10.65	7.65	1.2	8.53	0.074	99.8
	10/15/2013	1:16:00	10/15/13 1:16	8.36	76	106.9	12.54	7.63	1.4	8.43	85	90.9	10.65	7.63	1.3	8.48	0.074	99.7
	10/15/2013	1:31:00	10/15/13 1:31	8.3	76	106.8	12.56	7.62	1.4	8.37	85	90.8	10.65	7.62	1.2	8.44	0.074	99.6
	10/15/2013	1:46:00	10/15/13 1:46	8.24	77	106.8	12.57	7.6	1.5	8.32	85	90.8	10.67	7.61	1.4	8.38	0.074	99.5
	10/15/2013	2:01:00	10/15/13 2:01	8.18	77	106.8	12.59	7.59	1.5	8.26	85	90.7	10.67	7.59	1.2	8.33	0.074	99.5
	10/15/2013	2:16:00	10/15/13 2:16	8.11	77	106.8	12.61	7.58	1.4	8.2	85	90.8	10.7	7.57	1.5	8.27	0.074	99.4
	10/15/2013	2:31:00	10/15/13 2:31	8.04	77	107	12.66	7.56	1.6	8.14	85	90.8	10.72	7.57	1.2	8.22	0.074	99.3
	10/15/2013	2:46:00	10/15/13 2:46	7.97	77	106.8	12.66	7.56	1.5	8.07	85	90.9	10.74	7.55	1.2	8.16	0.074	99.3
	10/15/2013	3:01:00	10/15/13 3:01	7.9	77	106.8	12.68	7.55	1.4	8	85	90.8	10.75	7.54	1.3	8.1	0.074	99.2
	10/15/2013	3:16:00	10/15/13 3:16	7.83	77	106.8	12.7	7.54	1.4	7.94	86	91	10.79	7.53	1.2	8.03	0.074	99.3
	10/15/2013	3:31:00	10/15/13 3:31	7.76	77	106.9	12.73	7.53	1.5	7.87	86	91.1	10.82	7.52	1.3	7.97	0.074	99.2
	10/15/2013	3:46:00	10/15/13 3:46	7.68	77	107	12.77	7.53	1.4	7.81	86	91	10.83	7.51	1.3	7.9	0.074	99.2

10/15/2013	4:01:00	10/15/13 4:01	7.61	77	107	12.8	7.52	1.4	7.73	86	91.2	10.87	7.5	1.3	7.83	0.074	99.1
10/15/2013	4:16:00	10/15/13 4:16	7.53	77	107.1	12.82	7.51	1.4	7.66	86	91.2	10.89	7.49	1.3	7.77	0.074	99.3
10/15/2013	4:31:00	10/15/13 4:31	7.45	77	107.1	12.86	7.51	1.4	7.59	86	91.2	10.9	7.49	1.4	7.69	0.074	99.3
10/15/2013	4:46:00	10/15/13 4:46	7.37	77	107.1	12.89	7.5	1.4	7.52	86	91.2	10.92	7.49	1.2	7.63	0.074	99.3
10/15/2013	5:01:00	10/15/13 5:01	7.29	77	107.2	12.92	7.5	1.4	7.44	86	91.3	10.96	7.48	1.2	7.56	0.074	99.3
10/15/2013	5:16:00	10/15/13 5:16	7.21	77	107.3	12.95	7.5	1.5	7.36	86	91.3	10.98	7.47	1.3	7.48	0.074	99.4
10/15/2013	5:31:00	10/15/13 5:31	7.12	77	107.3	12.99	7.5	1.6	7.27	86	91.4	11.02	7.47	1.2	7.41	0.074	99.4
10/15/2013	5:46:00	10/15/13 5:46	7.04	77	107.4	13.02	7.49	1.4	7.19	86	91.4	11.03	7.46	1.2	7.33	0.074	99.5
10/15/2013	6:01:00	10/15/13 6:01	6.97	77	107.5	13.06	7.49	1.4	7.11	86	91.4	11.06	7.46	1.2	7.25	0.075	99.5
10/15/2013	6:16:00	10/15/13 6:16	6.89	77	107.6	13.09	7.49	1.4	7.03	86	91.4	11.08	7.47	1.2	7.17	0.075	99.6
10/15/2013	6:31:00	10/15/13 6:31	6.81	77	107.6	13.13	7.48	1.4	6.95	86	91.5	11.12	7.46	1.2	7.1	0.075	99.7
10/15/2013	6:46:00	10/15/13 6:46	6.73	77	107.7	13.16	7.48	1.5	6.87	86	91.5	11.14	7.46	1.3	7.02	0.075	99.8
10/15/2013	7:01:00	10/15/13 7:01	6.66	77	107.7	13.18	7.48	1.4	6.79	86	91.6	11.17	7.45	1.3	6.94	0.075	99.8
10/15/2013	7:16:00	10/15/13 7:16	6.59	77	107.7	13.2	7.48	1.8	6.72	86	91.6	11.19	7.45	1.2	6.88	0.075	99.8
10/15/2013	7:31:00	10/15/13 7:31	6.53	77	107.9	13.25	7.48	1.4	6.65	86	91.6	11.22	7.46	1.2	6.8	0.075	100.1
10/15/2013	7:46:00	10/15/13 7:46	6.47	77	108.1	13.29	7.48	1.5	6.58	86	91.8	11.26	7.45	1.2	6.73	0.075	100.3
10/15/2013	8:01:00	10/15/13 8:01	6.43	77	108.5	13.36	7.49	1.4	6.52	86	92	11.31	7.46	1.2	6.66	0.075	100.7
10/15/2013	8:16:00	10/15/13 8:16	6.38	77	109	13.43	7.5	1.5	6.47	86	92.3	11.36	7.47	1.3	6.6	0.074	101.2
10/15/2013	8:31:00	10/15/13 8:31	6.33	77	109.5	13.52	7.51	1.4	6.43	86	92.9	11.43	7.48	1.2	6.55	0.074	102
10/15/2013	8:46:00	10/15/13 8:46	6.28	77	110.3	13.63	7.52	1.4	6.41	86	93.5	11.52	7.5	1.2	6.52	0.074	102.9
10/15/2013	9:01:00	10/15/13 9:01	6.24	77	110.5	13.67	7.53	1.4	6.41	86	94.2	11.61	7.53	1.3	6.5	0.074	103.9
10/15/2013	9:16:00	10/15/13 9:16	6.22	77	111.3	13.77	7.55	5.3	6.41	86	95	11.7	7.55	1.1	6.51	0.074	105
10/15/2013	9:31:00	10/15/13 9:31	6.22	77	112	13.86	7.57	1.4	6.42	86	95.6	11.77	7.57	1.2	6.53	0.074	106.3
10/15/2013	9:46:00	10/15/13 9:46	6.24	77	112.9	13.97	7.59	1.3	6.45	85	96.4	11.86	7.61	1.3	6.56	0.074	107.4
10/15/2013	10:01:00	10/15/13 10:01	6.26	77	113.6	14.05	7.62	1.4	6.51	85	97	11.91	7.64	1.2	6.61	0.074	108.5
10/15/2013	10:16:00	10/15/13 10:16	6.3	77	114.3	14.12	7.65	1.3	6.58	85	97.7	11.99	7.69	1.2	6.66	0.074	109.7
10/15/2013	10:31:00	10/15/13 10:31	6.35	77	115.1	14.21	7.68	1.4	6.66	85	98.4	12.05	7.72	1.2	6.74	0.074	110.7
10/15/2013	10:46:00	10/15/13 10:46	6.41	76	115.9	14.27	7.71	1.3	6.76	85	99	12.09	7.75	1	6.82	0.074	111.8
10/15/2013	11:01:00	10/15/13 11:01	6.49	76	116.8	14.35	7.74	1.3	6.85	85	99.6	12.14	7.79	1.2	6.93	0.074	112.7
10/15/2013	11:16:00	10/15/13 11:16	6.57	76	117.4	14.41	7.77	1.2	6.97	85	100.2	12.18	7.83	1.1	7.03	0.074	113.7
10/15/2013	11:31:00	10/15/13 11:31	6.67	76	118.2	14.46	7.81	1.4	7.09	85	100.8	12.2	7.87	1	7.14	0.074	114.6
10/15/2013	11:46:00	10/15/13 11:46	6.79	76	119	14.52	7.85	1.4	7.21	85	101.5	12.26	7.9	1.2	7.26	0.074	115.4
10/15/2013	12:01:00	10/15/13 12:01	6.91	76	119.9	14.59	7.89	1.2	7.33	85	102	12.28	7.95	1.1	7.36	0.073	116.4
10/15/2013	12:16:00	10/15/13 12:16	7.06	76	120.6	14.62	7.94	1.4	7.47	85	102.6	12.3	7.99	1.1	7.49	0.073	117.1
10/15/2013	12:31:00	10/15/13 12:31	7.21	76	121.2	14.63	7.98	1.4	7.62	85	103.2	12.34	8.04	1.2	7.64	0.074	117.8
10/15/2013	12:46:00	10/15/13 12:46	7.37	76	121.9	14.67	8.03	1.4	7.77	85	103.5	12.33	8.07	1.2	7.77	0.073	118.5
10/15/2013	13:01:00	10/15/13 13:01	7.53	76	122.6	14.68	8.08	1.3	7.93	85	104	12.34	8.11	1	7.91	0.074	119.1
10/15/2013	13:16:00	10/15/13 13:16	7.7	76	123	14.67	8.12	1.3	8.08	85	104.5	12.35	8.15	1.1	8.07	0.073	119.6
10/15/2013	13:31:00	10/15/13 13:31	7.87	76	123.4	14.66	8.16	1.4	8.24	85	104.9	12.36	8.19	1.1	8.21	0.073	120.1
10/15/2013	13:46:00	10/15/13 13:46	8.03	76	123.8	14.65	8.2	1.3	8.4	85	105.2	12.33	8.23	1.3	8.36	0.073	120.6
10/15/2013	14:01:00	10/15/13 14:01	8.19	76	124.2	14.63	8.24	1.2	8.57	85	105.5	12.32	8.27	1.1	8.51	0.074	121.1
10/15/2013	14:16:00	10/15/13 14:16	8.35	76	124.3	14.6	8.28	1.2	8.71	85	105.9	12.33	8.31	1.2	8.65	0.073	121.4
10/15/2013	14:31:00	10/15/13 14:31	8.5	76	124.5	14.56	8.31	3.3	8.85	85	106.2	12.31	8.36	1.2	8.79	0.073	121.7
10/15/2013	14:46:00	10/15/13 14:46	8.65	76	125.6	14.64	8.34	1.3	8.99	85	106.3	12.29	8.39	1	8.93	0.073	122
10/15/2013	15:01:00	10/15/13 15:01	8.78	76	125.1	14.53	8.38	1.3	9.11	85	106.5	12.27	8.41	2.6	9.04	0.074	121.6
10/15/2013	15:16:00	10/15/13 15:16	8.91	76	125.2	14.5	8.41	3.3	9.22	85	106.5	12.25	8.43	2	9.14	0.073	121.8
10/15/2013	15:31:00	10/15/13 15:31	9.02	76	125.3	14.47	8.44	1.2	9.32	85	106.6	12.23	8.45	1.5	9.26	0.074	121.9
10/15/2013	15:46:00	10/15/13 15:46	9.13	76	125.2	14.43	8.46	1.2	9.41	85	106.5	12.19	8.49	1.2	9.36	0.073	121.8
10/15/2013	16:01:00	10/15/13 16:01	9.23	76	125.4	14.42	8.48	1.2	9.48	85	106.6	12.18	8.5	2	9.42	0.074	121.7
10/15/2013	16:16:00	10/15/13 16:16	9.31	76	125.3	14.37	8.49	1.2	9.55	85	106.3	12.13	8.52	1.4	9.51	0.074	121.5
10/15/2013	16:31:00	10/15/13 16:31	9.38	76	124.7	14.28	8.5	2	9.59	85	106.3	12.11	8.54	1.4	9.56	0.074	121.2
10/15/2013	16:46:00	10/15/13 16:46	9.43	76	124.8	14.28	8.52	1.3	9.62	85	106	12.08	8.55	1.3	9.59	0.074	120.7
10/15/2013	17:01:00	10/15/13 17:01	9.47	76	124.2	14.2	8.52	1.2	9.63	85	105.6	12.03	8.57	1.2	9.6	0.074	120

10/15/2013	17:16:00	10/15/13 17:16	9.49	76	123.6	14.11	8.51	1.2	9.63	85	105.1	11.97	8.57	1.2	9.6	0.074	119.2
10/15/2013	17:31:00	10/15/13 17:31	9.5	76	123.4	14.1	8.52	1.2	9.61	85	104.4	11.89	8.57	1.2	9.59	0.074	118.1
10/15/2013	17:46:00	10/15/13 17:46	9.49	76	122.2	13.96	8.5	1.4	9.58	85	103.6	11.81	8.56	1.1	9.58	0.074	116.9
10/15/2013	18:01:00	10/15/13 18:01	9.47	77	121.2	13.85	8.48	1.4	9.54	85	102.7	11.72	8.54	1	9.55	0.074	115.8
10/15/2013	18:16:00	10/15/13 18:16	9.43	77	119.9	13.71	8.45	1.3	9.48	86	101.5	11.6	8.51	1.2	9.53	0.074	114.6
10/15/2013	18:31:00	10/15/13 18:31	9.39	77	118.6	13.58	8.41	1.2	9.43	86	100.3	11.48	8.48	1.1	9.49	0.074	113.3
10/15/2013	18:46:00	10/15/13 18:46	9.35	77	117.5	13.46	8.38	1.3	9.38	86	99	11.34	8.43	1.1	9.45	0.074	112
10/15/2013	19:01:00	10/15/13 19:01	9.3	77	116.4	13.35	8.33	1.7	9.34	86	97.8	11.21	8.39	1.1	9.41	0.074	110.7
10/15/2013	19:16:00	10/15/13 19:16	9.25	77	115.5	13.26	8.29	1.3	9.29	86	96.9	11.13	8.33	1.4	9.37	0.074	109.5
10/15/2013	19:31:00	10/15/13 19:31	9.2	77	114.6	13.19	8.25	1.3	9.25	86	96	11.03	8.3	1.1	9.32	0.074	108.4
10/15/2013	19:46:00	10/15/13 19:46	9.15	77	113.8	13.11	8.21	1.3	9.2	86	95.2	10.95	8.26	1.4	9.27	0.074	107.3
10/15/2013	20:01:00	10/15/13 20:01	9.1	77	113.1	13.04	8.17	1.4	9.15	86	94.5	10.89	8.21	1.2	9.23	0.074	106.4
10/15/2013	20:16:00	10/15/13 20:16	9.05	77	112.5	12.99	8.14	1.3	9.1	86	94	10.84	8.16	1.1	9.19	0.074	105.5
10/15/2013	20:31:00	10/15/13 20:31	9.01	77	112	12.94	8.11	1.4	9.05	86	93.4	10.78	8.12	1.2	9.13	0.074	104.7
10/15/2013	20:46:00	10/15/13 20:46	8.97	77	111.5	12.9	8.09	1.3	9	86	93	10.75	8.08	1.2	9.08	0.074	104.1
10/15/2013	21:01:00	10/15/13 21:01	8.94	77	111.1	12.86	8.06	1.2	8.96	86	92.6	10.72	8.05	1.2	9.03	0.074	103.5
10/15/2013	21:16:00	10/15/13 21:16	8.91	77	111	12.85	8.04	1.3	8.92	86	92.3	10.68	8.02	1.7	9	0.074	103
10/15/2013	21:31:00	10/15/13 21:31	8.88	77	110.6	12.82	8.01	1.3	8.88	86	91.9	10.65	7.99	1.2	8.93	0.074	102.5
10/15/2013	21:46:00	10/15/13 21:46	8.85	77	110.1	12.78	7.98	1.4	8.85	85	91.7	10.63	7.97	1.2	8.89	0.074	102.1
10/15/2013	22:01:00	10/15/13 22:01	8.82	77	109.8	12.75	7.95	1.3	8.82	86	91.4	10.61	7.93	1.2	8.85	0.074	101.7
10/15/2013	22:16:00	10/15/13 22:16	8.79	77	109.6	12.73	7.92	1.4	8.78	86	91.1	10.59	7.91	1.4	8.81	0.074	101.4
10/15/2013	22:31:00	10/15/13 22:31	8.76	77	109.4	12.71	7.9	1.4	8.75	85	90.8	10.56	7.89	1.2	8.78	0.074	101.1
10/15/2013	22:46:00	10/15/13 22:46	8.73	77	109.1	12.69	7.87	1.3	8.73	85	90.6	10.54	7.88	1.2	8.75	0.074	100.8
10/15/2013	23:01:00	10/15/13 23:01	8.7	77	108.9	12.68	7.85	1.4	8.69	85	90.5	10.53	7.84	1.3	8.71	0.074	100.6
10/15/2013	23:16:00	10/15/13 23:16	8.67	77	108.8	12.67	7.83	1.3	8.67	85	90.1	10.5	7.83	1.2	8.68	0.074	100.4
10/15/2013	23:31:00	10/15/13 23:31	8.64	77	109.1	12.72	7.81	1.4	8.64	85	90.1	10.5	7.8	1.2	8.65	0.074	100.1
10/15/2013	23:46:00	10/15/13 23:46	8.61	77	108.5	12.66	7.78	1.3	8.61	85	89.9	10.49	7.78	1.3	8.62	0.074	100
10/16/2013	0:01:00	10/16/13 0:01	8.57	77	108.4	12.65	7.76	1.5	8.58	85	89.8	10.48	7.76	1.4	8.59	0.074	99.8
10/16/2013	0:16:00	10/16/13 0:16	8.53	77	108.3	12.66	7.74	1.4	8.55	86	89.7	10.48	7.75	1.2	8.55	0.074	99.7
10/16/2013	0:31:00	10/16/13 0:31	8.48	77	108.1	12.66	7.72	1.4	8.51	86	89.6	10.48	7.72	1.2	8.52	0.074	99.5
10/16/2013	0:46:00	10/16/13 0:46	8.44	77	108	12.66	7.7	1.4	8.47	86	89.4	10.46	7.71	1.2	8.49	0.074	99.4
10/16/2013	1:01:00	10/16/13 1:01	8.39	77	108.2	12.7	7.68	1.4	8.43	86	89.4	10.48	7.69	1.1	8.45	0.074	99.3
10/16/2013	1:16:00	10/16/13 1:16	8.34	77	108	12.68	7.67	1.4	8.39	86	89.3	10.47	7.67	1.2	8.41	0.074	99.2
10/16/2013	1:31:00	10/16/13 1:31	8.29	77	107.8	12.68	7.65	1.4	8.35	86	89.4	10.5	7.65	1.3	8.39	0.074	99.1
10/16/2013	1:46:00	10/16/13 1:46	8.24	77	107.8	12.69	7.63	1.4	8.3	86	89.2	10.49	7.64	1.4	8.34	0.074	99.1
10/16/2013	2:01:00	10/16/13 2:01	8.18	77	107.8	12.7	7.62	1.4	8.25	86	89.2	10.5	7.63	1.2	8.29	0.074	99
10/16/2013	2:16:00	10/16/13 2:16	8.12	77	107.7	12.71	7.6	1.4	8.2	86	89.3	10.52	7.61	1.3	8.25	0.074	98.9
10/16/2013	2:31:00	10/16/13 2:31	8.05	77	107.7	12.74	7.59	1.3	8.14	86	89.3	10.54	7.59	1.4	8.21	0.074	98.9
10/16/2013	2:46:00	10/16/13 2:46	7.98	78	107.8	12.78	7.58	1.4	8.08	86	89.2	10.54	7.58	1.2	8.15	0.074	98.9
10/16/2013	3:01:00	10/16/13 3:01	7.9	78	107.7	12.78	7.57	1.4	8.02	86	89.1	10.54	7.58	1.2	8.11	0.074	98.9
10/16/2013	3:16:00	10/16/13 3:16	7.83	78	107.7	12.81	7.56	1.3	7.96	86	89.1	10.56	7.57	1.2	8.04	0.074	98.9
10/16/2013	3:31:00	10/16/13 3:31	7.75	78	108	12.86	7.55	1.4	7.88	86	89.1	10.58	7.55	1.2	7.98	0.074	98.9
10/16/2013	3:46:00	10/16/13 3:46	7.67	78	107.7	12.86	7.54	1.4	7.81	86	89.1	10.6	7.54	1.8	7.91	0.074	98.8
10/16/2013	4:01:00	10/16/13 4:01	7.59	78	107.8	12.9	7.54	1.3	7.73	87	89.1	10.62	7.52	1.2	7.84	0.074	98.8
10/16/2013	4:16:00	10/16/13 4:16	7.51	78	107.9	12.93	7.53	1.4	7.66	87	89.2	10.64	7.53	1.3	7.77	0.074	98.8
10/16/2013	4:31:00	10/16/13 4:31	7.43	78	107.9	12.96	7.52	1.4	7.58	87	89.2	10.67	7.51	1.2	7.7	0.075	98.9
10/16/2013	4:46:00	10/16/13 4:46	7.35	78	107.9	12.99	7.52	1.4	7.5	87	89.2	10.7	7.5	1.2	7.63	0.075	98.9
10/16/2013	5:01:00	10/16/13 5:01	7.27	78	108.4	13.07	7.51	1.4	7.42	87	89.3	10.73	7.5	1.2	7.56	0.075	98.9
10/16/2013	5:16:00	10/16/13 5:16	7.18	78	108	13.05	7.51	1.2	7.34	87	89.4	10.76	7.49	1.2	7.49	0.075	99
10/16/2013	5:31:00	10/16/13 5:31	7.1	78	108.1	13.09	7.5	1.4	7.26	87	89.4	10.78	7.49	1.1	7.41	0.075	99.1
10/16/2013	5:46:00	10/16/13 5:46	7.02	78	108.2	13.12	7.51	1.3	7.18	87	89.5	10.81	7.49	1.2	7.33	0.075	99.1
10/16/2013	6:01:00	10/16/13 6:01	6.94	78	108.3	13.16	7.5	1.2	7.1	87	89.5	10.84	7.48	1.2	7.25	0.075	99.2
10/16/2013	6:16:00	10/16/13 6:16	6.86	78	108.9	13.26	7.5	1.4	7.02	87	89.5	10.86	7.48	1.1	7.18	0.075	99.2

10/16/2013	6:31:00	10/16/13 6:31	6.79	78	108.5	13.23	7.49	1.4	6.94	87	89.6	10.89	7.48	1.1	7.09	0.075	99.4
10/16/2013	6:46:00	10/16/13 6:46	6.72	78	108.5	13.26	7.49	1.4	6.86	87	89.6	10.92	7.47	1.2	7.01	0.075	99.5
10/16/2013	7:01:00	10/16/13 7:01	6.65	78	108.5	13.29	7.49	1.3	6.77	87	89.7	10.95	7.46	1.5	6.93	0.075	99.5
10/16/2013	7:16:00	10/16/13 7:16	6.58	78	108.7	13.33	7.49	1.4	6.7	87	89.7	10.97	7.46	1.4	6.89	0.075	99.6
10/16/2013	7:31:00	10/16/13 7:31	6.52	78	108.8	13.36	7.49	1.3	6.64	87	89.8	11	7.46	1.3	6.78	0.075	99.7
10/16/2013	7:46:00	10/16/13 7:46	6.46	78	109	13.4	7.49	1.3	6.57	87	90	11.04	7.46	1.2	6.71	0.075	99.9
10/16/2013	8:01:00	10/16/13 8:01	6.41	78	109.3	13.46	7.5	1.2	6.52	87	90.2	11.08	7.47	1	6.65	0.075	100.2
10/16/2013	8:16:00	10/16/13 8:16	6.37	78	109.9	13.55	7.51	1.4	6.47	87	90.4	11.12	7.48	1	6.6	0.075	100.7
10/16/2013	8:31:00	10/16/13 8:31	6.33	77	110.4	13.62	7.52	1.4	6.43	86	90.9	11.19	7.48	1.1	6.55	0.075	101.3
10/16/2013	8:46:00	10/16/13 8:46	6.29	77	111	13.71	7.53	1.2	6.39	86	91.4	11.27	7.49	1.2	6.5	0.075	101.9
10/16/2013	9:01:00	10/16/13 9:01	6.27	77	111.6	13.8	7.55	1.3	6.38	86	92.2	11.36	7.52	1	6.48	0.074	102.7
10/16/2013	9:16:00	10/16/13 9:16	6.26	77	112.5	13.91	7.57	1.2	6.4	86	93.2	11.48	7.53	1.1	6.51	0.074	104.2
10/16/2013	9:31:00	10/16/13 9:31	6.28	77	113.4	14.02	7.6	1.2	6.39	86	93.8	11.56	7.56	1	6.47	0.074	105.3
10/16/2013	9:46:00	10/16/13 9:46	6.27	77	114.2	14.11	7.62	1.2	6.41	86	94.8	11.67	7.58	1.2	6.48	0.074	106.1
10/16/2013	10:01:00	10/16/13 10:01	6.27	77	114.7	14.18	7.65	1.2	6.44	86	95.5	11.76	7.62	1	6.5	0.074	107.2
10/16/2013	10:16:00	10/16/13 10:16	6.29	77	115.4	14.25	7.67	1.3	6.52	86	96.5	11.85	7.65	1.1	6.59	0.074	108.6
10/16/2013	10:31:00	10/16/13 10:31	6.35	77	116.3	14.34	7.7	1.2	6.6	86	97.2	11.92	7.7	1	6.67	0.074	109.9
10/16/2013	10:46:00	10/16/13 10:46	6.42	77	117.1	14.43	7.74	1.5	6.69	86	97.8	11.97	7.73	1.1	6.75	0.074	111.1
10/16/2013	11:01:00	10/16/13 11:01	6.49	77	117.9	14.49	7.77	1.3	6.81	86	98.8	12.05	7.76	1.2	6.85	0.074	112.1
10/16/2013	11:16:00	10/16/13 11:16	6.57	77	118.8	14.57	7.81	1.2	6.92	85	99.4	12.09	7.8	1.7	6.95	0.074	113.3
10/16/2013	11:31:00	10/16/13 11:31	6.66	77	119.4	14.62	7.84	1.2	7.05	85	100.1	12.14	7.84	1.1	7.08	0.074	114.2
10/16/2013	11:46:00	10/16/13 11:46	6.76	77	120	14.65	7.88	1.2	7.16	85	100.6	12.17	7.87	1.1	7.16	0.074	114.9
10/16/2013	12:01:00	10/16/13 12:01	6.87	77	120.3	14.65	7.82	7.5	7.29	85	101.2	12.2	7.89	1.9	7.29	0.074	115.8
10/16/2013	12:16:00	10/16/13 12:16	6.99	77	121.2	14.71	7.95	2.2	7.41	85	101.9	12.25	7.94	1.4	7.41	0.074	116.5
10/16/2013	12:31:00	10/16/13 12:31	7.13	77	121.9	14.75	8.01	1.4	7.54	85	102.3	12.26	7.98	1.1	7.55	0.074	117.1
10/16/2013	12:46:00	10/16/13 12:46	7.27	77	122.7	14.8	8.05	1.4	7.69	85	102.9	12.28	8.02	1.1	7.68	0.074	117.8
10/16/2013	13:01:00	10/16/13 13:01	7.42	77	123.1	14.78	8.09	1.2	7.83	85	103.5	12.31	8.06	1.8	7.81	0.073	118.6
10/16/2013	13:16:00	10/16/13 13:16	7.58	77	123.6	14.79	8.13	1.2	7.98	85	103.9	12.31	8.08	1.7	7.96	0.073	119
10/16/2013	13:31:00	10/16/13 13:31	7.74	77	124.1	14.79	8.17	1.2	8.12	85	104.5	12.34	8.13	1.8	8.09	0.073	119.3
10/16/2013	13:46:00	10/16/13 13:46	7.89	77	124.9	14.82	8.22	4.4	8.27	85	104.9	12.34	8.16	1.4	8.23	0.073	120
10/16/2013	14:01:00	10/16/13 14:01	8.06	77	124.8	14.75	8.26	1.2							8.36	0.074	120.5
10/16/2013	14:16:00	10/16/13 14:16	8.22	77	125.7	14.81	8.3	1.2	9.18	152	105.8	12.17	7.82	1.4			
10/16/2013	14:31:00	10/16/13 14:31	8.37	77	125.5	14.73	8.33	1.2	9.3	153	105.9	12.15	7.83	1.4	8.47	0.087	119
10/16/2013	14:46:00	10/16/13 14:46	8.5	77	125.7	14.7	8.36	1.2	9.42	153	106	12.12	7.84	1.7	8.61	0.088	119.2
10/16/2013	15:01:00	10/16/13 15:01	8.64	77	125.9	14.67	8.39	1.1	9.54	152	105.8	12.07	7.84	1.5	8.74	0.088	119.4
10/16/2013	15:16:00	10/16/13 15:16	8.76	77	126.1	14.66	8.43	1.4	9.65	152	105.6	12.01	7.84	1.5	8.86	0.088	119.2
10/16/2013	15:31:00	10/16/13 15:31	8.87	77	126.1	14.62	8.44	1.1	9.75	152	105.2	11.94	7.84	1.2	8.97	0.088	119.3
10/16/2013	15:46:00	10/16/13 15:46	8.97	77	126	14.58	8.46	1.2	9.83	151	104.8	11.87	7.84	1.2	9.07	0.087	119.4
10/16/2013	16:01:00	10/16/13 16:01	9.05	77	126	14.55	8.49	1.4	9.91	151	104.2	11.78	7.83	1.2	9.15	0.087	119.2
10/16/2013	16:16:00	10/16/13 16:16	9.12	77	126	14.52	8.5	1.4	9.97	150	103.4	11.67	7.81	1.1	9.23	0.087	118.9
10/16/2013	16:31:00	10/16/13 16:31	9.18	77	125.6	14.45	8.51	1.2	10.03	150	102.4	11.55	7.79	1.1	9.31	0.088	118.3
10/16/2013	16:46:00	10/16/13 16:46	9.22	77	125.2	14.4	8.52	1.2	10.07	150	101.3	11.41	7.76	1.2	9.35	0.087	118
10/16/2013	17:01:00	10/16/13 17:01	9.25	77	124.8	14.34	8.52	1.3	10.11	150	100	11.25	7.73	1.1	9.39	0.086	117.6
10/16/2013	17:16:00	10/16/13 17:16	9.26	77	124.4	14.29	8.52	1.2	10.13	150	98.5	11.08	7.69	1.1	9.45	0.088	116.7
10/16/2013	17:31:00	10/16/13 17:31	9.26	77	123.8	14.22	8.51	1.2	10.14	150	97	10.91	7.65	1.1	9.45	0.086	116.2
10/16/2013	17:46:00	10/16/13 17:46	9.25	77	123	14.13	8.5	1.4	10.15	150	95.6	10.75	7.62	1.2	9.49	0.087	115.2
10/16/2013	18:01:00	10/16/13 18:01	9.22	77	122	14.03	8.48	1.3	10.16	150	94.1	10.58	7.58	1.1	9.46	0.087	114.5
10/16/2013	18:16:00	10/16/13 18:16	9.18	77	120.7	13.89	8.45	1.2	10.16	149	92.7	10.42	7.55	1	9.44	0.087	113.3
10/16/2013	18:31:00	10/16/13 18:31	9.13	77	119.4	13.76	8.4	1.2	10.15	149	91.3	10.26	7.52	1.2	9.41	0.087	112.1
10/16/2013	18:46:00	10/16/13 18:46	9.08	77	118.3	13.65	8.37	1.3	10.14	149	89.9	10.11	7.49	1.2	9.4	0.087	111
10/16/2013	19:01:00	10/16/13 19:01	9.03	77	117.2	13.54	8.32	1.2	10.11	148	88.6	9.98	7.47	1.1	9.38	0.088	109.8
10/16/2013	19:16:00	10/16/13 19:16	8.99	77	116.3	13.45	8.29	1.4	10.07	147	87.5	9.85	7.45	1.2	9.29	0.086	108.7
10/16/2013	19:31:00	10/16/13 19:31	8.93	77	115.5	13.37	8.25	1.2	10.02	146	86.5	9.75	7.43	1.2	9.24	0.086	107.8

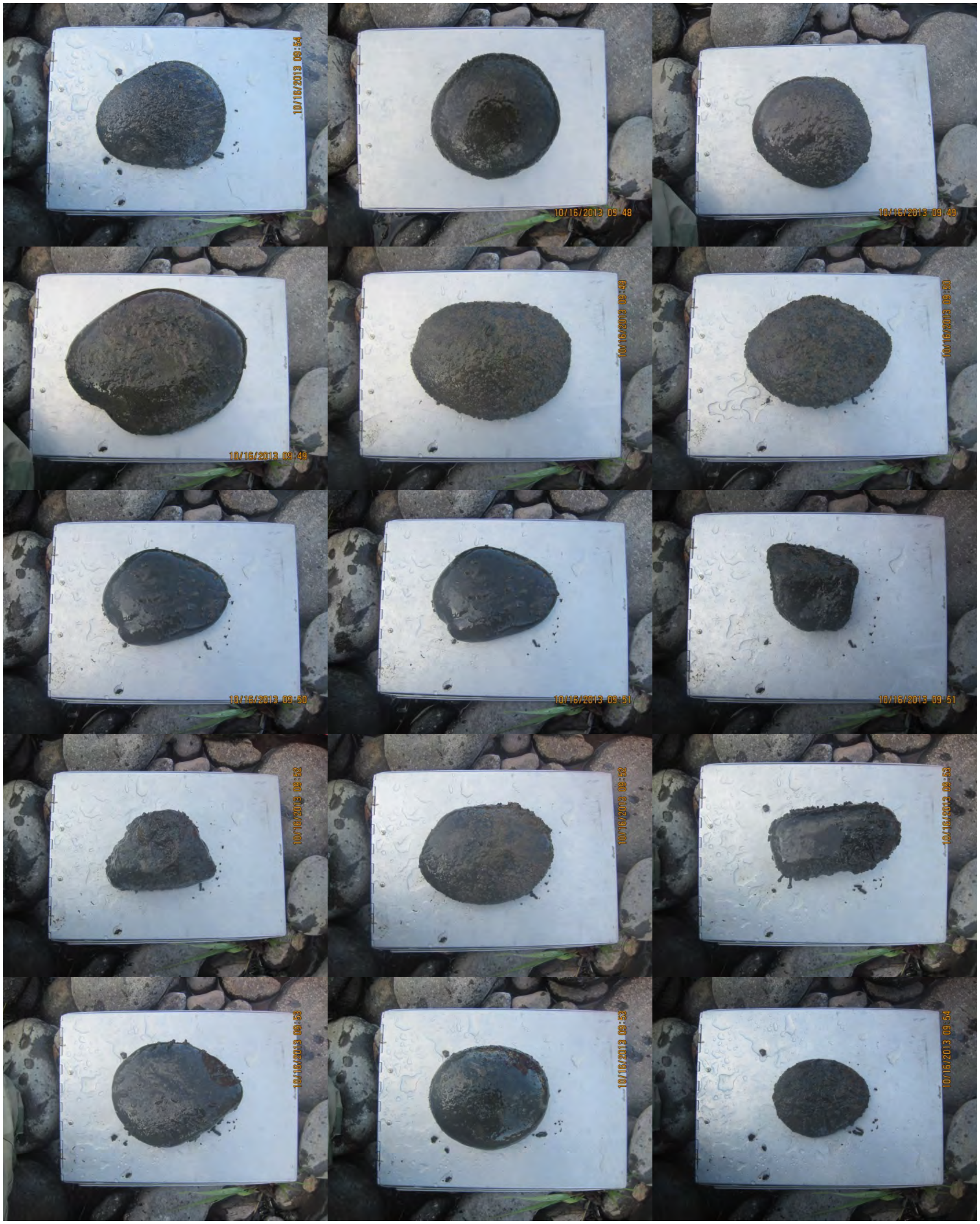
10/16/2013	19:46:00	10/16/13 19:46	8.88	77	114.7	13.3	8.21	1.3	9.98	146	85.6	9.66	7.41	1.2	9.18	0.084	107.1
10/16/2013	20:01:00	10/16/13 20:01	8.83	77	114.1	13.24	8.17	1.3	9.94	146	84.8	9.58	7.4	1.2	9.22	0.088	105.9
10/16/2013	20:16:00	10/16/13 20:16	8.78	77	113.5	13.19	8.14	1.5	9.91	146	84.1	9.51	7.38	1.3	9.15	0.087	105.4
10/16/2013	20:31:00	10/16/13 20:31	8.74	77	112.9	13.14	8.1	1.4	9.87	146	83.5	9.46	7.37	1.2	9.08	0.086	104.8
10/16/2013	20:46:00	10/16/13 20:46	8.7	77	112.5	13.1	8.07	1.4	9.83	146	83	9.4	7.36	1.1	9.06	0.088	104
10/16/2013	21:01:00	10/16/13 21:01	8.66	77	112.1	13.07	8.05	1.3	9.79	147	82.6	9.37	7.34	1.6	9	0.087	103.6
10/16/2013	21:16:00	10/16/13 21:16	8.63	77	111.8	13.04	8.02	1.3	9.74	146	82.2	9.34	7.34	1.2	8.94	0.086	103.1
10/16/2013	21:31:00	10/16/13 21:31	8.59	77	111.5	13.02	7.99	1.3	9.69	146	82	9.32	7.33	1	8.9	0.086	102.9
10/16/2013	21:46:00	10/16/13 21:46	8.55	77	111.2	12.99	7.95	1.3	9.65	146	81.8	9.3	7.32	1.1	8.86	0.086	102.4
10/16/2013	22:01:00	10/16/13 22:01	8.52	77	111	12.98	7.92	1.4	9.62	147	81.5	9.28	7.31	1.2	8.82	0.086	102
10/16/2013	22:16:00	10/16/13 22:16	8.48	77	110.9	12.98	7.9	1.4	9.59	147	81.3	9.26	7.3	1.2	8.8	0.087	101.7
10/16/2013	22:31:00	10/16/13 22:31	8.45	77	110.5	12.94	7.88	1.5	9.56	148	81.1	9.25	7.3	1.2	8.79	0.088	101.5
10/16/2013	22:46:00	10/16/13 22:46	8.42	77	110.3	12.93	7.85	1.3	9.53	148	81	9.25	7.29	1.1	8.7	0.085	101.5
10/16/2013	23:01:00	10/16/13 23:01	8.39	77	110.1	12.92	7.83	1.3	9.51	149	80.9	9.24	7.29	1.2	8.67	0.086	101.2
10/16/2013	23:16:00	10/16/13 23:16	8.36	77	110	12.91	7.81	1.3	9.48	149	80.8	9.23	7.28	1.1	8.63	0.086	100.9
10/16/2013	23:31:00	10/16/13 23:31	8.33	77	110	12.92	7.78	1.3	9.45	150	80.6	9.22	7.27	1.2	8.65	0.088	100.5
10/16/2013	23:46:00	10/16/13 23:46	8.29	77	109.7	12.9	7.76	1.6	9.42	151	80.6	9.22	7.27	1.2	8.68	0.09	100.2
10/17/2013	0:01:00	10/17/13 0:01	8.25	77	109.6	12.9	7.74	1.3	9.4	151	80.4	9.21	7.27	1.2	8.57	0.087	100.5
10/17/2013	0:16:00	10/17/13 0:16	8.21	78	109.5	12.9	7.72	1.2	9.37	152	80.4	9.2	7.26	1.7	8.55	0.088	100.3
10/17/2013	0:31:00	10/17/13 0:31	8.17	78	109.4	12.9	7.7	1.3	9.33	151	80.4	9.22	7.26	1.3	8.5	0.087	100.3
10/17/2013	0:46:00	10/17/13 0:46	8.13	78	109.3	12.9	7.69	1.4	9.29	151	80.4	9.22	7.25	1.2	8.44	0.086	100.2
10/17/2013	1:01:00	10/17/13 1:01	8.08	78	109.3	12.92	7.67	1.4	9.24	151	80.4	9.24	7.25	1.1	8.45	0.088	100.1
10/17/2013	1:16:00	10/17/13 1:16	8.03	78	109.2	12.93	7.65	1.3	9.19	150	80.4	9.25	7.24	1.2	8.36	0.086	100.2
10/17/2013	1:31:00	10/17/13 1:31	7.97	78	109.1	12.93	7.63	1.3	9.15	150	80.5	9.26	7.24	1.3	8.34	0.087	100
10/17/2013	1:46:00	10/17/13 1:46	7.92	78	109.1	12.95	7.62	1.4	9.09	149	80.6	9.29	7.24	1.2	8.31	0.087	99.8
10/17/2013	2:01:00	10/17/13 2:01	7.86	78	109.2	12.98	7.61	1.3	9.04	148	80.5	9.3	7.24	1.1	8.25	0.087	99.8
10/17/2013	2:16:00	10/17/13 2:16	7.8	78	109.1	12.99	7.6	1.3	8.97	147	80.8	9.34	7.24	1.2	8.2	0.087	99.7
10/17/2013	2:31:00	10/17/13 2:31	7.74	78	109.1	13	7.58	1.3	8.89	145	80.8	9.36	7.24	1.2	8.12	0.086	100
10/17/2013	2:46:00	10/17/13 2:46	7.68	78	109.1	13.02	7.58	1.4	8.82	144	81.1	9.41	7.24	1	8.05	0.086	99.8
10/17/2013	3:01:00	10/17/13 3:01	7.61	78	109.1	13.05	7.57	1.3	8.74	142	81.1	9.43	7.23	1.2	7.99	0.085	100
10/17/2013	3:16:00	10/17/13 3:16	7.54	78	109.1	13.07	7.56	1.2	8.67	141	81.4	9.48	7.23	1.2	7.94	0.085	99.9
10/17/2013	3:31:00	10/17/13 3:31	7.47	78	109.2	13.1	7.55	1.5	8.58	139	81.4	9.51	7.24	1.2	7.87	0.085	99.9
10/17/2013	3:46:00	10/17/13 3:46	7.4	78	109.6	13.17	7.54	1.2	8.51	138	81.6	9.55	7.23	1.2	7.79	0.084	100
10/17/2013	4:01:00	10/17/13 4:01	7.32	78	109.4	13.17	7.54	1.2	8.43	136	81.9	9.6	7.23	1.2	7.72	0.084	100.1
10/17/2013	4:16:00	10/17/13 4:16	7.24	78	109.3	13.18	7.54	1.3	8.34	135	82.1	9.64	7.23	1.2	7.61	0.083	100.2
10/17/2013	4:31:00	10/17/13 4:31	7.17	78	109.3	13.22	7.53	1.4	8.26	134	82.4	9.69	7.23	1.1	7.59	0.084	100.1
10/17/2013	4:46:00	10/17/13 4:46	7.09	78	109.3	13.24	7.52	1.2	8.17	132	82.6	9.74	7.23	1.1	7.52	0.084	100
10/17/2013	5:01:00	10/17/13 5:01	7.01	78	110.5	13.41	7.51	1.3	8.08	131	82.7	9.78	7.23	1.1	7.45	0.084	100
10/17/2013	5:16:00	10/17/13 5:16	6.93	78	109.5	13.32	7.51	1.4	7.99	130	83	9.83	7.24	1.2	7.36	0.083	100.3
10/17/2013	5:31:00	10/17/13 5:31	6.86	78	109.6	13.34	7.51	1.3	7.89	128	83.3	9.89	7.24	1.2	7.24	0.082	100.5
10/17/2013	5:46:00	10/17/13 5:46	6.79	78	109.7	13.38	7.51	1.2	7.81	127	83.5	9.94	7.23	1.2	7.18	0.083	100.6
10/17/2013	6:01:00	10/17/13 6:01	6.72	78	109.7	13.41	7.51	1.3	7.73	127	83.7	9.98	7.24	1.3	7.06	0.082	100.7
10/17/2013	6:16:00	10/17/13 6:16	6.65	78	109.8	13.44	7.5	1.2	7.64	126	83.9	10.03	7.24	1.5	7.02	0.082	100.8
10/17/2013	6:31:00	10/17/13 6:31	6.58	78	109.8	13.48	7.5	1.3	7.55	125	84.2	10.08	7.23	4	6.93	0.081	100.8
10/17/2013	6:46:00	10/17/13 6:46	6.51	78	109.9	13.51	7.49	3.7	7.47	124	84.4	10.12	7.24	1.2	6.85	0.082	100.8
10/17/2013	7:01:00	10/17/13 7:01	6.44	78	110	13.54	7.5	1.4	7.39	124	84.7	10.18	7.25	1.8	6.79	0.081	101
10/17/2013	7:16:00	10/17/13 7:16	6.38	78	110.1	13.57	7.5	1.4	7.31	123	84.9	10.22	7.25	1.2	6.74	0.082	101.1
10/17/2013	7:31:00	10/17/13 7:31	6.32	78	110.2	13.61	7.5	1.3	7.23	122	85.2	10.28	7.25	1.1	6.64	0.081	101.2
10/17/2013	7:46:00	10/17/13 7:46	6.26	78	110.4	13.65	7.5	1.2	7.16	122	85.7	10.36	7.26	1.3	6.56	0.081	101.7
10/17/2013	8:01:00	10/17/13 8:01	6.21	78	110.8	13.71	7.51	1.2	7.11	122	86.5	10.47	7.27	1.1	6.53	0.081	101.8
10/17/2013	8:16:00	10/17/13 8:16	6.16	78	111.2	13.78	7.52	1.2	7.05	121	87.4	10.6	7.29	1.2	6.49	0.081	102.3
10/17/2013	8:31:00	10/17/13 8:31	6.12	78	111.6	13.85	7.52	1.2	7.01	121	88.5	10.74	7.31	1.2	6.44	0.081	103
10/17/2013	8:46:00	10/17/13 8:46	6.09	78	112.1	13.92	7.53	1.4	6.99	122	89.6	10.88	7.33	1.8	6.41	0.081	103.6

10/17/2013	9:01:00	10/17/13 9:01	6.06	78	112.6	14	7.55	2	6.98	123	90.9	11.04	7.36	1.7	6.42	0.082	104.3
10/17/2013	9:16:00	10/17/13 9:16	6.05	78	113.4	14.1	7.56	1.4	7	124	92.4	11.21	7.39	1.5	6.38	0.081	105.3
10/17/2013	9:31:00	10/17/13 9:31	6.05	78	114.2	14.19	7.58	1.3	7.03	125	93.9	11.38	7.42	1.4	6.39	0.082	106.1
10/17/2013	9:46:00	10/17/13 9:46	6.06	77	114.9	14.28	7.61	1.2	7.09	127	95.2	11.53	7.45	1.3	6.39	0.081	107.2
10/17/2013	10:01:00	10/17/13 10:01	6.08	77	115.7	14.36	7.63	1.3	7.16	129	96.6	11.67	7.48	1.2	6.43	0.082	108.1
10/17/2013	10:16:00	10/17/13 10:16	6.12	77	116.4	14.45	7.66	1.4	7.25	131	97.9	11.81	7.51	1.2	6.5	0.084	109.1
10/17/2013	10:31:00	10/17/13 10:31	6.17	77	117.5	14.57	7.69	1.2	7.35	133	99.3	11.94	7.54	1.2	6.54	0.083	110.1
10/17/2013	10:46:00	10/17/13 10:46	6.22	77	118	14.6	7.72	1.2	7.46	136	100.5	12.06	7.56	1.3	6.6	0.083	111.2
10/17/2013	11:01:00	10/17/13 11:01	6.29	77	118.6	14.65	7.74	2.5	7.59	138	101.8	12.17	7.59	1.1	6.71	0.086	111.9
10/17/2013	11:16:00	10/17/13 11:16	6.37	77	119.4	14.72	7.78	1.5	7.71	140	102.8	12.25	7.61	1.1	6.79	0.086	112.8
10/17/2013	11:31:00	10/17/13 11:31	6.46	77	120.2	14.78	7.81	1.3	7.81	141	103.8	12.35	7.63	1.2	6.86	0.085	113.9
10/17/2013	11:46:00	10/17/13 11:46	6.57	77	121.9	14.96	7.85	1.4	7.91	142	104.7	12.42	7.66	1.2	6.94	0.085	114.7
10/17/2013	12:01:00	10/17/13 12:01	6.69	77	121.5	14.87	7.89	1.3	8.01	142	105.5	12.48	7.69	1.1	7.05	0.086	115.3
10/17/2013	12:16:00	10/17/13 12:16	6.81	77	122.3	14.91	7.93	1.3	8.11	142	106.2	12.54	7.71	1.1	7.14	0.085	116
10/17/2013	12:31:00	10/17/13 12:31	6.95	77	123	14.95	7.97	1.2	8.22	142	106.9	12.58	7.73	1.3	7.27	0.087	116.5
10/17/2013	12:46:00	10/17/13 12:46	7.09	77	123.4	14.95	8.01	1.4	8.32	142	107.3	12.6	7.76	1.5	7.37	0.086	117.3
10/17/2013	13:01:00	10/17/13 13:01	7.24	77	124	14.96	8.06	1.2	8.43	142	107.7	12.62	7.78	1.3	7.5	0.087	117.7
10/17/2013	13:16:00	10/17/13 13:16	7.39	77	124.6	14.97	8.1	1.2	8.56	142	108	12.62	7.79	1.3	7.62	0.086	118.2
10/17/2013	13:31:00	10/17/13 13:31	7.54	77	125	14.97	8.14	1.5	8.68	142	108.4	12.62	7.81	1.2	7.75	0.086	118.7
10/17/2013	13:46:00	10/17/13 13:46	7.7	77	125.4	14.96	8.18	1.3	8.81	142	108.6	12.61	7.83	1.2	7.88	0.086	119.2
10/17/2013	14:01:00	10/17/13 14:01	7.85	77	125.8	14.95	8.22	1.3	8.94	143	108.8	12.59	7.84	1.2	8.02	0.085	119.6
10/17/2013	14:16:00	10/17/13 14:16	8.01	77	126.1	14.92	8.25	1.2	9.07	143	109	12.57	7.85	1.1	8.16	0.086	119.6
10/17/2013	14:31:00	10/17/13 14:31	8.16	77	126.4	14.9	8.28	1.2	9.19	143	109	12.54	7.86	1.2	8.3	0.088	119.7
10/17/2013	14:46:00	10/17/13 14:46	8.31	77	126.7	14.89	8.32	1.2	9.31	143	108.9	12.49	7.86	1.5	8.43	0.087	119.9
10/17/2013	15:01:00	10/17/13 15:01	8.45	77	126.7	14.84	8.35	1.2	9.41	142	108.8	12.45	7.87	1.2	8.54	0.086	120.2
10/17/2013	15:16:00	10/17/13 15:16	8.58	77	126.8	14.8	8.38	1.4	9.51	141	108.5	12.39	7.87	1.2	8.67	0.087	120
10/17/2013	15:31:00	10/17/13 15:31	8.7	77	127	14.78	8.41	1.1	9.6	141	108.2	12.32	7.87	1.5	8.77	0.086	120
10/17/2013	15:46:00	10/17/13 15:46	8.81	77	126.9	14.73	8.43	1.2	9.7	141	107.5	12.22	7.86	1.2	8.89	0.087	119.7
10/17/2013	16:01:00	10/17/13 16:01	8.91	77	126.8	14.69	8.45	1.2	9.79	142	106.9	12.12	7.84	1.4	8.99	0.086	119.7
10/17/2013	16:16:00	10/17/13 16:16	9	77	126.7	14.64	8.47	1.1	9.86	142	106	12	7.82	1.3	9.08	0.087	119.2
10/17/2013	16:31:00	10/17/13 16:31	9.08	77	126.4	14.59	8.48	1.2	9.92	142	105	11.87	7.8	1.2	9.14	0.086	119
10/17/2013	16:46:00	10/17/13 16:46	9.13	77	126.1	14.53	8.49	1.1	9.95	140	103.8	11.73	7.78	1.1	9.21	0.086	118.5
10/17/2013	17:01:00	10/17/13 17:01	9.17	77	125.7	14.47	8.49	1.2	9.97	140	102.4	11.56	7.75	1	9.25	0.084	118

Appendix I: Biological Sampling Photos

Appendix I. Rocks randomly selected and sampled for algae

Riffle 1.

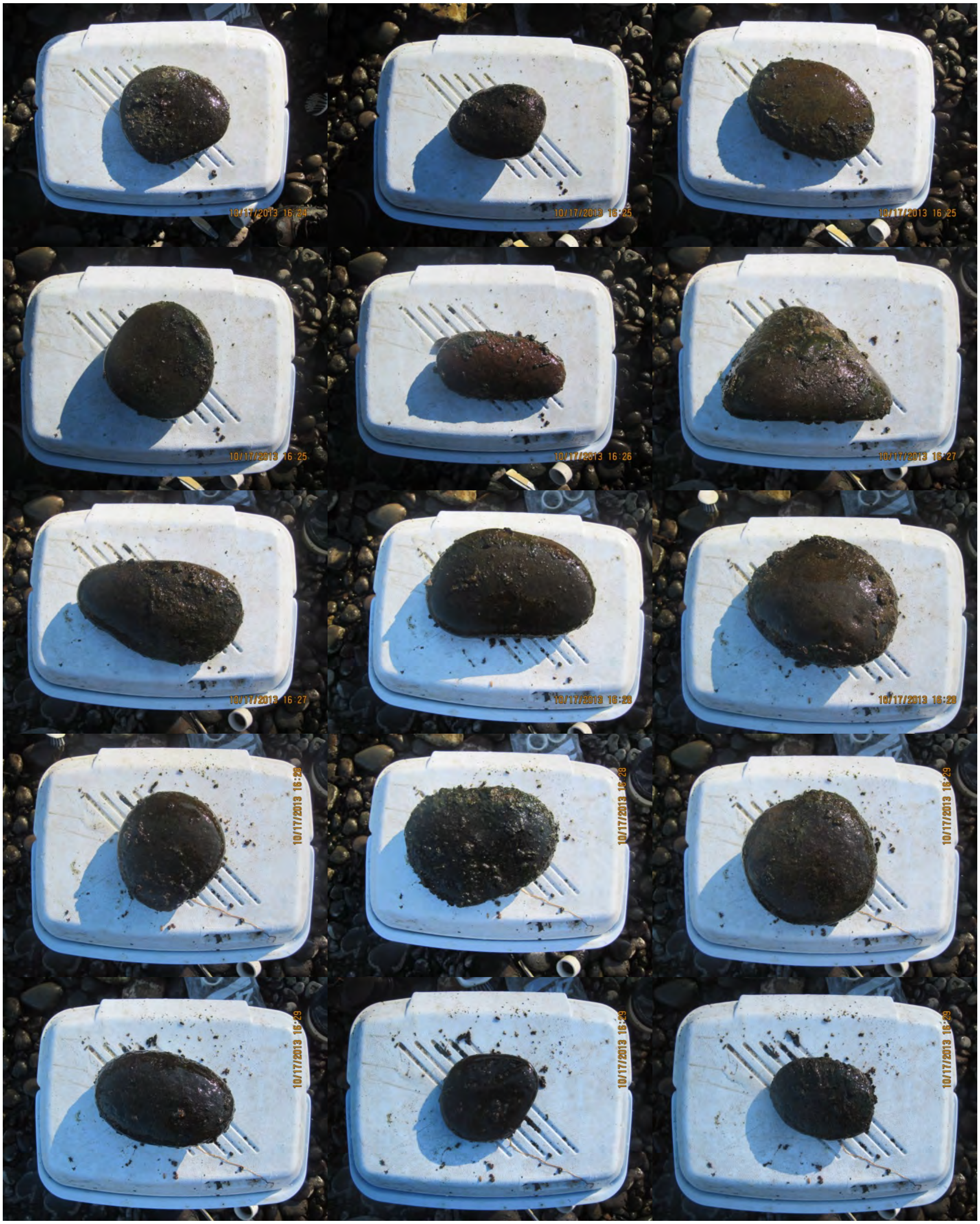


Riffle 2

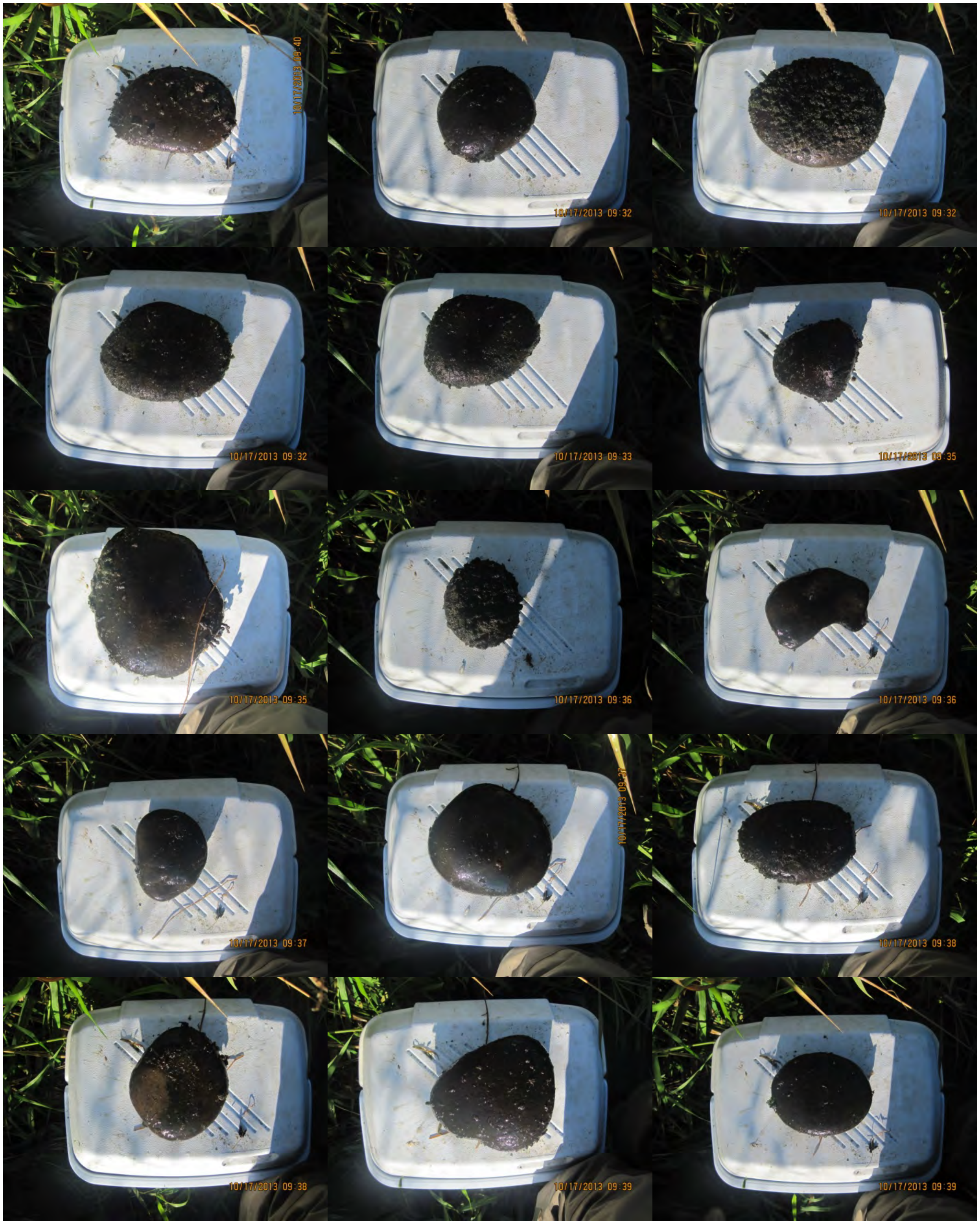

10/15/2013 16:32
10/15/2013 15:58
10/15/2013 15:58
10/15/2013 15:59
10/15/2013 15:59
10/15/2013 15:59
10/15/2013 15:59
10/15/2013 16:00
10/15/2013 16:00
10/15/2013 16:01
10/15/2013 16:31
10/15/2013 16:31
10/15/2013 16:31
10/15/2013 16:32
10/15/2013 16:32

Riffle 3

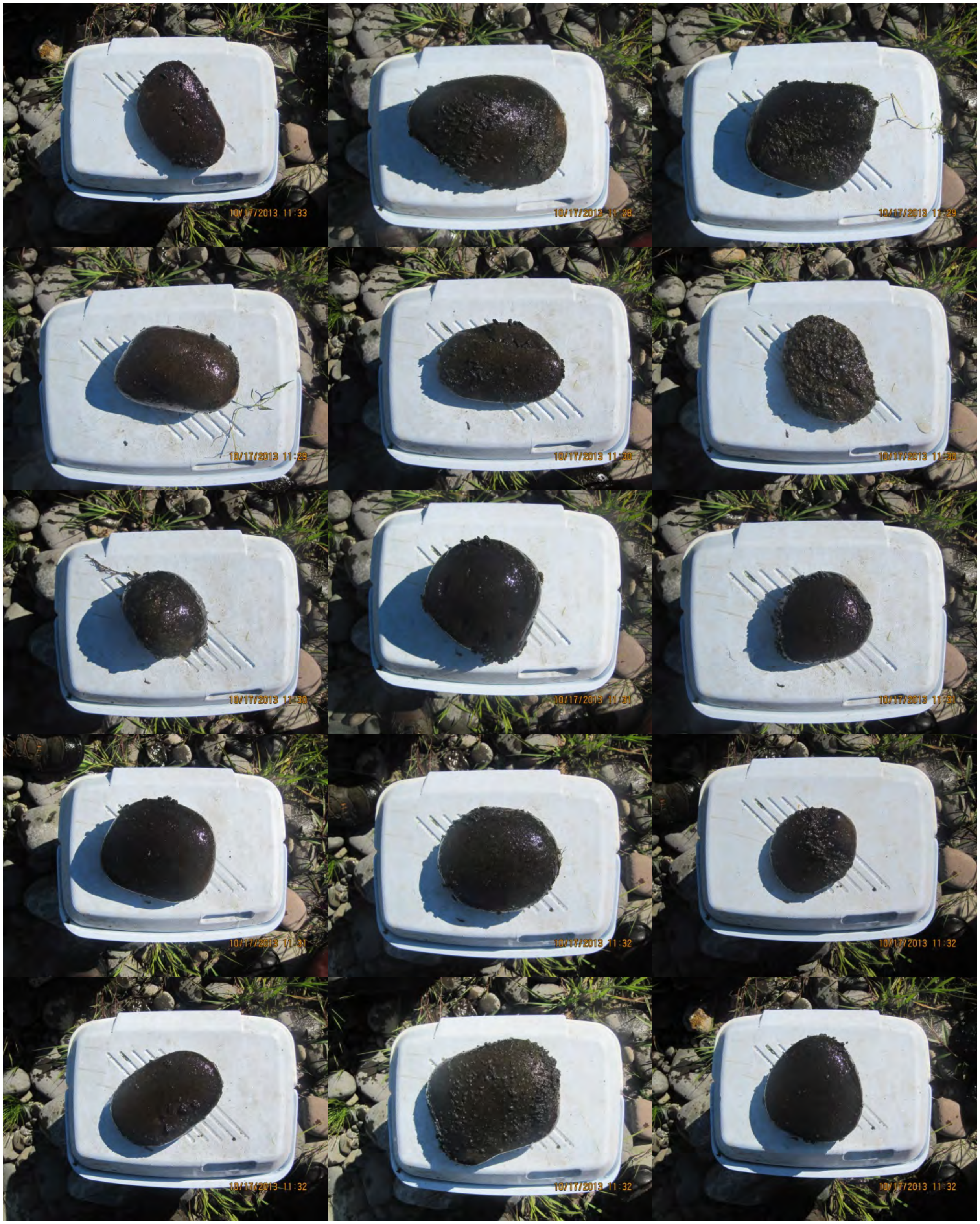
Riffle 3 Duplicate



Riffle 4


10/17/2013 09:32
10/17/2013 09:32
10/17/2013 09:32
10/17/2013 09:33
10/17/2013 09:35
10/17/2013 09:35
10/17/2013 09:36
10/17/2013 09:36
10/17/2013 09:37
10/17/2013 09:38
10/17/2013 09:38
10/17/2013 09:39
10/17/2013 09:39

Riffle 5



Appendix J: Algae Taxa Data

Appendix J. Alga taxa occurrence and relative abundance

Alga taxa occurrence and biovolume percent. Haefelel (2013) results included in shaded columns

Taxa	Riffle/sample									
	1	2	US	3	3 dup	LS1	LS1 QA	4	LS2	5
Achnanthes exigua								0.5	0.1	
Achnanthes lanceolata	0.5	0.1		0.9		0.4	0.5		0.2	0.5
Achnanthes linearis				0.3	0.2					
Achnanthes minutissima	0.1	0.5	0.9	2.7		0.4	0.3	2.4	0.5	3.8
Ankistrodesmus falcatus					0.0					
Calothrix spp.	62.2	35.7		1.9	5.5			5.2		13.5
Amphora perpusilla			0.7			2.3				
Cocconeis klmathensis					0.5					
Cocconeis plancentula		1.5	5.9	2.2	1.6	6.7	4.5	8.7	4.0	5.0
Cryptomonas erosa				1.2						2.0
Cymbella affinis	1.2		10.0			0.9	5.0	4.9		
Cymbella minuta	0.2	0.7	2.6	3.5			2.1	5.0	0.5	
Cymbella sinuata	0.2	0.1				0.7			0.2	0.8
Cymbella tumida						3.1				
Diatoma vulgare	7.6	2.5	5.6			19.7	10.7		7.3	10.7
Epithemia sorex	2.2								1.4	
Epithemia turgida	8.2	5.4							15.9	
Fragilaria construens venter	1.4			0.5	0.7			0.4	0.6	0.9
Fragilaria pinnata									0.2	

Alga taxa occurrence and biovolume percent. Haefelel (2013) results included in shaded columns										
Taxa	**Riffle/sample**									
	1	**2**	**US**	**3**	**3 dup**	**LS1**	**LS1 QA**	**4**	**LS2**	**5**
Fragilaria vaucheria	0.7	0.7	0.4	0.7			1.2		0.4	
Gomphoneis herculeana							7.5			
Gomphonema augustatum		0.2	0.8	1.7	0.6	2.7	1.8	1.0	1.3	2.4
Gomphonema clevei	0.1									
Gomphonema sp.			0.3							
Gomphonema olivaceum						0.3				0.6
Gomphonema sublclavatum	1.9	4.6	1.7	10.2	10.8	0.7	2.5	4.9	1.5	7.9
Gomphonema tenellum	0.1		0.3							
Gomphonema ventricosum		0.5				2.1	2.4			2.3
Hannaea arcus		1.1					2.4			
Melosira varians	1.7	2.1	7.7		3.4	4.0		1.8	11.4	8.9
Navicula cascadensis									0.1	
Navicula cryptocephala	0.4	0.4	0.8	1.9	1.0	0.5	0.8	2.5	0.5	
Navicula cryptocephala veneta	0.4	0.7	1.9	1.8	1.2	0.4	0.5	3.3	0.9	1.0
Navicula decussis									0.2	
Navicula minuscula	0.0	0.0	0.1	0.1	0.1		0.1	0.1	0.1	
Navicula tripunctata	2.2	0.7			1.9			3.0		
Navicula viridula									0.6	
Nitzschia amphibia	0.3	0.7	0.7	1.8	1.3	0.7	0.5	1.3		2.1
Nitzschia communis	0.1	0.0		0.1	0.1	1.1	0.2		0.1	

Alga taxa occurrence and biovolume percent. Haefelel (2013) results included in shaded columns

Taxa	Riffle/sample									
	1	**2**	**US**	**3**	**3 dup**	**LS1**	**LS1 QA**	**4**	**LS2**	**5**
Nitzschia dissipata	2.3	0.9	1.5	15.4	9.3	7.7	16.1	6.6	2.0	12.5
Nitzschia frustulum	1.8	3.5	7.0	12.8	5.5	15.6	20.9	34.0	9.5	16.6
Nitzschia innominate						0.1				
Nitzschia linearis			2.2							
Nitzschia microcephalum										0.3
Nitzschia palea	0.2		0.5	0.9	0.6			0.8		0.5
Nitzschia paleacea	0.3	0.2	0.4	0.2	0.3	0.2	0.3			2.1
Oscillatoria limnetica			38.4		53.7	4.8	0.9		1.9	
Oscillatoria limosa									13.9	
Oscillatoria spp.	2.0	35.8		39				10.1		1.7
Pinnularia sp										1.1
Rhodomonas minuta	0.1									
Rhoicosphenia curvata			0.5	0.6	0.2			2.9	2.1	1.9
Stephanodiscus Astraea minutula										
Synedra mazamaensis	0.3	0.2	0.7	0.6	0.4			0.7		0.7
Synedra rumpens				0.3						
Synedra ulna	1.3	1.3	8.5			24.5	16.7			
Number of taxa	**29**	**26**	**25**	**24**	**23**	**24**	**24**	**21**	**27**	**24**
Total density (#/cm^2)	**446,376**	**493,631**	**517,677**	**1,269,750**	**965,044**	**6,529,509**	**7,477,968**	**1,008,056**	**3,578,640**	**1,028,914**
Total biovolume (µm^3/cm^2)	**575,288,808**	**451,188,792**	**208,446,248**	**360,707,964**	**456,594,093**	**2,873,469,430**	**2,448,594,004**	**204,341,893**	**2,031,248,711**	**271,924,168**

Appendix J. Algal autecological designations

Alga indicator status from Porter et al (2008)								
	Riffle/sample							
Taxa	**nitrogen fixers**	**eutrophic**	**oligotrophic**	**Indicative of high n**	**indicative of low n**	**indicative of high p**	**indicative of low p**	**tolerant (Bahls) (1=most, 3=least)**
Achnanthes exigua				X		X		3
Achnanthes lanceolata								2
Achnanthes linearis								3
Achnanthes minutissima								3
Ankistrodesmus falcatus								
Calothrix spp.	X							3
Amphora perpusilla								3
Cocconeis klmathensis		X						3
Cocconeis plancentula		X						3
Cryptomonas erosa		X						3
Cymbella affinis		X			X		X	3
Cymbella minuta								2
Cymbella sinuata								3
Cymbella tumida		X						3
Diatoma vulgare		X						3
Epithemia sorex	X	X			X			3
Epithemia turgida	X	X			X			3
Fragilaria construens venter		X						3
Fragilaria pinnata		X						3
Fragilaria vaucheria								3
Gomphoneis herculeana		X			X		X	2
Gomphonema augustatum								3
Gomphonema clevei			X					2
Gomphonema sp.								3
Gomphonema olivaceum								
Gomphonema sublclavatum		X						3
Gomphonema tenellum							X	2

Alga indicator status from Porter et al (2008)								
	Riffle/sample							
Taxa	**nitrogen fixers**	**eutrophic**	**oligotrophic**	**Indicative of high n**	**indicative of low n**	**indicative of high p**	**indicative of low p**	**tolerant (Bahls) (1=most, 3=least)**
Gomphonema ventricosum								3
Hannaea arcus			X					
Melosira varians					X		X	3
Navicula cascadensis		X						2
Navicula cryptocephala								
Navicula cryptocephala veneta		X						2
Navicula decussis		X						3
Navicula minuscula		X						3
Navicula tripunctata		X		X				2
Navicula viridula		X		X				3
Nitzschia amphibia		X						2
Nitzschia communis				X			X	
Nitzschia dissipata								1
Nitzschia frustulum		X		X		X		3
Nitzschia innominate		X		X		X		2
Nitzschia linearis								
Nitzschia microcephalum		X		X				2
Nitzschia palea		X						1
Nitzschia paleacea		X		X		X		1
Oscillatoria limnetica		X						2
Oscillatoria limosa								
Oscillatoria spp.								
Pinnularia sp								
Rhodomonas minuta								
Rhoicosphenia curvata		X						3
Stephanodiscus Astraea minutula								
Synedra mazamaensis					X		X	3
Synedra rumpens								2
Synedra ulna							X	2

Appendix K: Macroinvertebrate Taxa Data

Appendix K. Macro-invertebrate species abundance.

Subsample results converted to total abundance/one square meter. Hafaele (2013) results provided in shaded columns. When a taxon is listed twice (i.e. Glossosoma), it indicates that there were two lifestages within that group.

Common name	Taxon	Riffles/replicates															
		1/1	1/2	2/1	2/2	US	US/ QA	3/1	3/2	LS1	LS1/ QA	4/1	4/2	LS2	LS2/ QA	5/1	5/2
Flatworms	Turbellaria	171	25	122	360	242	525	5		1069	1120	855	263	1081	595	225	
Roundworms	Nemata	64	25	9	30	81	81	14	13	20	30		25	16	20	50	9
Segmented worms	Oligochaeta	471	350	263	675	1170	1816	5	25	1180	1160	690	125	1146	646	450	56
	Naidinae*	86	38	94	75							1860	363			50	19
Leeches	Helobdella stagnalis									20							
Snails	Lanx			9													
	Fluminicola								6	10	20						
	Physa								6	202	141	465	838	194	10	50	1181
	Helisoma										10						
	Juga	43	25	131				28	44		20	15	125		1	50	66
Seed shrimp	Ostracoda			9				5	6			15	50				56
Clams	Pisidium									40	10						
Scuds	Crangonyx					40				40		30	38			25	19
Mites	Acari	557	338	291	570	968	1210	84	113	151	161	465	350	258	212	775	431
Dragon flies	Ophiogomphus		13														
Mayflies	Acentrella insignificans	43	13		15	81	81			10		30	50	48	40	25	19
	Baetis tricaudatus	386	75	66	120	242	444	9	19	20	20	180	213	226	30	375	103
	Drunella grandis	43	13	38	75	40	81	9	56	10		150	113	81	212	300	56
	Ephemerella excrusians	1393	275	563	960	2461	2703	267	231			75	100	258		825	131
	Ephemerella tibialis	43					40	5							10		
	Cinygma		13													25	
	Epeorus	214	275	38	15	363	242			10				145	50	150	47
	Rhithrogena	171	238	169	300	404	444		13								
	Paraleptophlebia	21		9	30	40	81										
Stoneflies	Capniidae	21	13	9				9	6								9
	Sweltsa	21		19	30	81	40		25			15		32	10		
	Zapada cinctipes	21	25			81	40	9					13		10	25	
	Calineuria californica			9	45	40			1				1	16			

Common name	Taxon	Riffles/replicates															
		1/1	1/2	2/1	2/2	US	US/ QA	3/1	3/2	LS1	LS1/ QA	4/1	4/2	LS2	LS2/ QA	5/1	5/2
	Claassenia sabulosa	21	38	56	60	121	282	9	1		1				10	1	1
	Hesperoperla pacifica	21			30												
	Perlodidae			9	60	121	40	5	13								
	Isoperla	43	38	66	105	121	202										
	Skwala		13	19	15	121	121	23								25	
	Pteronarcys californica			1		1	1										
	Pteronarcys princeps													16			
Alder flies	Sialis		13						6		10						
Caddis flies	Amiocentrus aspilus					81				40	20			16		25	9
	Brachycentrus occidentalis	643	163	469	300	1049	1654	131	369	30	91	345	550	533	545	1725	544
	Glossosoma	150	113	38	135	121	323								20		
	Glossosoma					40	40								10		
	Cheumatopsyche	129	225	9	30		40		6								9
	Hydropsyche	1607	325	319	675	1816	1412	389	475			45	88	16	101	975	206
	Hydroptila	429	125		15	81		5									
	Lepidostoma			9						20	20			16			
	Lepidostoma (Neodinarthrum)	536	1013	413	570	323	686	328	388	50	101	45	138	323	81	525	431
	Lepidostoma (Neodinarthrum)										10						
	Lepidostoma-turret case larvae							5									19
	Ceraclea							75	56	50	30	30			10		28
	Psychomyia		13														
	Dicosmoecus gilvipes					1								16	1		
	Rhyacophila brunnea/vemna group	21															
	Rhyacophila coloradensis group			9	30	40	81		6								
	Rhyacophila malkini															25	
Aquatic moths	Petrophila	150	125					5				30					

Common name	Taxon	Riffles/replicates															
		1/1	1/2	2/1	2/2	US	US/ QA	3/1	3/2	LS1	LS1/ QA	4/1	4/2	LS2	LS2/ QA	5/1	5/2
Riffle beetles	Microcylloepus												13				
	Narpus concolor		25	9							20				40		
	Optioservus	86	175	38	15	81	202		25	171	10	45	75		10	75	47
	Optioservus	1050	1000	338	795	1210	1574	230	263		262	675	775	533	494	1725	534
	Zaitzevia			9	15	121	40						13	16	10	25	9
	Zaitzevia	386	88	272	315	807	726	33	25			15	25	16	30		19
No-see-ums	Ceratopogonidae											15		16			
Dance flies	Hemerodromia	43	63	19		121	121		13	10				65	10		9
	Neoplasta			9													
Black flies	Simulium	107	25	9		40		5		10		45	88	113	10	275	47
	Simulium													16	10		
Crane flies	Antocha	429	88	188	285	807	525	9	19				25	16	10	75	28
	Antocha					81											9
Midges	Chironomidae	429	175	66	285	726	282	38	106	121	212	855	438	646	262	900	216
	Cardiocladius				15				13			90	113	16		50	
	Cricotopus	836	425	244	330	1574	888	70	119	182	71	360	213	581	262	200	103
	Cricotopus bicinctus group									40	50						9
	Cricotopus (Nostococladius)	236	300	216	510	807	847	9	13			15				50	
	Cricotopus trifascia group	21	13			40				141	61	1080	325	258	121	75	9
	Cryptochironomus										10						
	Diamesa			56	135	40	161	38	19								
	Eukiefferiella brehmi group	43		9	45		121	23	19			30				50	38
	Eukiefferiella claripennis group	321		56	105	686	888	23	88	30	20	225	363	145	81	675	225
	Eukiefferiella devonica group	386	63	47	60	242	282	23	88	10	10	915	650	339	81	700	188
	Eukiefferiella pseudomontana group									10							
	Micropsectra		25	19	75	81	81	14	38			30		65	50	25	19
	Microtendipes pedellus group							9	13	20	10		25	16			
	Orthocladius	43	50	141	165	40	161	211	244	393	272	825	563	662	282	1200	300
	Orthocladius complex	450	313	441	435	1896	1775	492	594	101	272	600	525	145	333	925	394
	Orthocladius	21	50														

Common name	Taxon	Riffles/replicates															
		1/1	1/2	2/1	2/2	US	US/ QA	3/1	3/2	LS1	LS1/ QA	4/1	4/2	LS2	LS2/ QA	5/1	5/2
	(Euorthocladius)																
	Paratanytarsus	21	13														9
	Polypedilum	43	25		15	1614	605	66	19	595	151	90	25	1081	484	200	38
	Potthastia gaedii group					81	40	56	106						10	50	19
	Rheocricotopus															25	
	Rheotanytarsus	21						9									
	Synorthocladius	86	38		15	40	40		31	40	20	60	450	97	20		28
	Thienemanniella						81							16	40		9
	Thienemannimyia complex	21						28	13		10				10	50	9

*Naidinae were included with the rest of the oligochaetes in Haefele (2013).

Appendix K. Macro-invertebrate indicator designations.

Taxon	Feeding. Group[a]	Habit[b]	Tolerance[c]	HBI[d]	tolerant [e]	sensitive[f]	Sediment tolerant[g]
Turbellaria	PR	CL	0	4			
Nemata	PA	BU	0	5			
Oligochaeta	CG	BU	0	5	yes		yes
Naidinae	CG	BU	0	8			
Juga	OM	CL	MT	7	yes		yes
Acari	PA	SW	0	5			
Acentrella insignificans	CG	CL	0	6			
Baetis tricaudatus	CG	CL	0	6		yes	
Drunella grandis	PR	CL	0	1			
Ephemerella excrusians	CG	CL	0	1			
Ephemerella tibialis	CG	CL	0	2			
Epeorus	SC	CL	0	0			
Rhithrogena	SC	CL	0	0			
Paraleptophlebia	CG	SP	0	4			
Capniidae	SH	SP	MI	1		yes	
Sweltsa	PR	BU	0	1			
Zapada cinctipes	SH	SP	0	2			
Claassenia sabulosa	PR	CL	0	3			
Hesperoperla pacifica	PR	CL	0	2			
Isoperla	PR	CL	0	2			
Brachycentrus occidentalis	OM	CL	0	1			
Glossosoma	SC	CL	0	1			no
Cheumatopsyche	CF	CL	MT	8	yes		
Hydropsyche	CF	CL	0	4	yes		
Hydroptila	PH	CL	MT	6	yes		
Lepidostoma (Neodinarthrum)	SH	CM	0	1			
Rhyacophila brunnea/vemna group	PR	CL	0	1			
Petrophila	SC	CL	MT	5	yes		
Optioservus	SC	CL	MT	4	yes		
Optioservus	CG	CL	MT	4	yes		
Zaitzevia	CG	CL	MT	6	yes		
Hemerodromia	PR	SP	MT	6			
Simulium	CF	CL	0	6			
Antocha	CG	CL	0	3			yes
Chironomidae	CG	BU	0	6			
Cricotopus (Nostococladius)	UN	BU	MI	3			
Cricotopus	CG	CL	0	7			
Cricotopus trifascia group	CG	CL	MT	6			
Eukiefferiella brehmi group	CG	SP	0	8			
Eukiefferiella claripennis group	CG	SP	MT	8			
Eukiefferiella devonica group	CG	SP	0	8			
Orthocladius complex	CG	SP	0	6			
Orthocladius	CG	SP	0	6			
Orthocladius (Euorthocladius)	CG	SP	0	6			
Paratanytarsus	CF	CL	0	6			
Polypedilum	MH	CL	0	6			
Rheotanytarsus	CF	CL	0	6			
Synorthocladius	CG	SP	0	2			
Thienemannimyia complex	PR	SP	0	6			
Ophiogomphus	PR	BU	MT	4	yes		yes
Cinygma	SC	CL	0	2		yes	
Skwala	PR	CL	0	2			
Sialis	PR	SP	MT	4	yes		
Psychomyia	SC	CL	0	2			no

Narpus concolor	CG	CL	0	4			
Micropsectra	CG	CL	0	7			
Ostracoda	CG	SW	0	8			
Lanx	SC	CL	0	8			
Calineuria californica	PR	CL	0	2			
Perlodidae	PR	CL	0	2			
Lepidostoma	SH	CM	0	1			
Rhyacophila coloradensis group	PR	CL	0	2			
Zaitzevia	CG	CL	MT	6	yes		
Neoplasta	PR	SP	0	6			
Diamesa	CG	SP	HI	5			
Pteronarcys californica	SH	SP	0	1			
Cardiocladius	PR	BU	MT	5			
Ceraclea	CG	CM	0	3			
Lepidostoma-turret case larvae	SH	CM	0	1			
Microtendipes pedellus group	CF	CL	MT	6			
Potthastia gaedii group	CG	SP	0	2			
Physa	CG	CL	HT	8	yes		
Fluminicola	SC	CL	MT	4	yes		
Crangonyx	CG	SW	MT	11			
Ceratopogonidae	PR	SP	0	6			
Microcylloepus	CG	CL	MT	7	yes		
Amiocentrus aspilus	CG	CL	0	3			
Rhyacophila malkini	PR	CL	0	0			
Rheocricotopus	CG	SP	0	6			
Antocha	CG	CL	0	3			
Cricotopus bicinctus group	CG	CL	MT	7			
Thienemanniella	CG	SP	0	6			

[a]Feeding groups: CF – collector filterer, CG – collector gatherer, MH – macrophyte herbivore, OM – omnivore, PA – parasite, PH – piercer herbivore, PR – predator, SC – scraper, SH – shredder, UN – unknown

[b]Habitat: BU – burrower, CL – clinger, CM – climber, SP – sprawler, SW – swimmer

[c]Tolerance as reported by Aquatic Biology Associates (ABA). HI – highly intolerantm HT – highly tolerant, MI – moderately intolerant, HI – highly intolerant.

[d]Wyoming HBI as report by ABA

[e]Tolerant as defined by WQIW, 1999

[f]Sensitive as defined by WQIW, 1999

[g]Sediment sensitive as defined by WQIW, 1999

Appendix L: Biological Analytical Statistics

Tukey HSD All-Pairwise Comparisons Test of EPT_Tax by riffle

riffle	Mean	Homogeneous Groups
2	21.000	A
1	20.000	A
3	15.000	B
5	14.000	B
4	9.0000	C

```
Alpha               0.05     Standard Error for Comparison  0.6325
Critical Q Value  5.675     Critical Value for Comparison  2.5381
There are 3 groups (A, B, etc.) in which the means
are not significantly different from one another.
```

Tukey HSD All-Pairwise Comparisons Test of Taxa_R by riffle

riffle	Mean	Homogeneous Groups
1	46.000	A
2	43.000	A
3	41.000	A
5	41.000	A
4	33.500	B

```
Alpha               0.05     Standard Error for Comparison  1.7029
Critical Q Value  5.675     Critical Value for Comparison  6.8341
There are 2 groups (A and B) in which the means
are not significantly different from one another.
```

Tukey HSD All-Pairwise Comparisons Test of intol by riffle

riffle	Mean	Homogeneous Groups
2	6.1885	A
1	3.2850	AB
3	1.5005	B
5	0.2592	B
4	0.0663	B

```
Alpha               0.05     Standard Error for Comparison  1.0704
Critical Q Value  5.675     Critical Value for Comparison  4.2957
There are 2 groups (A and B) in which the means
are not significantly different from one another.
```

Tukey HSD All-Pairwise Comparisons Test of nonins by riffle

riffle	Mean	Homogeneous Groups
4	32.790	A
5	21.890	A
2	18.085	A
1	11.320	A
3	5.3360	A

```
Alpha               0.05     Standard Error for Comparison  7.4168
Critical Q Value  5.675     Critical Value for Comparison  29.764
There are no significant pairwise differences among the means.
```

Tukey HSD All-Pairwise Comparisons Test of olig by riffle

riffle	Mean	Homogeneous Groups
4	14.270	A
2	7.4640	A
1	5.0190	A
5	2.4295	A
3	0.4170	A

Alpha	0.05	Standard Error for Comparison	5.3332
Critical Q Value	5.675	Critical Value for Comparison	21.403

There are no significant pairwise differences among the means.

Tukey HSD All-Pairwise Comparisons Test of tot_A by riffle

riffle	Mean	Homogeneous Groups
5	9909.0	A
1	9749.0	A
4	9724.5	A
2	7194.0	A
3	3279.0	A

Alpha	0.05	Standard Error for Comparison	3524.4
Critical Q Value	5.675	Critical Value for Comparison	14144

There are no significant pairwise differences among the means.

Tukey HSD All-Pairwise Comparisons Test of EPT_A by riffle

riffle	Mean	Homogeneous Groups
1	4489.0	A
5	3320.0	A
2	2975.5	A
3	1472.5	A
4	1089.5	A

Alpha	0.05	Standard Error for Comparison	1497.2
Critical Q Value	5.675	Critical Value for Comparison	6008.4

There are no significant pairwise differences among the means.

Tukey HSD All-Pairwise Comparisons Test of cling by riffle

riffle	Mean	Homogeneous Groups
1	63.775	A
2	58.965	AB
5	54.820	AB
3	47.305	AB
4	44.225	B

Alpha	0.05	Standard Error for Comparison	4.4965
Critical Q Value	5.675	Critical Value for Comparison	18.045

There are 2 groups (A and B) in which the means
are not significantly different from one another.

Tukey HSD All-Pairwise Comparisons Test of dom by riffle

riffle	Mean	Homogeneous Groups
3	16.675	A

5	16.645	A
1	14.895	A
4	13.445	A
2	10.530	A

Alpha 0.05 Standard Error for Comparison 3.4071
Critical Q Value 5.675 Critical Value for Comparison 13.673
There are no significant pairwise differences among the means.

Tukey HSD All-Pairwise Comparisons Test of shred by riffle

riffle	Mean	Homogeneous Groups
1	19.750	A
2	12.385	A
5	11.800	A
3	7.9205	A
4	7.8775	A

Alpha 0.05 Standard Error for Comparison 4.1886
Critical Q Value 5.675 Critical Value for Comparison 16.809
There are no significant pairwise differences among the means.

Appendix M: Tideflex Effective Area Calculations

Field Study Conditiom			
Total Effluent Flow	18.2 mgd	12639 gal/min	
Effluent Flow Per Port (3)	6.07 mgd	4213 gal/min	
Effective Area	260 in2	1.81 ft2	Based upon 36" tideflex area vs. flow curve
Port Diameter	18.2 in	1.52 ft	

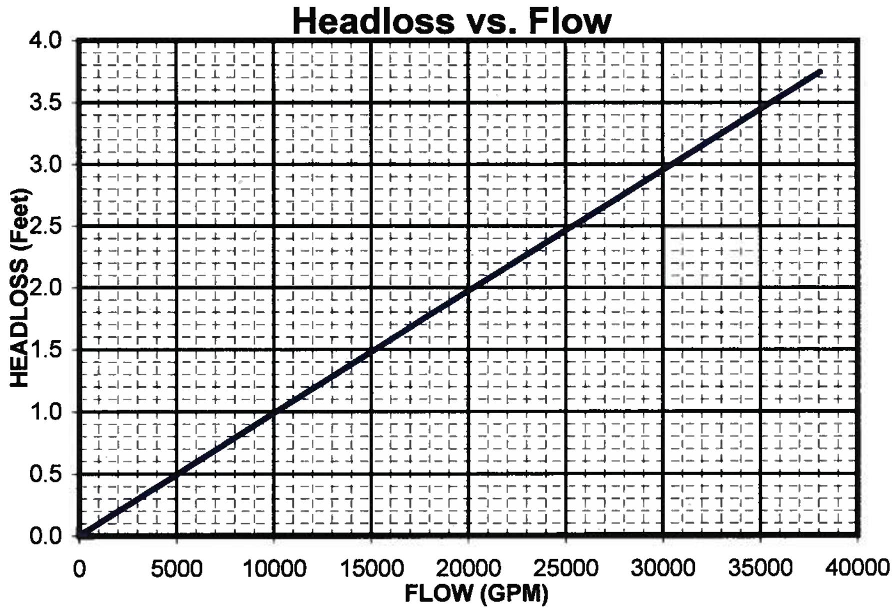
Max Daily Flow - Critical Period			
Total Effluent Flow	26.0 mgd	18056 gal/min	
Effluent Flow Per Port (3)	8.67 mgd	6019 gal/min	
Effective Area	300 in2	2.08 ft2	Based upon 36" tideflex area vs. flow curve
Port Diameter	19.5 in	1.63 ft	

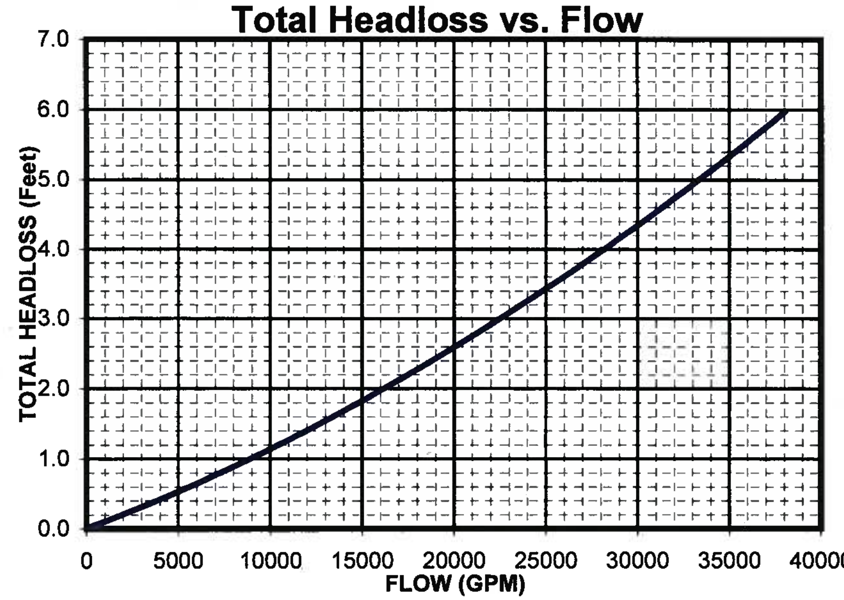
Max Monthly Flow - Critical Period			
Total Effluent Flow	18.2 mgd	12639 gal/min	
Effluent Flow Per Port (3)	6.07 mgd	4213 gal/min	
Effective Area	260 in2	1.81 ft2	Based upon 36" tideflex area vs. flow curve
Port Diameter	18.2 in	1.52 ft	

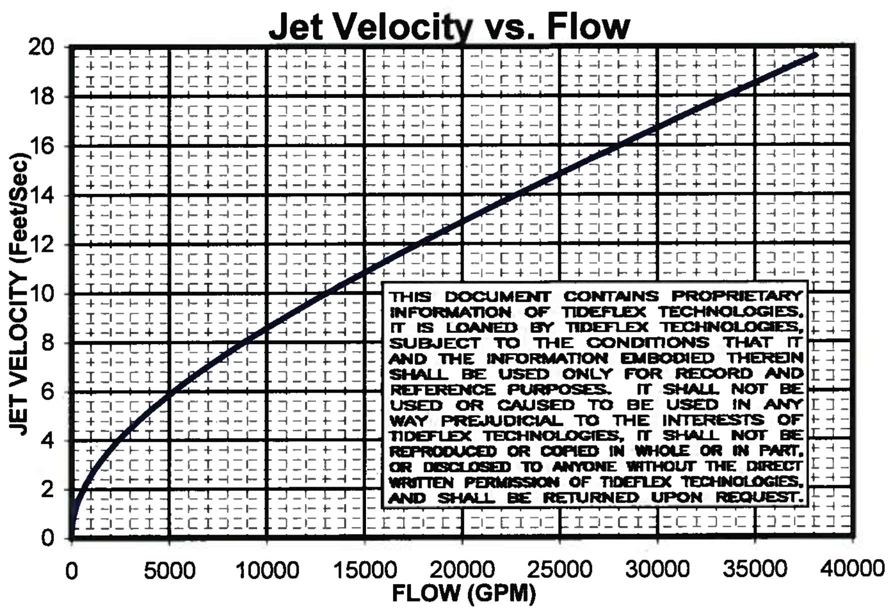
Average Annual Flow			
Total Effluent Flow	18.2 mgd	12639 gal/min	
Effluent Flow Per Port (3)	6.07 mgd	4213 gal/min	
Effective Area	260 in2	1.81 ft2	Based upon 36" tideflex area vs. flow curve
Port Diameter	18.2 in	1.52 ft	

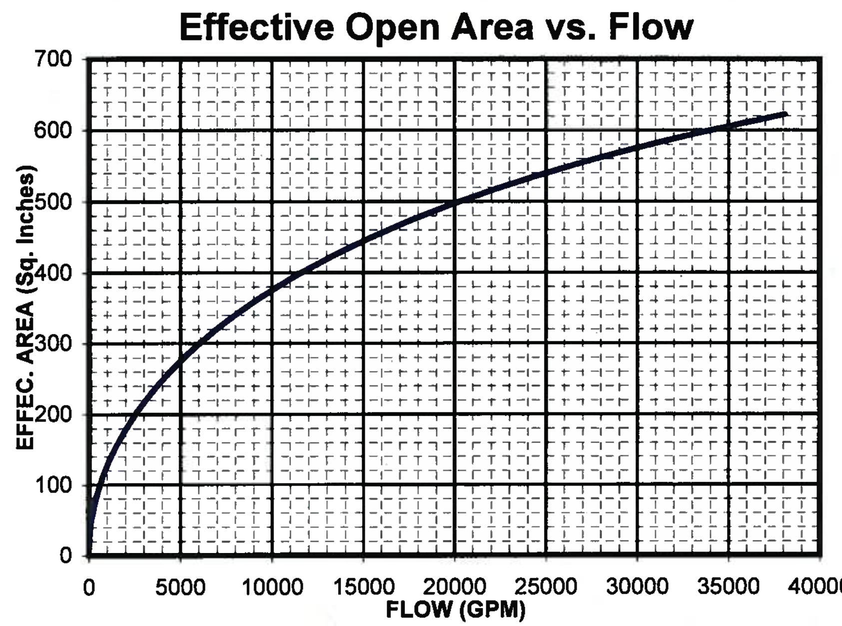
36 " TIDEFLEX SERIES TF-2, SERIES 35 CATALOG NUMBER 10165

Maximum Backpressure = 8 psi









11-Jun-2007

Appendix N: CORMIX Model Output Data

Medford Acute Conditions.prd

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
                         CORMIX MIXING ZONE EXPERT SYSTEM
                  Subsystem CORMIX2: Multiport Diffuser Discharges
                               CORMIX Version 8.0GTD
                         HYDRO2 Version 8.0.0.0 April 2012
-------------------------------------------------------------------------------
----------
-------------------------------------------------------------------------------
----------
CASE DESCRIPTION
 Site name/label:   Medford RWRF Mixing Zone Study
 Design case:       Acute Conditions
 FILE NAME:         C:\Program Files\CORMIX 8.0\Medford.prd
 Time stamp:        Tue Nov 12 13:44:46 2013

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS     =      60.96  AS     =     115.20  QA     =      24.01  ICHREG= 2
 HA     =       1.89  HD     =       2.44
 UA     =      0.208  F      =      0.078  USTAR =0.2055E-01
 UW     =      2.000  UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U           RHOAM =  998.6678

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:       DITYPE= unidirectional_perpendicular
 BANK   =  LEFT       DISTB =      10.97  YB1    =       9.14  YB2    =      12.80
 LD     =       3.66  NOPEN =    3        SPAC   =       1.83
 D0     =      0.488  A0     =      0.187  H0     =       0.61  SUB0   =       1.83
 D0INP  =      0.488  CR0    =      1.000
 Nozzle/port arrangement:   unidirectional_with_fanning
 GAMMA  =      90.00  THETA =      10.00  SIGMA =     345.00  BETA   =      75.00
 U0     =      2.033  Q0     =      1.139         =0.1139E+01
 RHO0   =   997.4061  DRHO0 =0.1262E+01  GP0    =0.1239E-01
 C0     =0.1000E+03  CUNITS=  %
 IPOLL  =  1          KS     =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0     =0.3114E+00  m0     =0.6331E+00  j0     =0.3859E-02  SIGNJ0=       1.0
 Associated 2-d length scales (meters)
 lQ=B   =      0.153  lM     =      25.65  lm     =      14.57
 lmp    =   99999.00  lbp    =   99999.00  la     =   99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0     =0.1139E+01  M0     =0.2316E+01  J0     =0.1411E-01
 Associated 3-d length scales (meters)
 LQ     =       0.43  LM     =      15.80  Lm     =       7.30  Lb     =       1.56
                                           Lmp    =   99999.00  Lbp    =   99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =      46.66  FRD0   =      26.15  R      =       9.75  PL     =     1.23
 (slot)               (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0     =      2.033  D0     =      0.488  A0     =      0.187  THETA =      10.00
 FR0    =      46.66  FRD0   =      26.15  R      =       9.75
 (slot)               (riser group)

FLOW CLASSIFICATION
 2222222222222222222222222222222222222222
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 2  Flow class (CORMIX2)      =    MU2    2
 2  Applicable layer depth HS =     2.44  2
 22222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+03  CUNITS=  %
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =  10000.00  XMAX  =  10000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        10.97 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  50 display intervals per module
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BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = top-hat half-width, in horizontal plane 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        BV        BH        Uc         TT
      0.00       0.00      0.61      1.0 0.100E+03    0.12      1.83      1.835   .00000E+00

END OF MOD201: DIFFUSER DISCHARGE MODULE
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BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

 Because of the FANNED-OUT HORIZONTAL ORIENTATION of the diffuser jets,
   the near-field dilution is slightly improved.

 In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY
  MIXED over the entire layer depth (HS =    2.44m).
   Full mixing is achieved after a plume distance of about five
   layer depths from the diffuser.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, in horizontal plane normal to trajectory
   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        TT
     0.00     -0.00      0.61      1.0 0.100E+03    0.12      1.83 .00000E+00
     0.04     -0.01      0.61      1.4 0.695E+02    0.13      1.79 .22565E-01
     0.07     -0.02      0.61      1.6 0.617E+02    0.14      1.76 .50020E-01
     0.11     -0.03      0.62      1.8 0.568E+02    0.15      1.72 .80502E-01
     0.14     -0.04      0.62      1.9 0.532E+02    0.20      1.69 .11335E+00
```

0.18	-0.05	0.62	2.0	0.505E+02	0.24	1.66	.14819E+00
0.21	-0.06	0.62	2.1	0.482E+02	0.29	1.63	.18476E+00
0.25	-0.07	0.62	2.2	0.463E+02	0.34	1.61	.22288E+00
0.28	-0.08	0.62	2.2	0.446E+02	0.39	1.58	.26240E+00
0.32	-0.09	0.63	2.3	0.432E+02	0.44	1.56	.30322E+00
0.35	-0.09	0.63	2.4	0.419E+02	0.49	1.54	.34523E+00
0.39	-0.10	0.63	2.5	0.407E+02	0.54	1.52	.38836E+00
0.42	-0.11	0.63	2.5	0.397E+02	0.59	1.50	.43254E+00
0.46	-0.12	0.63	2.6	0.387E+02	0.63	1.48	.47772E+00
0.49	-0.13	0.64	2.6	0.378E+02	0.68	1.46	.52383E+00
0.53	-0.14	0.64	2.7	0.370E+02	0.73	1.44	.57083E+00
0.57	-0.15	0.64	2.8	0.363E+02	0.78	1.42	.61869E+00
0.60	-0.16	0.64	2.8	0.356E+02	0.83	1.41	.66737E+00
0.64	-0.17	0.64	2.9	0.349E+02	0.88	1.39	.71683E+00
0.67	-0.18	0.64	2.9	0.343E+02	0.93	1.38	.76704E+00
0.71	-0.19	0.65	3.0	0.337E+02	0.98	1.36	.81798E+00
0.74	-0.20	0.65	3.0	0.332E+02	1.02	1.35	.86961E+00
0.78	-0.21	0.65	3.1	0.327E+02	1.07	1.34	.92193E+00
0.81	-0.22	0.65	3.1	0.322E+02	1.12	1.33	.97489E+00
0.85	-0.23	0.65	3.2	0.317E+02	1.17	1.32	.10285E+01
0.88	-0.24	0.66	3.2	0.313E+02	1.22	1.30	.10827E+01
0.92	-0.25	0.66	3.2	0.309E+02	1.27	1.29	.11375E+01
0.95	-0.26	0.66	3.3	0.305E+02	1.32	1.28	.11929E+01
0.99	-0.27	0.66	3.3	0.301E+02	1.37	1.27	.12489E+01
1.02	-0.27	0.66	3.4	0.297E+02	1.41	1.27	.13054E+01
1.06	-0.28	0.66	3.4	0.294E+02	1.46	1.26	.13624E+01
1.10	-0.29	0.67	3.4	0.290E+02	1.51	1.25	.14200E+01
1.13	-0.30	0.67	3.5	0.287E+02	1.56	1.24	.14780E+01
1.17	-0.31	0.67	3.5	0.284E+02	1.61	1.24	.15366E+01
1.20	-0.32	0.67	3.6	0.281E+02	1.66	1.23	.15956E+01
1.24	-0.33	0.67	3.6	0.278E+02	1.71	1.22	.16552E+01
1.27	-0.34	0.68	3.6	0.275E+02	1.76	1.22	.17152E+01
1.31	-0.35	0.68	3.7	0.272E+02	1.80	1.21	.17756E+01
1.34	-0.36	0.68	3.7	0.270E+02	1.85	1.21	.18365E+01
1.38	-0.37	0.68	3.7	0.267E+02	1.90	1.21	.18978E+01
1.41	-0.38	0.68	3.8	0.265E+02	1.95	1.20	.19596E+01
1.45	-0.39	0.68	3.8	0.262E+02	2.00	1.20	.20218E+01
1.48	-0.40	0.69	3.8	0.260E+02	2.05	1.20	.20844E+01
1.52	-0.41	0.69	3.9	0.258E+02	2.10	1.19	.21474E+01
1.55	-0.42	0.69	3.9	0.256E+02	2.15	1.19	.22108E+01
1.59	-0.43	0.69	3.9	0.253E+02	2.19	1.19	.22746E+01
1.63	-0.44	0.69	4.0	0.251E+02	2.24	1.19	.23387E+01
1.66	-0.44	0.70	4.0	0.249E+02	2.29	1.19	.24033E+01
1.70	-0.45	0.70	4.0	0.247E+02	2.34	1.19	.24682E+01
1.73	-0.46	0.70	4.1	0.245E+02	2.39	1.19	.25335E+01
1.77	-0.47	0.70	4.1	0.244E+02	2.44	1.19	.25991E+01

Cumulative travel time = 2.5991 sec (0.00 hrs)
Plume centerline may exhibit slight discontinuities in transition
to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

BEGIN MOD251: DIFFUSER PLUME IN CO-FLOW

Phase 1: Vertically mixed, Phase 2: Re-stratified

Phase 1: The diffuser plume is VERTICALLY FULLY MIXED over the
entire layer depth.

Profile definitions:
BV = layer depth (vertically mixed)

BH = Gaussian 1/e (37%) half-width in horizontal plane 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	TT
1.77	-0.47	2.44	4.1	0.244E+02	2.44	1.33	.25991E+01
2.45	-0.47	2.44	4.2	0.239E+02	2.44	1.37	.81140E+01
3.13	-0.47	2.44	4.3	0.234E+02	2.44	1.42	.13737E+02
3.81	-0.47	2.44	4.3	0.230E+02	2.44	1.47	.19466E+02
4.50	-0.47	2.44	4.4	0.226E+02	2.44	1.51	.25299E+02
5.18	-0.47	2.44	4.5	0.222E+02	2.44	1.56	.31234E+02
5.86	-0.47	2.44	4.6	0.219E+02	2.44	1.60	.37270E+02
6.54	-0.47	2.44	4.6	0.215E+02	2.44	1.65	.43405E+02
7.23	-0.47	2.44	4.7	0.212E+02	2.44	1.69	.49637E+02
7.91	-0.47	2.44	4.8	0.209E+02	2.44	1.74	.55965E+02
8.59	-0.47	2.44	4.9	0.206E+02	2.44	1.78	.62387E+02
9.27	-0.47	2.44	4.9	0.203E+02	2.44	1.82	.68903E+02
9.96	0.50	2.44	5.0	0.200E+02	2.44	1.87	.75510E+02
10.64	0.61	2.44	5.1	0.197E+02	2.44	1.91	.82207E+02
11.32	0.72	2.44	5.1	0.195E+02	2.44	1.95	.88994E+02
12.00	0.83	2.44	5.2	0.192E+02	2.44	2.00	.95869E+02
12.69	0.95	2.44	5.3	0.190E+02	2.44	2.04	.10283E+03
13.37	1.08	2.44	5.3	0.188E+02	2.44	2.08	.10988E+03
14.05	1.20	2.44	5.4	0.185E+02	2.44	2.12	.11701E+03
14.73	1.33	2.44	5.5	0.183E+02	2.44	2.16	.12423E+03
15.42	1.47	2.44	5.5	0.181E+02	2.44	2.21	.13153E+03
16.10	1.61	2.44	5.6	0.179E+02	2.44	2.25	.13891E+03
16.78	1.75	2.44	5.6	0.177E+02	2.44	2.29	.14637E+03
17.46	1.89	2.44	5.7	0.175E+02	2.44	2.33	.15391E+03
18.15	2.04	2.44	5.8	0.174E+02	2.44	2.37	.16153E+03
18.83	2.19	2.44	5.8	0.172E+02	2.44	2.41	.16924E+03
19.51	2.35	2.44	5.9	0.170E+02	2.44	2.45	.17701E+03
20.19	2.50	2.44	5.9	0.169E+02	2.44	2.49	.18487E+03
20.88	2.67	2.44	6.0	0.167E+02	2.44	2.53	.19280E+03
21.56	2.83	2.44	6.0	0.165E+02	2.44	2.57	.20081E+03
22.24	3.00	2.44	6.1	0.164E+02	2.44	2.61	.20889E+03
22.92	3.17	2.44	6.2	0.162E+02	2.44	2.65	.21704E+03
23.61	3.34	2.44	6.2	0.161E+02	2.44	2.69	.22527E+03
24.29	3.52	2.44	6.3	0.160E+02	2.44	2.73	.23358E+03
24.97	3.70	2.44	6.3	0.158E+02	2.44	2.77	.24195E+03
25.65	3.89	2.44	6.4	0.157E+02	2.44	2.81	.25040E+03
26.34	4.07	2.44	6.4	0.156E+02	2.44	2.84	.25891E+03
27.02	4.26	2.44	6.5	0.154E+02	2.44	2.88	.26750E+03
27.70	4.46	2.44	6.5	0.153E+02	2.44	2.92	.27616E+03
28.38	4.65	2.44	6.6	0.152E+02	2.44	2.96	.28488E+03
29.07	4.85	2.44	6.6	0.151E+02	2.44	3.00	.29368E+03
29.75	5.05	2.44	6.7	0.149E+02	2.44	3.04	.30254E+03
30.43	5.26	2.44	6.7	0.148E+02	2.44	3.07	.31147E+03
31.11	5.47	2.44	6.8	0.147E+02	2.44	3.11	.32047E+03
31.80	5.68	2.44	6.8	0.146E+02	2.44	3.15	.32953E+03
32.48	5.89	2.44	6.9	0.145E+02	2.44	3.19	.33866E+03
33.16	6.11	2.44	6.9	0.144E+02	2.44	3.22	.34786E+03
33.84	6.33	2.44	7.0	0.143E+02	2.44	3.26	.35712E+03
34.53	6.55	2.44	7.0	0.142E+02	2.44	3.30	.36645E+03
35.21	6.77	2.44	7.1	0.141E+02	2.44	3.33	.37584E+03
35.89	7.00	2.44	7.1	0.140E+02	2.44	3.37	.38529E+03

Cumulative travel time = 385.2940 sec (0.11 hrs)
End of Phase 1:
The mixed diffuser flow has RESTRATIFIED and is now detached
from the bottom or surface/interface.

Phase 2: The flow has RESTRATIFIED at the beginning of this zone.

Profile definitions:
BV = top-hat thickness, measured vertically
BH = Gaussian 1/e (37%) half-width in horizontal plane 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	TT
35.89	7.00	2.44	7.1	0.140E+02	2.44	3.37	.38529E+03
36.14	7.08	2.44	7.1	0.140E+02	2.27	3.64	.38872E+03
36.38	7.17	2.44	7.2	0.140E+02	2.18	3.80	.39215E+03
36.63	7.25	2.44	7.2	0.139E+02	2.11	3.94	.39559E+03
36.88	7.34	2.44	7.2	0.139E+02	2.05	4.06	.39904E+03
37.12	7.42	2.44	7.2	0.139E+02	2.01	4.18	.40250E+03
37.37	7.50	2.44	7.2	0.138E+02	1.96	4.29	.40596E+03
37.61	7.59	2.44	7.3	0.138E+02	1.92	4.40	.40944E+03
37.86	7.67	2.44	7.3	0.138E+02	1.89	4.50	.41292E+03
38.11	7.76	2.44	7.3	0.137E+02	1.85	4.59	.41641E+03
38.35	7.85	2.44	7.3	0.137E+02	1.82	4.69	.41991E+03
38.60	7.93	2.44	7.3	0.137E+02	1.79	4.78	.42341E+03
38.84	8.02	2.44	7.3	0.136E+02	1.77	4.87	.42693E+03
39.09	8.11	2.44	7.4	0.136E+02	1.74	4.96	.43045E+03
39.34	8.19	2.44	7.4	0.136E+02	1.72	5.05	.43398E+03
39.58	8.28	2.44	7.4	0.135E+02	1.70	5.13	.43752E+03
39.83	8.37	2.44	7.4	0.135E+02	1.67	5.22	.44106E+03
40.07	8.46	2.44	7.4	0.135E+02	1.65	5.30	.44462E+03
40.32	8.55	2.44	7.4	0.134E+02	1.64	5.38	.44818E+03
40.57	8.63	2.44	7.5	0.134E+02	1.62	5.46	.45175E+03
40.81	8.72	2.44	7.5	0.134E+02	1.60	5.54	.45532E+03
41.06	8.81	2.44	7.5	0.134E+02	1.58	5.62	.45891E+03
41.30	8.90	2.44	7.5	0.133E+02	1.57	5.69	.46250E+03
41.55	8.99	2.44	7.5	0.133E+02	1.55	5.77	.46610E+03
41.80	9.09	2.44	7.5	0.133E+02	1.54	5.85	.46971E+03
42.04	9.18	2.44	7.5	0.132E+02	1.52	5.92	.47333E+03
42.29	9.27	2.44	7.6	0.132E+02	1.51	5.99	.47695E+03
42.53	9.36	2.44	7.6	0.132E+02	1.50	6.07	.48059E+03
42.78	9.45	2.44	7.6	0.132E+02	1.48	6.14	.48423E+03
43.03	9.54	2.44	7.6	0.131E+02	1.47	6.21	.48787E+03
43.27	9.64	2.44	7.6	0.131E+02	1.46	6.29	.49153E+03
43.52	9.73	2.44	7.6	0.131E+02	1.45	6.36	.49519E+03
43.77	9.82	2.44	7.7	0.131E+02	1.44	6.43	.49886E+03
44.01	9.92	2.44	7.7	0.130E+02	1.43	6.50	.50254E+03
44.26	10.01	2.44	7.7	0.130E+02	1.41	6.57	.50623E+03
44.50	10.11	2.44	7.7	0.130E+02	1.40	6.64	.50992E+03
44.75	10.20	2.44	7.7	0.129E+02	1.39	6.71	.51362E+03
45.00	10.30	2.44	7.7	0.129E+02	1.39	6.78	.51733E+03
45.24	10.39	2.44	7.8	0.129E+02	1.38	6.84	.52105E+03
45.49	10.49	2.44	7.8	0.129E+02	1.37	6.91	.52478E+03
45.73	10.58	2.44	7.8	0.128E+02	1.36	6.98	.52851E+03
45.98	10.68	2.44	7.8	0.128E+02	1.35	7.05	.53225E+03
46.23	10.78	2.44	7.8	0.128E+02	1.34	7.11	.53599E+03
46.47	10.87	2.44	7.8	0.128E+02	1.33	7.18	.53975E+03
46.72	10.97	2.44	7.9	0.127E+02	1.32	7.25	.54351E+03
46.96	11.07	2.44	7.9	0.127E+02	1.32	7.31	.54728E+03
47.21	11.17	2.44	7.9	0.127E+02	1.31	7.38	.55106E+03
47.46	11.27	2.44	7.9	0.127E+02	1.30	7.45	.55484E+03
47.70	11.36	2.44	7.9	0.126E+02	1.29	7.51	.55863E+03

```
    47.95    11.46    2.44     7.9 0.126E+02   1.29     7.58 .56243E+03
    48.19    11.56    2.44     7.9 0.126E+02   1.28     7.64 .56624E+03
 Cumulative travel time =        566.2380 sec  (    0.16 hrs)

END OF MOD251: DIFFUSER PLUME IN CO-FLOW
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** End of NEAR-FIELD REGION (NFR) **

 The initial plume WIDTH values in the next far-field module will be
  CORRECTED by a factor  1.46 to conserve the mass flux in the far-field!

 In this design case, the diffuser is located CLOSE TO BANK/SHORE.
 SEVERE BOUNDARY INTERACTION occurs in near-field.
 Consider locating outfall further away from bank or shore.
 No predictive techniques available for this situation; SIMULATION ENDS.
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CORMIX2: Multiport Diffuser Discharges       End of Prediction File
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
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Medford Chronic Conditions.prd

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CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
                               CORMIX MIXING ZONE EXPERT SYSTEM
                        Subsystem CORMIX2: Multiport Diffuser Discharges
                                     CORMIX Version 8.0GTD
                              HYDRO2 Version 8.0.0.0 April 2012
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CASE DESCRIPTION
 Site name/label:    Medford RWRF Mixing Zone Study
 Design case:        Chronic Conditions
 FILE NAME:          C:\Program Files\CORMIX 8.0\Medford.prd
 Time stamp:         Tue Nov 12 13:46:41 2013

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS     =      60.96  AS     =     115.20  QA     =      24.98  ICHREG= 2
 HA     =       1.89  HD     =       2.44
 UA     =      0.217  F      =      0.078  USTAR =0.2137E-01
 UW     =      2.000  UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U           RHOAM =  998.6678

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:       DITYPE= unidirectional_perpendicular
 BANK   =  LEFT       DISTB =      10.97  YB1    =       9.14  YB2    =      12.80
 LD     =       3.66  NOPEN =   3         SPAC   =       1.83
 D0     =      0.457  A0     =      0.164  H0     =       0.61  SUB0   =       1.83
 D0INP  =      0.457  CR0    =      1.000
 Nozzle/port arrangement:   unidirectional_with_fanning
 GAMMA  =      90.00  THETA  =      10.00  SIGMA  =     345.00  BETA   =      75.00
 U0     =      1.619  Q0     =      0.797         =0.7974E+00
 RHO0   =   997.8589  DRHO0  =0.8088E+00  GP0    =0.7943E-02
 C0     =0.1000E+03   CUNITS=  %
 IPOLL  =  1          KS     =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0     =0.2180E+00  m0     =0.3530E+00  j0     =0.1732E-02  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B   =      0.135 lM     =      24.40 lm     =       7.51
 lmp    =   99999.00 lbp    =   99999.00 la     =   99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0     =0.7974E+00  M0     =0.1291E+01  J0     =0.6333E-02
 Associated 3-d length scales (meters)
 LQ     =       0.41 LM     =      15.22 Lm     =       5.24 Lb     =       0.62
                                         Lmp    =   99999.00 Lbp    =   99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =      49.51 FRD0   =      26.87 R      =       7.47 PL     =     1.34
 (slot)              (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0     =      1.619 D0     =      0.457 A0     =      0.164 THETA =      10.00
 FR0    =      49.51 FRD0   =      26.87 R      =       7.47
 (slot)              (riser group)

 FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
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 2  Flow class (CORMIX2)       =    MU2    2
 2  Applicable layer depth HS =     2.44  2
 2222222222222222222222222222222222222222
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MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS

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 C0    =0.1000E+03  CUNITS=  %
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =  10000.00  XMAX  =  10000.00
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X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        10.97 m from the LEFT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 50 display intervals per module

BEGIN MOD201: DIFFUSER DISCHARGE MODULE

Due to complex near-field motions: EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

Profile definitions:
- BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
- BH = top-hat half-width, in horizontal plane 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	BV	BH	Uc	TT
0.00	0.00	0.61	1.0	0.100E+03	0.11	1.83	1.413	.00000E+00

END OF MOD201: DIFFUSER DISCHARGE MODULE

BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

Because of the FANNED-OUT HORIZONTAL ORIENTATION of the diffuser jets,
the near-field dilution is slightly improved.

In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY
MIXED over the entire layer depth (HS =   2.44m).
Full mixing is achieved after a plume distance of about five
layer depths from the diffuser.

Profile definitions:
- BV = layer depth (vertically mixed)
- BH = top-hat half-width, in horizontal plane normal to trajectory
- 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	TT
0.00	-0.00	0.61	1.0	0.100E+03	0.11	1.83	.00000E+00
0.04	-0.01	0.61	1.5	0.646E+02	0.11	1.80	.28976E-01
0.07	-0.02	0.61	1.8	0.563E+02	0.12	1.77	.64821E-01
0.11	-0.03	0.62	2.0	0.513E+02	0.15	1.74	.10480E+00
0.14	-0.04	0.62	2.1	0.477E+02	0.20	1.71	.14796E+00

0.18	-0.05	0.62	2.2	0.449E+02	0.24	1.69	.19374E+00
0.21	-0.06	0.62	2.3	0.427E+02	0.29	1.66	.24180E+00
0.25	-0.07	0.62	2.5	0.408E+02	0.34	1.64	.29185E+00
0.28	-0.08	0.62	2.6	0.392E+02	0.39	1.62	.34371E+00
0.32	-0.09	0.63	2.6	0.378E+02	0.44	1.60	.39720E+00
0.35	-0.09	0.63	2.7	0.366E+02	0.49	1.58	.45221E+00
0.39	-0.10	0.63	2.8	0.355E+02	0.54	1.56	.50861E+00
0.42	-0.11	0.63	2.9	0.345E+02	0.59	1.54	.56631E+00
0.46	-0.12	0.63	3.0	0.336E+02	0.63	1.53	.62524E+00
0.49	-0.13	0.64	3.1	0.328E+02	0.68	1.51	.68532E+00
0.53	-0.14	0.64	3.1	0.320E+02	0.73	1.50	.74649E+00
0.57	-0.15	0.64	3.2	0.313E+02	0.78	1.48	.80869E+00
0.60	-0.16	0.64	3.3	0.307E+02	0.83	1.47	.87187E+00
0.64	-0.17	0.64	3.3	0.301E+02	0.88	1.45	.93600E+00
0.67	-0.18	0.64	3.4	0.295E+02	0.93	1.44	.10010E+01
0.71	-0.19	0.65	3.5	0.290E+02	0.98	1.43	.10669E+01
0.74	-0.20	0.65	3.5	0.285E+02	1.02	1.42	.11336E+01
0.78	-0.21	0.65	3.6	0.280E+02	1.07	1.41	.12011E+01
0.81	-0.22	0.65	3.6	0.275E+02	1.12	1.40	.12694E+01
0.85	-0.23	0.65	3.7	0.271E+02	1.17	1.39	.13384E+01
0.88	-0.24	0.66	3.7	0.267E+02	1.22	1.38	.14081E+01
0.92	-0.25	0.66	3.8	0.263E+02	1.27	1.37	.14785E+01
0.95	-0.26	0.66	3.9	0.260E+02	1.32	1.36	.15496E+01
0.99	-0.27	0.66	3.9	0.256E+02	1.37	1.35	.16214E+01
1.02	-0.27	0.66	4.0	0.253E+02	1.41	1.34	.16937E+01
1.06	-0.28	0.66	4.0	0.250E+02	1.46	1.34	.17667E+01
1.10	-0.29	0.67	4.1	0.247E+02	1.51	1.33	.18402E+01
1.13	-0.30	0.67	4.1	0.244E+02	1.56	1.32	.19144E+01
1.17	-0.31	0.67	4.2	0.241E+02	1.61	1.32	.19891E+01
1.20	-0.32	0.67	4.2	0.238E+02	1.66	1.31	.20643E+01
1.24	-0.33	0.67	4.2	0.236E+02	1.71	1.31	.21401E+01
1.27	-0.34	0.68	4.3	0.233E+02	1.76	1.30	.22164E+01
1.31	-0.35	0.68	4.3	0.231E+02	1.80	1.30	.22932E+01
1.34	-0.36	0.68	4.4	0.228E+02	1.85	1.30	.23706E+01
1.38	-0.37	0.68	4.4	0.226E+02	1.90	1.29	.24484E+01
1.41	-0.38	0.68	4.5	0.224E+02	1.95	1.29	.25266E+01
1.45	-0.39	0.68	4.5	0.222E+02	2.00	1.29	.26054E+01
1.48	-0.40	0.69	4.6	0.220E+02	2.05	1.29	.26845E+01
1.52	-0.41	0.69	4.6	0.218E+02	2.10	1.28	.27642E+01
1.55	-0.42	0.69	4.6	0.216E+02	2.15	1.28	.28442E+01
1.59	-0.43	0.69	4.7	0.214E+02	2.19	1.28	.29247E+01
1.63	-0.44	0.69	4.7	0.212E+02	2.24	1.28	.30056E+01
1.66	-0.44	0.70	4.8	0.210E+02	2.29	1.28	.30870E+01
1.70	-0.45	0.70	4.8	0.208E+02	2.34	1.28	.31687E+01
1.73	-0.46	0.70	4.8	0.207E+02	2.39	1.28	.32508E+01
1.77	-0.47	0.70	4.9	0.205E+02	2.44	1.28	.33333E+01

Cumulative travel time = 3.3333 sec (0.00 hrs)
Plume centerline may exhibit slight discontinuities in transition
to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

BEGIN MOD251: DIFFUSER PLUME IN CO-FLOW

Phase 1: Vertically mixed, Phase 2: Re-stratified

Phase 1: The diffuser plume is VERTICALLY FULLY MIXED over the
entire layer depth.
Profile definitions:
BV = layer depth (vertically mixed)

BH = Gaussian 1/e (37%) half-width in horizontal plane 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	TT
1.77	-0.47	2.44	4.9	0.205E+02	2.44	1.42	.33333E+01
2.01	-0.47	2.44	4.9	0.204E+02	2.44	1.44	.61986E+01
2.25	-0.47	2.44	4.9	0.203E+02	2.44	1.45	.90805E+01
2.49	-0.47	2.44	5.0	0.201E+02	2.44	1.47	.11979E+02
2.73	-0.47	2.44	5.0	0.200E+02	2.44	1.48	.14894E+02
2.98	-0.47	2.44	5.0	0.199E+02	2.44	1.49	.17826E+02
3.22	-0.47	2.44	5.0	0.198E+02	2.44	1.51	.20774E+02
3.46	-0.47	2.44	5.1	0.197E+02	2.44	1.52	.23738E+02
3.70	-0.47	2.44	5.1	0.196E+02	2.44	1.53	.26718E+02
3.94	-0.47	2.44	5.1	0.195E+02	2.44	1.55	.29715E+02
4.19	-0.47	2.44	5.2	0.194E+02	2.44	1.56	.32727E+02
4.43	-0.47	2.44	5.2	0.193E+02	2.44	1.57	.35755E+02
4.67	-0.47	2.44	5.2	0.192E+02	2.44	1.59	.38799E+02
4.91	-0.47	2.44	5.2	0.191E+02	2.44	1.60	.41859E+02
5.15	0.50	2.44	5.3	0.190E+02	2.44	1.62	.44935E+02
5.39	0.57	2.44	5.3	0.189E+02	2.44	1.63	.48026E+02
5.64	0.65	2.44	5.3	0.188E+02	2.44	1.64	.51132E+02
5.88	0.72	2.44	5.3	0.187E+02	2.44	1.65	.54254E+02
6.12	0.80	2.44	5.4	0.186E+02	2.44	1.67	.57392E+02
6.36	0.88	2.44	5.4	0.185E+02	2.44	1.68	.60544E+02
6.60	0.96	2.44	5.4	0.184E+02	2.44	1.69	.63712E+02
6.85	1.04	2.44	5.4	0.184E+02	2.44	1.71	.66895E+02
7.09	1.12	2.44	5.5	0.183E+02	2.44	1.72	.70093E+02
7.33	1.20	2.44	5.5	0.182E+02	2.44	1.73	.73306E+02
7.57	1.28	2.44	5.5	0.181E+02	2.44	1.75	.76534E+02
7.81	1.36	2.44	5.6	0.180E+02	2.44	1.76	.79777E+02
8.05	1.44	2.44	5.6	0.179E+02	2.44	1.77	.83034E+02
8.30	1.52	2.44	5.6	0.179E+02	2.44	1.79	.86306E+02
8.54	1.61	2.44	5.6	0.178E+02	2.44	1.80	.89593E+02
8.78	1.69	2.44	5.7	0.177E+02	2.44	1.81	.92895E+02
9.02	1.78	2.44	5.7	0.176E+02	2.44	1.82	.96211E+02
9.26	1.86	2.44	5.7	0.175E+02	2.44	1.84	.99541E+02
9.51	1.95	2.44	5.7	0.175E+02	2.44	1.85	.10289E+03
9.75	2.04	2.44	5.7	0.174E+02	2.44	1.86	.10625E+03
9.99	2.12	2.44	5.8	0.173E+02	2.44	1.88	.10962E+03
10.23	2.21	2.44	5.8	0.172E+02	2.44	1.89	.11301E+03
10.47	2.30	2.44	5.8	0.172E+02	2.44	1.90	.11641E+03
10.72	2.39	2.44	5.8	0.171E+02	2.44	1.91	.11982E+03
10.96	2.48	2.44	5.9	0.170E+02	2.44	1.93	.12325E+03
11.20	2.57	2.44	5.9	0.170E+02	2.44	1.94	.12670E+03
11.44	2.66	2.44	5.9	0.169E+02	2.44	1.95	.13016E+03
11.68	2.75	2.44	5.9	0.168E+02	2.44	1.96	.13363E+03
11.92	2.85	2.44	6.0	0.168E+02	2.44	1.98	.13711E+03
12.17	2.94	2.44	6.0	0.167E+02	2.44	1.99	.14061E+03
12.41	3.03	2.44	6.0	0.166E+02	2.44	2.00	.14412E+03
12.65	3.13	2.44	6.0	0.166E+02	2.44	2.01	.14765E+03
12.89	3.22	2.44	6.1	0.165E+02	2.44	2.03	.15119E+03
13.13	3.32	2.44	6.1	0.164E+02	2.44	2.04	.15475E+03
13.38	3.42	2.44	6.1	0.164E+02	2.44	2.05	.15831E+03
13.62	3.51	2.44	6.1	0.163E+02	2.44	2.06	.16189E+03
13.86	3.61	2.44	6.1	0.163E+02	2.44	2.08	.16549E+03

Cumulative travel time = 165.4876 sec (0.05 hrs)

Entire region is occupied by Phase 1.
Plume does not re-stratify in this flow region.

END OF MOD251: DIFFUSER PLUME IN CO-FLOW

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

The initial plume WIDTH values in the next far-field module will be
CORRECTED by a factor 2.16 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.

BEGIN MOD241: 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
13.86	3.61	2.44	6.1	0.163E+02	2.44	4.49	2.44	0.00	.16549E+03
14.23	3.61	2.44	6.2	0.162E+02	2.41	4.56	2.44	0.03	.16715E+03
14.60	3.61	2.44	6.2	0.161E+02	2.39	4.62	2.44	0.05	.16881E+03
14.97	3.61	2.44	6.2	0.161E+02	2.37	4.69	2.44	0.07	.17047E+03
15.34	3.61	2.44	6.2	0.160E+02	2.34	4.75	2.44	0.10	.17213E+03
15.72	3.61	2.44	6.3	0.159E+02	2.32	4.82	2.44	0.12	.17379E+03
16.09	3.61	2.44	6.3	0.159E+02	2.30	4.88	2.44	0.14	.17545E+03
16.46	3.61	2.44	6.3	0.158E+02	2.28	4.94	2.44	0.16	.17711E+03
16.83	3.61	2.44	6.3	0.158E+02	2.26	5.01	2.44	0.18	.17877E+03
17.20	3.61	2.44	6.4	0.157E+02	2.24	5.07	2.44	0.20	.18043E+03
17.57	3.61	2.44	6.4	0.156E+02	2.22	5.13	2.44	0.22	.18209E+03
17.94	3.61	2.44	6.4	0.156E+02	2.20	5.19	2.44	0.24	.18374E+03
18.32	3.61	2.44	6.4	0.155E+02	2.18	5.25	2.44	0.25	.18540E+03
18.69	3.61	2.44	6.5	0.155E+02	2.17	5.31	2.44	0.27	.18706E+03
19.06	3.61	2.44	6.5	0.154E+02	2.15	5.37	2.44	0.29	.18872E+03
19.43	3.61	2.44	6.5	0.154E+02	2.13	5.43	2.44	0.31	.19038E+03
19.80	3.61	2.44	6.5	0.153E+02	2.12	5.49	2.44	0.32	.19204E+03
20.17	3.61	2.44	6.5	0.153E+02	2.10	5.55	2.44	0.34	

.19370E+03	20.54	3.61	2.44	6.6 0.152E+02	2.09	5.61	2.44	0.35
.19536E+03	20.91	3.61	2.44	6.6 0.152E+02	2.07	5.67	2.44	0.37
.19702E+03	21.29	3.61	2.44	6.6 0.151E+02	2.06	5.73	2.44	0.38
.19868E+03	21.66	3.61	2.44	6.6 0.151E+02	2.04	5.79	2.44	0.39
.20034E+03	22.03	3.61	2.44	6.7 0.150E+02	2.03	5.85	2.44	0.41
.20200E+03	22.40	3.61	2.44	6.7 0.150E+02	2.02	5.90	2.44	0.42
.20366E+03	22.77	3.61	2.44	6.7 0.149E+02	2.00	5.96	2.44	0.43
.20532E+03	23.14	3.61	2.44	6.7 0.149E+02	1.99	6.02	2.44	0.45
.20698E+03	23.51	3.61	2.44	6.7 0.148E+02	1.98	6.07	2.44	0.46
.20864E+03	23.89	3.61	2.44	6.8 0.148E+02	1.97	6.13	2.44	0.47
.21030E+03	24.26	3.61	2.44	6.8 0.147E+02	1.95	6.19	2.44	0.48
.21196E+03	24.63	3.61	2.44	6.8 0.147E+02	1.94	6.24	2.44	0.50
.21362E+03	25.00	3.61	2.44	6.8 0.146E+02	1.93	6.30	2.44	0.51
.21528E+03	25.37	3.61	2.44	6.8 0.146E+02	1.92	6.35	2.44	0.52
.21694E+03	25.74	3.61	2.44	6.9 0.146E+02	1.91	6.41	2.44	0.53
.21860E+03	26.11	3.61	2.44	6.9 0.145E+02	1.90	6.46	2.44	0.54
.22026E+03	26.48	3.61	2.44	6.9 0.145E+02	1.89	6.52	2.44	0.55
.22192E+03	26.86	3.61	2.44	6.9 0.144E+02	1.88	6.57	2.44	0.56
.22358E+03	27.23	3.61	2.44	7.0 0.144E+02	1.87	6.63	2.44	0.57
.22524E+03	27.60	3.61	2.44	7.0 0.143E+02	1.86	6.68	2.44	0.58
.22690E+03	27.97	3.61	2.44	7.0 0.143E+02	1.85	6.74	2.44	0.59
.22856E+03	28.34	3.61	2.44	7.0 0.143E+02	1.84	6.79	2.44	0.60
.23022E+03	28.71	3.61	2.44	7.0 0.142E+02	1.83	6.84	2.44	0.61
.23188E+03	29.08	3.61	2.44	7.1 0.142E+02	1.82	6.90	2.44	0.61
.23354E+03	29.46	3.61	2.44	7.1 0.141E+02	1.81	6.95	2.44	0.62
.23520E+03	29.83	3.61	2.44	7.1 0.141E+02	1.81	7.00	2.44	0.63
.23686E+03	30.20	3.61	2.44	7.1 0.141E+02	1.80	7.05	2.44	0.64
.23852E+03	30.57	3.61	2.44	7.1 0.140E+02	1.79	7.11	2.44	0.65
.24018E+03	30.94	3.61	2.44	7.2 0.140E+02	1.78	7.16	2.44	0.66
.24184E+03	31.31	3.61	2.44	7.2 0.139E+02	1.77	7.21	2.44	0.66
.24350E+03	31.68	3.61	2.44	7.2 0.139E+02	1.77	7.26	2.44	0.67
.24516E+03								

32.05	3.61	2.44	7.2	0.138E+02	1.76	7.31	2.44	0.68	.24682E+03
32.43	3.61	2.44	7.2	0.138E+02	1.75	7.37	2.44	0.69	.24848E+03

Cumulative travel time = 248.4762 sec (0.07 hrs)

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

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
32.43	10.97	2.44	7.2	0.138E+02	1.75	14.73	2.44	0.69	.24848E+03
36.50	10.97	2.44	7.4	0.135E+02	1.73	15.29	2.44	0.71	.26667E+03
40.57	10.97	2.44	7.6	0.132E+02	1.70	15.83	2.44	0.74	.28486E+03
44.64	10.97	2.44	7.7	0.129E+02	1.68	16.37	2.44	0.75	.30305E+03
48.70	10.97	2.44	7.9	0.126E+02	1.67	16.90	2.44	0.77	.32124E+03
52.77	10.97	2.44	8.1	0.124E+02	1.65	17.42	2.44	0.78	.33943E+03
56.84	10.97	2.44	8.3	0.121E+02	1.64	17.93	2.44	0.79	.35762E+03
60.91	10.97	2.44	8.5	0.118E+02	1.64	18.44	2.44	0.80	.37581E+03
64.98	10.97	2.44	8.7	0.115E+02	1.63	18.94	2.44	0.81	.39400E+03
69.05	10.97	2.44	8.9	0.113E+02	1.63	19.43	2.44	0.81	.41220E+03
73.12	10.97	2.44	9.1	0.110E+02	1.63	19.92	2.44	0.81	.43039E+03
77.19	10.97	2.44	9.3	0.107E+02	1.63	20.40	2.44	0.81	.44858E+03
81.26	10.97	2.44	9.5	0.105E+02	1.63	20.87	2.44	0.81	.46677E+03
85.33	10.97	2.44	9.8	0.102E+02	1.63	21.34	2.44	0.81	.48496E+03
89.40	10.97	2.44	10.0	0.999E+01	1.64	21.80	2.44	0.80	.50315E+03
93.47	10.97	2.44	10.3	0.975E+01	1.64	22.26	2.44	0.80	.52134E+03
97.54	10.97	2.44	10.5	0.951E+01	1.65	22.72	2.44	0.79	.53953E+03
101.61	10.97	2.44	10.8	0.927E+01	1.66	23.17	2.44	0.78	.55772E+03
105.68	10.97	2.44	11.1	0.904E+01	1.67	23.61	2.44	0.77	.57591E+03
109.75	10.97	2.44	11.3	0.882E+01	1.68	24.05	2.44	0.76	.59411E+03
113.82	10.97	2.44	11.6	0.860E+01	1.69	24.49	2.44	0.75	.61230E+03
117.89	10.97	2.44	11.9	0.838E+01	1.71	24.92	2.44	0.73	.63049E+03
121.96	10.97	2.44	12.2	0.817E+01	1.72	25.35	2.44	0.72	.64868E+03
126.03	10.97	2.44	12.6	0.796E+01	1.74	25.78	2.44	0.70	.66687E+03
130.10	10.97	2.44	12.9	0.776E+01	1.75	26.20	2.44	0.69	

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.68506E+03
    134.17      10.97     2.44     13.2 0.757E+01   1.77     26.62     2.44     0.67
.70325E+03
    138.24      10.97     2.44     13.6 0.737E+01   1.79     27.04     2.44     0.65
.72144E+03
    142.31      10.97     2.44     13.9 0.719E+01   1.81     27.45     2.44     0.63
.73963E+03
    146.38      10.97     2.44     14.3 0.700E+01   1.83     27.86     2.44     0.61
.75782E+03
    150.45      10.97     2.44     14.6 0.683E+01   1.85     28.27     2.44     0.59
.77602E+03
    154.52      10.97     2.44     15.0 0.665E+01   1.87     28.67     2.44     0.57
.79421E+03
    158.59      10.97     2.44     15.4 0.648E+01   1.89     29.07     2.44     0.55
.81240E+03
    162.66      10.97     2.44     15.8 0.632E+01   1.91     29.47     2.44     0.52
.83059E+03
    166.73      10.97     2.44     16.2 0.616E+01   1.94     29.86     2.44     0.50
.84878E+03
    170.80      10.97     2.44     16.7 0.600E+01   1.96     30.26     2.44     0.48
.86697E+03
    174.87      10.97     2.44     17.1 0.585E+01   1.99     30.65     2.44     0.45
.88516E+03
    178.94      10.97     2.44     17.5 0.571E+01   2.01     31.03     2.44     0.43
.90335E+03
    183.01      10.97     2.44     18.0 0.556E+01   2.04     31.42     2.44     0.40
.92154E+03
    187.08      10.97     2.44     18.4 0.542E+01   2.07     31.80     2.44     0.37
.93973E+03
    191.15      10.97     2.44     18.9 0.529E+01   2.09     32.18     2.44     0.34
.95793E+03
    195.22      10.97     2.44     19.4 0.516E+01   2.12     32.56     2.44     0.32
.97612E+03
    199.29      10.97     2.44     19.9 0.503E+01   2.15     32.94     2.44     0.29
.99431E+03
    203.36      10.97     2.44     20.4 0.491E+01   2.18     33.31     2.44     0.26
.10125E+04
    207.43      10.97     2.44     20.9 0.479E+01   2.21     33.68     2.44     0.23
.10307E+04
    211.49      10.97     2.44     21.4 0.467E+01   2.24     34.05     2.44     0.20
.10489E+04
    215.56      10.97     2.44     22.0 0.456E+01   2.27     34.42     2.44     0.17
.10671E+04
    219.63      10.97     2.44     22.5 0.444E+01   2.31     34.79     2.44     0.13
.10853E+04
    223.70      10.97     2.44     23.1 0.434E+01   2.34     35.15     2.44     0.10
.11035E+04
    227.77      10.97     2.44     23.6 0.423E+01   2.37     35.51     2.44     0.07
.11216E+04
    231.84      10.97     2.44     24.2 0.413E+01   2.40     35.88     2.44     0.03
.11398E+04
    235.91      10.97     2.44     24.8 0.403E+01   2.44     36.23     2.44     0.00
.11580E+04
 Cumulative travel time =        1158.0269 sec  (    0.32 hrs)

END OF MOD241: BUOYANT AMBIENT SPREADING
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 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".
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BEGIN MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = 0.104E-01 m^2/s
Horizontal diffusivity (initial value) = 0.261E-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
235.91	10.97	2.44	24.8	0.403E+01	2.44	36.23	2.44	0.00	.11580E+04

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
431.20	10.97	2.44	25.5	0.393E+01	2.44	37.21	2.44	0.00	.20309E+04
626.48	10.97	2.44	26.1	0.383E+01	2.44	38.16	2.44	0.00	.29038E+04
821.76	10.97	2.44	26.7	0.374E+01	2.44	39.08	2.44	0.00	.37766E+04
1017.04	10.97	2.44	27.4	0.366E+01	2.44	39.99	2.44	0.00	.46495E+04
1212.32	10.97	2.44	28.0	0.358E+01	2.44	40.87	2.44	0.00	.55224E+04
1407.60	10.97	2.44	28.6	0.350E+01	2.44	41.74	2.44	0.00	.63953E+04
1602.89	10.97	2.44	29.1	0.343E+01	2.44	42.58	2.44	0.00	.72681E+04
1798.17	10.97	2.44	29.7	0.337E+01	2.44	43.42	2.44	0.00	.81410E+04
1993.45	10.97	2.44	30.3	0.330E+01	2.44	44.23	2.44	0.00	.90139E+04
2188.73	10.97	2.44	30.8	0.325E+01	2.44	45.03	2.44	0.00	.98868E+04
2384.01	10.97	2.44	31.3	0.319E+01	2.44	45.82	2.44	0.00	.10760E+05
2579.29	10.97	2.44	31.9	0.314E+01	2.44	46.59	2.44	0.00	.11632E+05
2774.58	10.97	2.44	32.4	0.309E+01	2.44	47.36	2.44	0.00	.12505E+05
2969.86	10.97	2.44	32.9	0.304E+01	2.44	48.10	2.44	0.00	.13378E+05
3165.14	10.97	2.44	33.4	0.299E+01	2.44	48.84	2.44	0.00	.14251E+05
3360.42	10.97	2.44	33.9	0.295E+01	2.44	49.57	2.44	0.00	.15124E+05
3555.70	10.97	2.44	34.4	0.291E+01	2.44	50.28	2.44	0.00	.15997E+05
3750.98	10.97	2.44	34.9	0.287E+01	2.44	50.99	2.44	0.00	.16870E+05
3946.27	10.97	2.44	35.4	0.283E+01	2.44	51.69	2.44	0.00	.17743E+05
4141.55	10.97	2.44	35.8	0.279E+01	2.44	52.37	2.44	0.00	

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.18615E+05
   4336.83      10.97     2.44      36.3 0.276E+01   2.44      53.05      2.44      0.00
.19488E+05
   4532.11      10.97     2.44      36.8 0.272E+01   2.44      53.72      2.44      0.00
.20361E+05
   4727.39      10.97     2.44      37.2 0.269E+01   2.44      54.38      2.44      0.00
.21234E+05
   4922.67      10.97     2.44      37.7 0.266E+01   2.44      55.04      2.44      0.00
.22107E+05
   5117.96      10.97     2.44      38.1 0.263E+01   2.44      55.68      2.44      0.00
.22980E+05
   5313.24      10.97     2.44      38.5 0.260E+01   2.44      56.32      2.44      0.00
.23853E+05
   5508.52      10.97     2.44      39.0 0.257E+01   2.44      56.95      2.44      0.00
.24726E+05
   5703.80      10.97     2.44      39.4 0.254E+01   2.44      57.58      2.44      0.00
.25598E+05
   5899.08      10.97     2.44      39.8 0.251E+01   2.44      58.20      2.44      0.00
.26471E+05
   6094.37      10.97     2.44      40.2 0.249E+01   2.44      58.81      2.44      0.00
.27344E+05
   6289.65      10.97     2.44      40.6 0.246E+01   2.44      59.41      2.44      0.00
.28217E+05
   6484.93      10.97     2.44      41.1 0.244E+01   2.44      60.01      2.44      0.00
.29090E+05
   6680.21      10.97     2.44      41.5 0.241E+01   2.44      60.60      2.44      0.00
.29963E+05
 The passive diffusion plume becomes LATERALLY FULLY MIXED over the channel
     width during the current prediction interval.
 The x-coordinate of bank attachment is    6798.73 m.
   6875.49      10.97     2.44      41.9 0.239E+01   2.44      60.96      2.44      0.00
.30836E+05
 Effluent is FULLY MIXED over the entire channel cross-section.
 Except for possible far-field decay or reaction processes, there are
     NO FURTHER CHANGES with downstream direction.
   7070.77      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.31709E+05
   7266.06      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.32581E+05
   7461.34      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.33454E+05
   7656.62      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.34327E+05
   7851.90      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.35200E+05
   8047.18      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.36073E+05
   8242.46      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.36946E+05
   8437.75      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.37819E+05
   8633.03      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.38692E+05
   8828.31      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.39564E+05
   9023.59      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.40437E+05
   9218.87      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.41310E+05
   9414.15      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.42183E+05
   9609.43      10.97     2.44      41.7 0.240E+01   2.44      60.96      2.44      0.00
.43056E+05
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  9804.71     10.97    2.44    41.7 0.240E+01   2.44     60.96    2.44    0.00
.43929E+05
 10000.00     10.97    2.44    41.7 0.240E+01   2.44     60.96    2.44    0.00
.44802E+05
 Cumulative travel time =       44801.6523 sec  (   12.44 hrs)

 Simulation limit based on maximum specified distance =  10000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
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CORMIX2: Multiport Diffuser Discharges       End of Prediction File
22222222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
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Medford HH Carcinogen.prd

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CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
                        CORMIX MIXING ZONE EXPERT SYSTEM
                Subsystem CORMIX2: Multiport Diffuser Discharges
                              CORMIX Version 8.0GTD
                         HYDRO2 Version 8.0.0.0 April 2012
-------------------------------------------------------------------------------------------
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CASE DESCRIPTION
 Site name/label:    Medford RWRF Mixing Zone Study
 Design case:        Human Health, Carcinogen
 FILE NAME:          C:\Program Files\CORMIX 8.0\Medford.prd
 Time stamp:         Tue Nov 12 13:50:35 2013

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS     =      60.96  AS     =     115.20  QA     =     53.75  ICHREG= 2
 HA     =       1.89  HD     =       2.44
 UA     =      0.467  F      =      0.078  USTAR =0.4599E-01
 UW     =      2.000  UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=   U          RHOAM =   999.7749

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:       DITYPE= unidirectional_perpendicular
 BANK   =   LEFT      DISTB =      10.97  YB1    =      9.14  YB2    =      12.80
 LD     =       3.66  NOPEN =    3        SPAC   =      1.83
 D0     =      0.457  A0     =      0.164  H0     =      0.61  SUB0   =       1.83
 D0INP  =      0.457  CR0    =      1.000
 Nozzle/port arrangement:    unidirectional_with_fanning
 GAMMA  =      90.00  THETA  =      10.00  SIGMA  =    345.00  BETA   =      75.00
 U0     =      1.619  Q0     =      0.797        =0.7974E+00
 RHO0   =   998.4709  DRHO0 =0.1304E+01  GP0    =0.1279E-01
 C0     =0.1000E+03  CUNITS=   %
 IPOLL  =   1         KS     =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0     =0.2180E+00  m0     =0.3530E+00  j0     =0.2788E-02  SIGNJ0=       1.0
 Associated 2-d length scales (meters)
 lQ=B   =      0.135  lM     =      17.77  lm     =      1.62
 lmp    =   99999.00  lbp    =   99999.00  la     =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0     =0.7974E+00  M0     =0.1291E+01  J0     =0.1020E-01
 Associated 3-d length scales (meters)
 LQ     =       0.41  LM     =      11.99  Lm     =      2.44  Lb     =       0.10
                                          Lmp    =  99999.00  Lbp    =   99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =      39.01  FRD0   =      21.17  R      =      3.47  PL     =     1.57
 (slot)               (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0     =      1.619  D0     =      0.457  A0     =     0.164  THETA =      10.00
 FR0    =      39.01  FRD0   =      21.17  R      =      3.47
 (slot)               (riser group)

FLOW CLASSIFICATION
 2222222222222222222222222222222222222222
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 2  Flow class (CORMIX2)        =    MU2    2
 2  Applicable layer depth HS =     2.44  2
 2222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     =0.1000E+03  CUNITS=  %
 NTOX   =  0
 NSTD   =  0
 REGMZ =  0
 XINT   =  10000.00  XMAX   =  10000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        10.97 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  50 display intervals per module
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BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = top-hat half-width, in horizontal plane 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         BV        BH        Uc         TT
      0.00       0.00      0.61       1.0 0.100E+03   0.11      1.83      1.175   .00000E+00

END OF MOD201: DIFFUSER DISCHARGE MODULE
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BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

 Because of the FANNED-OUT HORIZONTAL ORIENTATION of the diffuser jets,
   the near-field dilution is slightly improved.

 In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY
  MIXED over the entire layer depth (HS =    2.44m).
   Full mixing is achieved after a plume distance of about five
   layer depths from the diffuser.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, in horizontal plane normal to trajectory
   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          TT
      0.00      -0.00      0.61       1.0 0.100E+03   0.11      1.83 .00000E+00
      0.04      -0.01      0.61       1.9 0.532E+02   0.11      1.81 .27561E-01
      0.07      -0.02      0.61       2.2 0.445E+02   0.12      1.80 .61614E-01
      0.11      -0.03      0.62       2.5 0.396E+02   0.15      1.78 .99091E-01
      0.14      -0.04      0.62       2.8 0.362E+02   0.20      1.77 .13900E+00
```

0.18	-0.05	0.62	3.0	0.337E+02	0.24	1.75	.18080E+00
0.21	-0.06	0.62	3.2	0.317E+02	0.29	1.74	.22415E+00
0.25	-0.07	0.62	3.3	0.300E+02	0.34	1.73	.26881E+00
0.28	-0.08	0.62	3.5	0.286E+02	0.39	1.72	.31461E+00
0.32	-0.09	0.63	3.6	0.274E+02	0.44	1.70	.36141E+00
0.35	-0.09	0.63	3.8	0.264E+02	0.49	1.69	.40910E+00
0.39	-0.10	0.63	3.9	0.255E+02	0.54	1.68	.45760E+00
0.42	-0.11	0.63	4.1	0.247E+02	0.59	1.68	.50683E+00
0.46	-0.12	0.63	4.2	0.239E+02	0.63	1.67	.55673E+00
0.49	-0.13	0.64	4.3	0.233E+02	0.68	1.66	.60724E+00
0.53	-0.14	0.64	4.4	0.227E+02	0.73	1.65	.65833E+00
0.57	-0.15	0.64	4.5	0.221E+02	0.78	1.64	.70995E+00
0.60	-0.16	0.64	4.6	0.216E+02	0.83	1.64	.76206E+00
0.64	-0.17	0.64	4.7	0.211E+02	0.88	1.63	.81465E+00
0.67	-0.18	0.64	4.8	0.207E+02	0.93	1.62	.86767E+00
0.71	-0.19	0.65	4.9	0.202E+02	0.98	1.62	.92110E+00
0.74	-0.20	0.65	5.0	0.198E+02	1.02	1.61	.97492E+00
0.78	-0.21	0.65	5.1	0.195E+02	1.07	1.60	.10291E+01
0.81	-0.22	0.65	5.2	0.191E+02	1.12	1.60	.10837E+01
0.85	-0.23	0.65	5.3	0.188E+02	1.17	1.59	.11385E+01
0.88	-0.24	0.66	5.4	0.185E+02	1.22	1.59	.11938E+01
0.92	-0.25	0.66	5.5	0.182E+02	1.27	1.58	.12493E+01
0.95	-0.26	0.66	5.6	0.179E+02	1.32	1.58	.13051E+01
0.99	-0.27	0.66	5.7	0.177E+02	1.37	1.57	.13611E+01
1.02	-0.27	0.66	5.7	0.174E+02	1.41	1.57	.14175E+01
1.06	-0.28	0.66	5.8	0.172E+02	1.46	1.57	.14741E+01
1.10	-0.29	0.67	5.9	0.169E+02	1.51	1.56	.15309E+01
1.13	-0.30	0.67	6.0	0.167E+02	1.56	1.56	.15880E+01
1.17	-0.31	0.67	6.1	0.165E+02	1.61	1.56	.16454E+01
1.20	-0.32	0.67	6.1	0.163E+02	1.66	1.55	.17029E+01
1.24	-0.33	0.67	6.2	0.161E+02	1.71	1.55	.17607E+01
1.27	-0.34	0.68	6.3	0.159E+02	1.76	1.55	.18187E+01
1.31	-0.35	0.68	6.4	0.157E+02	1.80	1.55	.18768E+01
1.34	-0.36	0.68	6.4	0.155E+02	1.85	1.54	.19352E+01
1.38	-0.37	0.68	6.5	0.154E+02	1.90	1.54	.19937E+01
1.41	-0.38	0.68	6.6	0.152E+02	1.95	1.54	.20525E+01
1.45	-0.39	0.68	6.6	0.151E+02	2.00	1.54	.21114E+01
1.48	-0.40	0.69	6.7	0.149E+02	2.05	1.54	.21705E+01
1.52	-0.41	0.69	6.8	0.148E+02	2.10	1.54	.22297E+01
1.55	-0.42	0.69	6.8	0.146E+02	2.15	1.54	.22892E+01
1.59	-0.43	0.69	6.9	0.145E+02	2.19	1.54	.23487E+01
1.63	-0.44	0.69	7.0	0.143E+02	2.24	1.53	.24085E+01
1.66	-0.44	0.70	7.0	0.142E+02	2.29	1.53	.24684E+01
1.70	-0.45	0.70	7.1	0.141E+02	2.34	1.53	.25284E+01
1.73	-0.46	0.70	7.2	0.139E+02	2.39	1.53	.25885E+01
1.77	-0.47	0.70	7.2	0.138E+02	2.44	1.53	.26489E+01

Cumulative travel time = 2.6489 sec (0.00 hrs)
Plume centerline may exhibit slight discontinuities in transition
to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

BEGIN MOD251: DIFFUSER PLUME IN CO-FLOW

Phase 1: Vertically mixed, Phase 2: Re-stratified

Phase 1: The diffuser plume is VERTICALLY FULLY MIXED over the
entire layer depth.
This flow region is INSIGNIFICANT in spatial extent and will be by-passed.

Phase 2: The flow has RESTRATIFIED at the beginning of this zone.

This flow region is INSIGNIFICANT in spatial extent and will be by-passed.

END OF MOD251: DIFFUSER PLUME IN CO-FLOW

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

The initial plume WIDTH values in the next far-field module will be
CORRECTED by a factor 1.63 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.

BEGIN MOD241: 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
1.77	-0.47	2.44	7.2	0.138E+02	2.44	2.50	2.44	0.00	.26489E+01
2.41	-0.47	2.44	7.3	0.137E+02	2.40	2.56	2.44	0.04	.40101E+01
3.06	-0.47	2.44	7.4	0.136E+02	2.37	2.62	2.44	0.07	.53713E+01
3.70	-0.47	2.44	7.4	0.135E+02	2.33	2.68	2.44	0.11	.67325E+01
4.34	-0.47	2.44	7.5	0.133E+02	2.30	2.74	2.44	0.14	.80938E+01
4.99	-0.47	2.44	7.6	0.132E+02	2.27	2.80	2.44	0.17	.94550E+01
5.63	-0.47	2.44	7.6	0.131E+02	2.24	2.86	2.44	0.19	.10816E+02
6.28	-0.47	2.44	7.7	0.130E+02	2.22	2.92	2.44	0.22	.12177E+02
6.92	-0.47	2.44	7.8	0.129E+02	2.19	2.98	2.44	0.24	.13539E+02
7.57	-0.47	2.44	7.8	0.128E+02	2.17	3.04	2.44	0.27	.14900E+02
8.21	-0.47	2.44	7.9	0.127E+02	2.15	3.09	2.44	0.29	.16261E+02
8.86	-0.47	2.44	8.0	0.125E+02	2.13	3.15	2.44	0.31	.17622E+02
9.50	-0.47	2.44	8.0	0.124E+02	2.11	3.21	2.44	0.33	.18984E+02
10.14	-0.47	2.44	8.1	0.123E+02	2.09	3.26	2.44	0.35	.20345E+02
10.79	-0.47	2.44	8.2	0.122E+02	2.08	3.32	2.44	0.36	.21706E+02
11.43	-0.47	2.44	8.3	0.121E+02	2.06	3.37	2.44	0.38	

.23067E+02								
12.08	-0.47	2.44	8.3	0.120E+02	2.05	3.43	2.44	0.39
.24429E+02								
12.72	-0.47	2.44	8.4	0.119E+02	2.03	3.48	2.44	0.41
.25790E+02								
13.37	-0.47	2.44	8.5	0.118E+02	2.02	3.53	2.44	0.42
.27151E+02								
14.01	-0.47	2.44	8.5	0.117E+02	2.01	3.59	2.44	0.43
.28512E+02								
14.66	-0.47	2.44	8.6	0.116E+02	1.99	3.64	2.44	0.44
.29873E+02								
15.30	-0.47	2.44	8.7	0.115E+02	1.98	3.69	2.44	0.46
.31235E+02								
15.95	-0.47	2.44	8.8	0.114E+02	1.97	3.74	2.44	0.47
.32596E+02								
16.59	-0.47	2.44	8.8	0.113E+02	1.96	3.79	2.44	0.47
.33957E+02								
17.23	-0.47	2.44	8.9	0.112E+02	1.95	3.85	2.44	0.48
.35318E+02								
17.88	-0.47	2.44	9.0	0.111E+02	1.95	3.90	2.44	0.49
.36680E+02								
18.52	-0.47	2.44	9.1	0.110E+02	1.94	3.95	2.44	0.50
.38041E+02								
19.17	-0.47	2.44	9.2	0.109E+02	1.93	4.00	2.44	0.51
.39402E+02								
19.81	-0.47	2.44	9.3	0.108E+02	1.93	4.05	2.44	0.51
.40763E+02								
20.46	-0.47	2.44	9.3	0.107E+02	1.92	4.10	2.44	0.52
.42125E+02								
21.10	-0.47	2.44	9.4	0.106E+02	1.91	4.15	2.44	0.52
.43486E+02								
21.75	-0.47	2.44	9.5	0.105E+02	1.91	4.19	2.44	0.53
.44847E+02								
22.39	-0.47	2.44	9.6	0.104E+02	1.90	4.24	2.44	0.53
.46208E+02								
23.03	-0.47	2.44	9.7	0.103E+02	1.90	4.29	2.44	0.54
.47569E+02								
23.68	-0.47	2.44	9.8	0.102E+02	1.90	4.34	2.44	0.54
.48931E+02								
24.32	-0.47	2.44	9.9	0.101E+02	1.89	4.39	2.44	0.54
.50292E+02								
24.97	-0.47	2.44	10.0	0.100E+02	1.89	4.43	2.44	0.55
.51653E+02								
25.61	-0.47	2.44	10.1	0.995E+01	1.89	4.48	2.44	0.55
.53014E+02								
26.26	-0.47	2.44	10.1	0.986E+01	1.89	4.53	2.44	0.55
.54376E+02								
26.90	-0.47	2.44	10.2	0.976E+01	1.88	4.58	2.44	0.55
.55737E+02								
27.55	-0.47	2.44	10.3	0.967E+01	1.88	4.62	2.44	0.55
.57098E+02								
28.19	-0.47	2.44	10.4	0.958E+01	1.88	4.67	2.44	0.56
.58459E+02								
28.84	-0.47	2.44	10.5	0.949E+01	1.88	4.71	2.44	0.56
.59821E+02								
29.48	-0.47	2.44	10.6	0.940E+01	1.88	4.76	2.44	0.56
.61182E+02								
30.12	-0.47	2.44	10.7	0.931E+01	1.88	4.81	2.44	0.56
.62543E+02								
30.77	-0.47	2.44	10.8	0.922E+01	1.88	4.85	2.44	0.56
.63904E+02								
31.41	-0.47	2.44	10.9	0.913E+01	1.88	4.90	2.44	0.56
.65265E+02								

```
     32.06     -0.47     2.44     11.1 0.905E+01   1.88      4.94     2.44     0.55
.66627E+02
     32.70     -0.47     2.44     11.2 0.896E+01   1.89      4.99     2.44     0.55
.67988E+02
     33.35     -0.47     2.44     11.3 0.887E+01   1.89      5.03     2.44     0.55
.69349E+02
     33.99     -0.47     2.44     11.4 0.879E+01   1.89      5.08     2.44     0.55
.70710E+02
 Cumulative travel time =          70.7103 sec  (    0.02 hrs)

END OF MOD241: BUOYANT AMBIENT SPREADING
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 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB =  0.55m
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BEGIN MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

   Vertical diffusivity (initial value)   = 0.224E-01 m^2/s
   Horizontal diffusivity (initial value) = 0.561E-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 1 (not bank attached):
       X         Y         Z         S         C         BV        BH        ZU        ZL
TT
     33.99     -0.47     2.44     11.4 0.879E+01   1.89      5.08     2.44     0.55
.70710E+02
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
     39.65     -0.47     2.44     11.8 0.844E+01   1.89      5.28     2.44     0.55
.82656E+02
     45.30     -0.47     2.44     12.3 0.814E+01   1.89      5.47     2.44     0.55
.94601E+02
     50.96     -0.47     2.44     12.7 0.787E+01   1.89      5.66     2.44     0.55
.10655E+03
     56.61     -0.47     2.44     13.1 0.762E+01   1.89      5.85     2.44     0.55
.11849E+03
     62.27     -0.47     2.44     13.5 0.740E+01   1.89      6.02     2.44     0.55
.13044E+03
     67.93     -0.47     2.44     13.9 0.719E+01   1.89      6.20     2.44     0.55
.14238E+03
     73.58     -0.47     2.44     14.3 0.700E+01   1.89      6.36     2.44     0.55
.15433E+03
     79.24     -0.47     2.44     14.6 0.683E+01   1.89      6.53     2.44     0.55
.16627E+03
     84.89     -0.47     2.44     15.0 0.666E+01   1.89      6.69     2.44     0.55
.17822E+03
     90.55     -0.47     2.44     15.4 0.651E+01   1.89      6.84     2.44     0.55
.19016E+03
     96.20     -0.47     2.44     15.7 0.637E+01   1.89      6.99     2.44     0.55
.20211E+03
    101.86     -0.47     2.44     16.0 0.624E+01   1.89      7.14     2.44     0.55
```

.21406E+03

107.52	-0.47	2.44	16.4	0.611E+01	1.89	7.29	2.44	0.55	.22600E+03
113.17	-0.47	2.44	16.7	0.600E+01	1.89	7.43	2.44	0.55	.23795E+03
118.83	-0.47	2.44	17.0	0.588E+01	1.89	7.57	2.44	0.55	.24989E+03
124.48	-0.47	2.44	17.3	0.578E+01	1.89	7.71	2.44	0.55	.26184E+03
130.14	-0.47	2.44	17.6	0.568E+01	1.89	7.85	2.44	0.55	.27378E+03
135.79	-0.47	2.44	17.9	0.559E+01	1.89	7.98	2.44	0.55	.28573E+03
141.45	-0.47	2.44	18.2	0.550E+01	1.89	8.11	2.44	0.55	.29767E+03
147.11	-0.47	2.44	18.5	0.541E+01	1.89	8.24	2.44	0.55	.30962E+03
152.76	-0.47	2.44	18.8	0.533E+01	1.89	8.36	2.44	0.55	.32156E+03
158.42	-0.47	2.44	19.1	0.525E+01	1.89	8.49	2.44	0.55	.33351E+03
164.07	-0.47	2.44	19.3	0.517E+01	1.89	8.61	2.44	0.55	.34545E+03
169.73	-0.47	2.44	19.6	0.510E+01	1.89	8.73	2.44	0.55	.35740E+03
175.38	-0.47	2.44	19.9	0.503E+01	1.89	8.85	2.44	0.55	.36935E+03
181.04	-0.47	2.44	20.1	0.497E+01	1.89	8.97	2.44	0.55	.38129E+03
186.70	-0.47	2.44	20.4	0.490E+01	1.89	9.09	2.44	0.55	.39324E+03
192.35	-0.47	2.44	20.7	0.484E+01	1.89	9.20	2.44	0.55	.40518E+03
198.01	-0.47	2.44	20.9	0.478E+01	1.89	9.32	2.44	0.55	.41713E+03
203.66	-0.47	2.44	21.2	0.473E+01	1.89	9.43	2.44	0.55	.42907E+03
209.32	-0.47	2.44	21.4	0.467E+01	1.89	9.54	2.44	0.55	.44102E+03
214.97	-0.47	2.44	21.7	0.462E+01	1.89	9.65	2.44	0.55	.45296E+03
220.63	-0.47	2.44	21.9	0.457E+01	1.89	9.76	2.44	0.55	.46491E+03
226.28	-0.47	2.44	22.1	0.452E+01	1.89	9.87	2.44	0.55	.47685E+03
231.94	-0.47	2.44	22.4	0.447E+01	1.89	9.97	2.44	0.55	.48880E+03
237.60	-0.47	2.44	22.6	0.442E+01	1.89	10.08	2.44	0.55	.50075E+03
243.25	-0.47	2.44	22.8	0.438E+01	1.89	10.18	2.44	0.55	.51269E+03
248.91	-0.47	2.44	23.1	0.433E+01	1.89	10.28	2.44	0.55	.52464E+03
254.56	-0.47	2.44	23.3	0.429E+01	1.89	10.39	2.44	0.55	.53658E+03
260.22	-0.47	2.44	23.5	0.425E+01	1.89	10.49	2.44	0.55	.54853E+03
265.87	-0.47	2.44	23.8	0.421E+01	1.89	10.59	2.44	0.55	.56047E+03
271.53	-0.47	2.44	24.0	0.417E+01	1.89	10.69	2.44	0.55	.57242E+03
277.19	-0.47	2.44	24.2	0.413E+01	1.89	10.78	2.44	0.55	.58436E+03

```
     282.84      -0.47       2.44      24.4 0.410E+01    1.89      10.88      2.44      0.55
.59631E+03
     288.50      -0.47       2.44      24.6 0.406E+01    1.89      10.98      2.44      0.55
.60825E+03
     294.15      -0.47       2.44      24.8 0.402E+01    1.89      11.07      2.44      0.55
.62020E+03
     299.81      -0.47       2.44      25.1 0.399E+01    1.89      11.17      2.44      0.55
.63214E+03
     305.46      -0.47       2.44      25.3 0.396E+01    1.89      11.26      2.44      0.55
.64409E+03
     311.12      -0.47       2.44      25.5 0.392E+01    1.89      11.35      2.44      0.55
.65604E+03
     316.78      -0.47       2.44      25.7 0.389E+01    1.89      11.45      2.44      0.55
.66798E+03
 Cumulative travel time =          667.9812 sec  (    0.19 hrs)

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 Plume Stage 2 (bank attached):
         X           Y           Z           S         C         BV         BH         ZU         ZL
TT
     316.78      10.97       2.44      25.7 0.389E+01    1.89      22.89      2.44      0.55
.66798E+03
     510.44      10.97       2.44      27.4 0.365E+01    1.89      24.42      2.44      0.55
.10770E+04
     704.11      10.97       2.44      29.0 0.345E+01    1.89      25.85      2.44      0.55
.14861E+04
     897.77      10.97       2.44      30.5 0.328E+01    1.89      27.21      2.44      0.55
.18951E+04
    1091.43      10.97       2.44      32.0 0.313E+01    1.89      28.50      2.44      0.55
.23041E+04
    1285.10      10.97       2.44      33.4 0.300E+01    1.89      29.74      2.44      0.55
.27132E+04
    1478.76      10.97       2.44      34.7 0.288E+01    1.89      30.93      2.44      0.55
.31222E+04
    1672.43      10.97       2.44      36.0 0.278E+01    1.89      32.07      2.44      0.55
.35313E+04
    1866.09      10.97       2.44      37.2 0.269E+01    1.89      33.18      2.44      0.55
.39403E+04
    2059.76      10.97       2.44      38.4 0.260E+01    1.89      34.25      2.44      0.55
.43493E+04
    2253.42      10.97       2.44      39.6 0.253E+01    1.89      35.28      2.44      0.55
.47584E+04
    2447.09      10.97       2.44      40.7 0.246E+01    1.89      36.29      2.44      0.55
.51674E+04
    2640.75      10.97       2.44      41.8 0.239E+01    1.89      37.27      2.44      0.55
.55764E+04
    2834.41      10.97       2.44      42.9 0.233E+01    1.89      38.22      2.44      0.55
.59855E+04
    3028.08      10.97       2.44      43.9 0.228E+01    1.89      39.16      2.44      0.55
.63945E+04
    3221.74      10.97       2.44      45.0 0.222E+01    1.89      40.07      2.44      0.55
.68036E+04
    3415.41      10.97       2.44      46.0 0.218E+01    1.89      40.96      2.44      0.55
.72126E+04
    3609.07      10.97       2.44      46.9 0.213E+01    1.89      41.83      2.44      0.55
.76216E+04
    3802.74      10.97       2.44      47.9 0.209E+01    1.89      42.68      2.44      0.55
.80307E+04
    3996.40      10.97       2.44      48.8 0.205E+01    1.89      43.52      2.44      0.55
.84397E+04
    4190.07      10.97       2.44      49.7 0.201E+01    1.89      44.34      2.44      0.55
.88488E+04
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    4383.73      10.97      2.44      50.7 0.197E+01    1.89      45.14      2.44      0.55
.92578E+04
    4577.40      10.97      2.44      51.5 0.194E+01    1.89      45.93      2.44      0.55
.96668E+04
    4771.06      10.97      2.44      52.4 0.191E+01    1.89      46.71      2.44      0.55
.10076E+05
    4964.72      10.97      2.44      53.3 0.188E+01    1.89      47.48      2.44      0.55
.10485E+05
    5158.39      10.97      2.44      54.1 0.185E+01    1.89      48.23      2.44      0.55
.10894E+05
    5352.05      10.97      2.44      54.9 0.182E+01    1.89      48.97      2.44      0.55
.11303E+05
    5545.72      10.97      2.44      55.8 0.179E+01    1.89      49.70      2.44      0.55
.11712E+05
    5739.38      10.97      2.44      56.6 0.177E+01    1.89      50.42      2.44      0.55
.12121E+05
    5933.05      10.97      2.44      57.4 0.174E+01    1.89      51.13      2.44      0.55
.12530E+05
    6126.71      10.97      2.44      58.2 0.172E+01    1.89      51.83      2.44      0.55
.12939E+05
    6320.38      10.97      2.44      58.9 0.170E+01    1.89      52.52      2.44      0.55
.13348E+05
    6514.04      10.97      2.44      59.7 0.168E+01    1.89      53.20      2.44      0.55
.13757E+05
    6707.71      10.97      2.44      60.5 0.165E+01    1.89      53.88      2.44      0.55
.14166E+05
    6901.37      10.97      2.44      61.2 0.163E+01    1.89      54.54      2.44      0.55
.14575E+05
    7095.03      10.97      2.44      61.9 0.161E+01    1.89      55.20      2.44      0.55
.14984E+05
    7288.70      10.97      2.44      62.7 0.160E+01    1.89      55.85      2.44      0.55
.15393E+05
    7482.36      10.97      2.44      63.4 0.158E+01    1.89      56.49      2.44      0.55
.15802E+05
    7676.03      10.97      2.44      64.1 0.156E+01    1.89      57.12      2.44      0.55
.16211E+05
    7869.69      10.97      2.44      64.8 0.154E+01    1.89      57.75      2.44      0.55
.16620E+05
    8063.36      10.97      2.44      65.5 0.153E+01    1.89      58.37      2.44      0.55
.17030E+05
    8257.02      10.97      2.44      66.2 0.151E+01    1.89      58.99      2.44      0.55
.17439E+05
    8450.69      10.97      2.44      66.9 0.150E+01    1.89      59.59      2.44      0.55
.17848E+05
    8644.35      10.97      2.44      67.5 0.148E+01    1.89      60.20      2.44      0.55
.18257E+05
    8838.01      10.97      2.44      68.2 0.147E+01    1.89      60.79      2.44      0.55
.18666E+05
 The passive diffusion plume becomes LATERALLY FULLY MIXED over the channel
     width during the current prediction interval.
 The x-coordinate of bank attachment is    8892.82 m.
    9031.68      10.97      2.44      68.9 0.145E+01    1.89      60.96      2.44      0.55
.19075E+05
 Effluent is FULLY MIXED over the entire channel cross-section.
 Except for possible far-field decay or reaction processes, there are
     NO FURTHER CHANGES with downstream direction.
    9225.34      10.97      2.44      68.4 0.146E+01    1.89      60.96      2.44      0.55
.19484E+05
    9419.01      10.97      2.44      68.4 0.146E+01    1.89      60.96      2.44      0.55
.19893E+05
    9612.67      10.97      2.44      68.4 0.146E+01    1.89      60.96      2.44      0.55
.20302E+05
    9806.33      10.97      2.44      68.4 0.146E+01    1.89      60.96      2.44      0.55
```

```
.20711E+05
  10000.00    10.97    2.44    68.4 0.146E+01   1.89    60.96    2.44    0.55
.21120E+05
 Cumulative travel time =       21119.9180 sec  (    5.87 hrs)

 Simulation limit based on maximum specified distance =  10000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
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CORMIX2: Multiport Diffuser Discharges       End of Prediction File
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
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Medford HH Non-Carcinogen.prd

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CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
                    CORMIX MIXING ZONE EXPERT SYSTEM
          Subsystem CORMIX2: Multiport Diffuser Discharges
                      CORMIX Version 8.0GTD
                   HYDRO2 Version 8.0.0.0 April 2012
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CASE DESCRIPTION
 Site name/label:    Medford RWRF Mixing Zone Study
 Design case:        Human Health, Non-Carcinogen
 FILE NAME:          C:\Program Files\CORMIX 8.0\Medford.prd
 Time stamp:         Tue Nov 12 13:49:14 2013

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS     =      60.96  AS     =     115.20  QA     =     28.26  ICHREG= 2
 HA     =       1.89  HD     =       2.44
 UA     =      0.245  F      =      0.078  USTAR =0.2418E-01
 UW     =      2.000  UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U           RHOAM =  999.7749

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:       DITYPE= unidirectional_perpendicular
 BANK   =  LEFT       DISTB =      10.97  YB1    =      9.14  YB2    =      12.80
 LD     =       3.66  NOPEN =    3          SPAC   =      1.83
 D0     =      0.457  A0     =      0.164  H0     =      0.61  SUB0   =       1.83
 D0INP  =      0.457  CR0    =      1.000
 Nozzle/port arrangement:   unidirectional_with_fanning
 GAMMA  =      90.00  THETA =      10.00  SIGMA =     345.00  BETA   =      75.00
 U0     =      1.619  Q0     =      0.797          =0.7974E+00
 RHO0   =   998.4709  DRHO0 =0.1304E+01  GP0    =0.1279E-01
 C0     =0.1000E+03  CUNITS=  %
 IPOLL  =  1          KS     =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0     =0.2180E+00  m0     =0.3530E+00  j0     =0.2788E-02  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B   =      0.135 lM     =      17.77  lm     =      5.87
 lmp    =   99999.00 lbp    =   99999.00  la     =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0     =0.7974E+00  M0     =0.1291E+01  J0     =0.1020E-01
 Associated 3-d length scales (meters)
 LQ     =       0.41  LM     =      11.99  Lm     =      4.63  Lb     =       0.69
                                          Lmp    =  99999.00  Lbp    =   99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =      39.01  FRD0   =      21.17  R      =      6.60  PL     =    1.57
 (slot)               (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0     =      1.619  D0     =      0.457  A0     =     0.164  THETA =      10.00
 FR0    =      39.01  FRD0   =      21.17  R      =      6.60
 (slot)               (riser group)

FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
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 2  Flow class (CORMIX2)       =    MU2    2
 2  Applicable layer depth HS =     2.44  2
 2222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+03  CUNITS=  %
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =  10000.00  XMAX  =  10000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        10.97 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  50 display intervals per module
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BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = top-hat half-width, in horizontal plane 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         BV       BH       Uc        TT
      0.00     0.00     0.61     1.0 0.100E+03   0.11     1.83     1.386   .00000E+00

END OF MOD201: DIFFUSER DISCHARGE MODULE
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BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

 Because of the FANNED-OUT HORIZONTAL ORIENTATION of the diffuser jets,
   the near-field dilution is slightly improved.

 In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY
  MIXED over the entire layer depth (HS =    2.44m).
   Full mixing is achieved after a plume distance of about five
   layer depths from the diffuser.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, in horizontal plane normal to trajectory
   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        TT
      0.00    -0.00     0.61     1.0 0.100E+03   0.11     1.83 .00000E+00
      0.04    -0.01     0.61     1.6 0.632E+02   0.11     1.80 .28847E-01
      0.07    -0.02     0.61     1.8 0.548E+02   0.12     1.77 .64590E-01
      0.11    -0.03     0.62     2.0 0.497E+02   0.15     1.74 .10443E+00
      0.14    -0.04     0.62     2.2 0.462E+02   0.20     1.72 .14739E+00
```

0.18	-0.05	0.62	2.3	0.434E+02	0.24	1.70	.19291E+00
0.21	-0.06	0.62	2.4	0.412E+02	0.29	1.67	.24064E+00
0.25	-0.07	0.62	2.5	0.393E+02	0.34	1.65	.29030E+00
0.28	-0.08	0.62	2.6	0.377E+02	0.39	1.63	.34169E+00
0.32	-0.09	0.63	2.7	0.364E+02	0.44	1.61	.39464E+00
0.35	-0.09	0.63	2.8	0.352E+02	0.49	1.60	.44904E+00
0.39	-0.10	0.63	2.9	0.341E+02	0.54	1.58	.50477E+00
0.42	-0.11	0.63	3.0	0.331E+02	0.59	1.56	.56173E+00
0.46	-0.12	0.63	3.1	0.322E+02	0.63	1.55	.61984E+00
0.49	-0.13	0.64	3.2	0.314E+02	0.68	1.53	.67905E+00
0.53	-0.14	0.64	3.3	0.307E+02	0.73	1.52	.73927E+00
0.57	-0.15	0.64	3.3	0.300E+02	0.78	1.51	.80047E+00
0.60	-0.16	0.64	3.4	0.294E+02	0.83	1.49	.86258E+00
0.64	-0.17	0.64	3.5	0.288E+02	0.88	1.48	.92557E+00
0.67	-0.18	0.64	3.5	0.282E+02	0.93	1.47	.98940E+00
0.71	-0.19	0.65	3.6	0.277E+02	0.98	1.46	.10540E+01
0.74	-0.20	0.65	3.7	0.272E+02	1.02	1.45	.11194E+01
0.78	-0.21	0.65	3.7	0.268E+02	1.07	1.44	.11856E+01
0.81	-0.22	0.65	3.8	0.263E+02	1.12	1.43	.12524E+01
0.85	-0.23	0.65	3.9	0.259E+02	1.17	1.42	.13199E+01
0.88	-0.24	0.66	3.9	0.255E+02	1.22	1.41	.13881E+01
0.92	-0.25	0.66	4.0	0.252E+02	1.27	1.40	.14569E+01
0.95	-0.26	0.66	4.0	0.248E+02	1.32	1.39	.15263E+01
0.99	-0.27	0.66	4.1	0.245E+02	1.37	1.39	.15963E+01
1.02	-0.27	0.66	4.1	0.242E+02	1.41	1.38	.16669E+01
1.06	-0.28	0.66	4.2	0.238E+02	1.46	1.37	.17381E+01
1.10	-0.29	0.67	4.2	0.235E+02	1.51	1.37	.18098E+01
1.13	-0.30	0.67	4.3	0.233E+02	1.56	1.36	.18820E+01
1.17	-0.31	0.67	4.4	0.230E+02	1.61	1.35	.19547E+01
1.20	-0.32	0.67	4.4	0.227E+02	1.66	1.35	.20280E+01
1.24	-0.33	0.67	4.5	0.225E+02	1.71	1.34	.21017E+01
1.27	-0.34	0.68	4.5	0.222E+02	1.76	1.34	.21759E+01
1.31	-0.35	0.68	4.5	0.220E+02	1.80	1.34	.22505E+01
1.34	-0.36	0.68	4.6	0.218E+02	1.85	1.33	.23256E+01
1.38	-0.37	0.68	4.6	0.215E+02	1.90	1.33	.24011E+01
1.41	-0.38	0.68	4.7	0.213E+02	1.95	1.33	.24771E+01
1.45	-0.39	0.68	4.7	0.211E+02	2.00	1.33	.25535E+01
1.48	-0.40	0.69	4.8	0.209E+02	2.05	1.32	.26302E+01
1.52	-0.41	0.69	4.8	0.207E+02	2.10	1.32	.27074E+01
1.55	-0.42	0.69	4.9	0.205E+02	2.15	1.32	.27850E+01
1.59	-0.43	0.69	4.9	0.204E+02	2.19	1.32	.28630E+01
1.63	-0.44	0.69	5.0	0.202E+02	2.24	1.32	.29413E+01
1.66	-0.44	0.70	5.0	0.200E+02	2.29	1.32	.30200E+01
1.70	-0.45	0.70	5.0	0.198E+02	2.34	1.32	.30991E+01
1.73	-0.46	0.70	5.1	0.197E+02	2.39	1.32	.31785E+01
1.77	-0.47	0.70	5.1	0.195E+02	2.44	1.32	.32582E+01

Cumulative travel time = 3.2582 sec (0.00 hrs)
Plume centerline may exhibit slight discontinuities in transition
to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

BEGIN MOD251: DIFFUSER PLUME IN CO-FLOW

Phase 1: Vertically mixed, Phase 2: Re-stratified

Phase 1: The diffuser plume is VERTICALLY FULLY MIXED over the
entire layer depth.
This flow region is INSIGNIFICANT in spatial extent and will be by-passed.

Phase 2: The flow has RESTRATIFIED at the beginning of this zone.

Profile definitions:
BV = top-hat thickness, measured vertically
BH = Gaussian 1/e (37%) half-width in horizontal plane 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	TT
1.77	-0.47	2.44	5.1	0.195E+02	2.44	1.46	.32582E+01
1.83	-0.47	2.44	5.1	0.195E+02	2.31	1.55	.40216E+01
1.89	-0.47	2.44	5.1	0.195E+02	2.24	1.60	.47860E+01
1.95	-0.47	2.44	5.1	0.194E+02	2.19	1.64	.55515E+01
2.01	-0.47	2.44	5.2	0.194E+02	2.14	1.68	.63180E+01
2.08	-0.47	2.44	5.2	0.194E+02	2.10	1.72	.70855E+01
2.14	-0.47	2.44	5.2	0.194E+02	2.07	1.75	.78542E+01
2.20	-0.47	2.44	5.2	0.193E+02	2.04	1.78	.86238E+01
2.26	-0.47	2.44	5.2	0.193E+02	2.01	1.81	.93945E+01
2.32	-0.47	2.44	5.2	0.193E+02	1.98	1.84	.10166E+02
2.39	-0.47	2.44	5.2	0.193E+02	1.95	1.87	.10939E+02
2.45	-0.47	2.44	5.2	0.192E+02	1.93	1.90	.11713E+02
2.51	-0.47	2.44	5.2	0.192E+02	1.90	1.93	.12488E+02
2.57	-0.47	2.44	5.2	0.192E+02	1.88	1.95	.13264E+02
2.63	-0.47	2.44	5.2	0.191E+02	1.86	1.98	.14041E+02
2.69	-0.47	2.44	5.2	0.191E+02	1.84	2.01	.14819E+02
2.76	-0.47	2.44	5.2	0.191E+02	1.82	2.03	.15598E+02
2.82	-0.47	2.44	5.2	0.191E+02	1.80	2.06	.16378E+02
2.88	-0.47	2.44	5.2	0.190E+02	1.79	2.08	.17159E+02
2.94	-0.47	2.44	5.3	0.190E+02	1.77	2.10	.17941E+02
3.00	-0.47	2.44	5.3	0.190E+02	1.75	2.13	.18724E+02
3.07	-0.47	2.44	5.3	0.190E+02	1.74	2.15	.19508E+02
3.13	-0.47	2.44	5.3	0.189E+02	1.72	2.17	.20293E+02
3.19	-0.47	2.44	5.3	0.189E+02	1.71	2.20	.21079E+02
3.25	-0.47	2.44	5.3	0.189E+02	1.69	2.22	.21866E+02
3.31	-0.47	2.44	5.3	0.189E+02	1.68	2.24	.22655E+02
3.37	-0.47	2.44	5.3	0.189E+02	1.67	2.26	.23444E+02
3.44	-0.47	2.44	5.3	0.188E+02	1.66	2.29	.24234E+02
3.50	-0.47	2.44	5.3	0.188E+02	1.64	2.31	.25025E+02
3.56	-0.47	2.44	5.3	0.188E+02	1.63	2.33	.25818E+02
3.62	-0.47	2.44	5.3	0.188E+02	1.62	2.35	.26611E+02
3.68	-0.47	2.44	5.3	0.187E+02	1.61	2.37	.27405E+02
3.75	-0.47	2.44	5.3	0.187E+02	1.60	2.39	.28201E+02
3.81	-0.47	2.44	5.4	0.187E+02	1.59	2.41	.28997E+02
3.87	-0.47	2.44	5.4	0.187E+02	1.58	2.44	.29794E+02
3.93	-0.47	2.44	5.4	0.186E+02	1.57	2.46	.30593E+02
3.99	-0.47	2.44	5.4	0.186E+02	1.56	2.48	.31392E+02
4.05	-0.47	2.44	5.4	0.186E+02	1.55	2.50	.32192E+02
4.12	-0.47	2.44	5.4	0.186E+02	1.54	2.52	.32994E+02
4.18	-0.47	2.44	5.4	0.185E+02	1.53	2.54	.33796E+02
4.24	-0.47	2.44	5.4	0.185E+02	1.52	2.56	.34599E+02
4.30	0.49	2.44	5.4	0.185E+02	1.51	2.58	.35404E+02
4.36	0.51	2.44	5.4	0.185E+02	1.50	2.60	.36209E+02
4.43	0.54	2.44	5.4	0.185E+02	1.50	2.62	.37016E+02
4.49	0.56	2.44	5.4	0.184E+02	1.49	2.64	.37823E+02
4.55	0.59	2.44	5.4	0.184E+02	1.48	2.65	.38631E+02
4.61	0.61	2.44	5.4	0.184E+02	1.47	2.67	.39441E+02
4.67	0.64	2.44	5.4	0.184E+02	1.46	2.69	.40251E+02
4.74	0.66	2.44	5.5	0.183E+02	1.46	2.71	.41062E+02
4.80	0.69	2.44	5.5	0.183E+02	1.45	2.73	.41875E+02

```
     4.86      0.71     2.44      5.5 0.183E+02   1.44      2.75 .42688E+02
 Cumulative travel time =          42.6880 sec  (    0.01 hrs)

END OF MOD251: DIFFUSER PLUME IN CO-FLOW
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** End of NEAR-FIELD REGION (NFR) **

 The initial plume WIDTH values in the next far-field module will be
  CORRECTED by a factor  1.48 to conserve the mass flux in the far-field!
-------------------------------------------------------------------------------------
----------
BEGIN MOD241: 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
4.86	0.71	2.44	5.5	0.183E+02	2.13	4.06	2.44	0.31	.42688E+02
5.69	0.71	2.44	5.5	0.181E+02	2.07	4.22	2.44	0.37	.45968E+02
6.51	0.71	2.44	5.6	0.179E+02	2.01	4.38	2.44	0.42	.49248E+02
7.34	0.71	2.44	5.6	0.177E+02	1.96	4.54	2.44	0.47	.52528E+02
8.17	0.71	2.44	5.7	0.176E+02	1.92	4.69	2.44	0.52	.55808E+02
9.00	0.71	2.44	5.7	0.174E+02	1.88	4.84	2.44	0.56	.59087E+02
9.82	0.71	2.44	5.8	0.172E+02	1.84	4.99	2.44	0.60	.62367E+02
10.65	0.71	2.44	5.8	0.171E+02	1.80	5.14	2.44	0.64	.65647E+02
11.48	0.71	2.44	5.9	0.170E+02	1.77	5.28	2.44	0.67	.68927E+02
12.30	0.71	2.44	5.9	0.168E+02	1.73	5.42	2.44	0.70	.72207E+02
13.13	0.71	2.44	6.0	0.167E+02	1.70	5.56	2.44	0.73	.75487E+02
13.96	0.71	2.44	6.0	0.165E+02	1.68	5.70	2.44	0.76	.78767E+02
14.79	0.71	2.44	6.1	0.164E+02	1.65	5.84	2.44	0.79	.82047E+02
15.61	0.71	2.44	6.1	0.163E+02	1.62	5.97	2.44	0.81	.85327E+02
16.44	0.71	2.44	6.2	0.162E+02	1.60	6.11	2.44	0.84	.88607E+02
17.27	0.71	2.44	6.2	0.161E+02	1.58	6.24	2.44	0.86	.91887E+02
18.10	0.71	2.44	6.3	0.159E+02	1.56	6.37	2.44	0.88	.95167E+02
18.92	0.71	2.44	6.3	0.158E+02	1.54	6.50	2.44	0.90	.98447E+02
19.75	0.71	2.44	6.4	0.157E+02	1.52	6.63	2.44	0.92	

.10173E+03

20.58	0.71	2.44	6.4	0.156E+02	1.50	6.76	2.44	0.94	.10501E+03
21.41	0.71	2.44	6.5	0.155E+02	1.48	6.88	2.44	0.96	.10829E+03
22.23	0.71	2.44	6.5	0.154E+02	1.47	7.01	2.44	0.97	.11157E+03
23.06	0.71	2.44	6.5	0.153E+02	1.45	7.13	2.44	0.99	.11485E+03
23.89	0.71	2.44	6.6	0.152E+02	1.44	7.26	2.44	1.00	.11813E+03
24.71	0.71	2.44	6.6	0.151E+02	1.42	7.38	2.44	1.02	.12141E+03
25.54	0.71	2.44	6.7	0.150E+02	1.41	7.50	2.44	1.03	.12469E+03
26.37	0.71	2.44	6.7	0.149E+02	1.40	7.62	2.44	1.04	.12797E+03
27.20	0.71	2.44	6.8	0.148E+02	1.38	7.74	2.44	1.05	.13125E+03
28.02	0.71	2.44	6.8	0.147E+02	1.37	7.85	2.44	1.07	.13453E+03
28.85	0.71	2.44	6.9	0.146E+02	1.36	7.97	2.44	1.08	.13781E+03
29.68	0.71	2.44	6.9	0.145E+02	1.35	8.09	2.44	1.09	.14109E+03
30.51	0.71	2.44	7.0	0.144E+02	1.34	8.20	2.44	1.10	.14437E+03
31.33	0.71	2.44	7.0	0.143E+02	1.33	8.32	2.44	1.11	.14765E+03
32.16	0.71	2.44	7.1	0.142E+02	1.32	8.43	2.44	1.12	.15093E+03
32.99	0.71	2.44	7.1	0.141E+02	1.31	8.54	2.44	1.12	.15421E+03
33.82	0.71	2.44	7.2	0.140E+02	1.31	8.66	2.44	1.13	.15749E+03
34.64	0.71	2.44	7.2	0.139E+02	1.30	8.77	2.44	1.14	.16077E+03
35.47	0.71	2.44	7.2	0.138E+02	1.29	8.88	2.44	1.15	.16405E+03
36.30	0.71	2.44	7.3	0.137E+02	1.28	8.99	2.44	1.15	.16733E+03
37.12	0.71	2.44	7.3	0.136E+02	1.28	9.10	2.44	1.16	.17060E+03
37.95	0.71	2.44	7.4	0.135E+02	1.27	9.21	2.44	1.17	.17388E+03
38.78	0.71	2.44	7.4	0.134E+02	1.26	9.31	2.44	1.17	.17716E+03
39.61	0.71	2.44	7.5	0.133E+02	1.26	9.42	2.44	1.18	.18044E+03
40.43	0.71	2.44	7.6	0.132E+02	1.25	9.53	2.44	1.19	.18372E+03
41.26	0.71	2.44	7.6	0.132E+02	1.25	9.64	2.44	1.19	.18700E+03
42.09	0.71	2.44	7.7	0.131E+02	1.24	9.74	2.44	1.20	.19028E+03
42.92	0.71	2.44	7.7	0.130E+02	1.24	9.85	2.44	1.20	.19356E+03
43.74	0.71	2.44	7.8	0.129E+02	1.23	9.95	2.44	1.21	.19684E+03
44.57	0.71	2.44	7.8	0.128E+02	1.23	10.05	2.44	1.21	.20012E+03
45.40	0.71	2.44	7.9	0.127E+02	1.22	10.16	2.44	1.21	.20340E+03

```
     46.22      0.71     2.44      7.9 0.126E+02   1.22    10.26     2.44     1.22
.20668E+03
 Cumulative travel time =         206.6841 sec  (    0.06 hrs)

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

 Plume Stage 2 (bank attached):
        X         Y         Z         S         C        BV        BH        ZU        ZL
TT
     46.22     10.97     2.44      7.9 0.126E+02   1.22    20.52     2.44     1.22
.20668E+03
     50.30     10.97     2.44      8.1 0.123E+02   1.23    21.02     2.44     1.21
.22286E+03
     54.38     10.97     2.44      8.4 0.119E+02   1.23    21.52     2.44     1.21
.23903E+03
     58.46     10.97     2.44      8.6 0.116E+02   1.24    22.01     2.44     1.20
.25520E+03
     62.54     10.97     2.44      8.9 0.113E+02   1.25    22.49     2.44     1.19
.27137E+03
     66.62     10.97     2.44      9.1 0.109E+02   1.26    22.97     2.44     1.18
.28755E+03
     70.70     10.97     2.44      9.4 0.106E+02   1.27    23.45     2.44     1.17
.30372E+03
     74.78     10.97     2.44      9.7 0.103E+02   1.28    23.92     2.44     1.16
.31989E+03
     78.86     10.97     2.44     10.0 0.100E+02   1.29    24.38     2.44     1.14
.33606E+03
     82.94     10.97     2.44     10.3 0.973E+01   1.31    24.84     2.44     1.13
.35224E+03
     87.02     10.97     2.44     10.6 0.945E+01   1.32    25.30     2.44     1.12
.36841E+03
     91.10     10.97     2.44     10.9 0.918E+01   1.34    25.75     2.44     1.10
.38458E+03
     95.18     10.97     2.44     11.2 0.891E+01   1.35    26.20     2.44     1.08
.40075E+03
     99.26     10.97     2.44     11.6 0.865E+01   1.37    26.64     2.44     1.07
.41693E+03
    103.33     10.97     2.44     11.9 0.840E+01   1.39    27.09     2.44     1.05
.43310E+03
    107.41     10.97     2.44     12.3 0.815E+01   1.41    27.52     2.44     1.03
.44927E+03
    111.49     10.97     2.44     12.6 0.792E+01   1.43    27.96     2.44     1.01
.46544E+03
    115.57     10.97     2.44     13.0 0.769E+01   1.45    28.39     2.44     0.99
.48162E+03
    119.65     10.97     2.44     13.4 0.747E+01   1.47    28.81     2.44     0.97
.49779E+03
    123.73     10.97     2.44     13.8 0.725E+01   1.49    29.24     2.44     0.95
.51396E+03
    127.81     10.97     2.44     14.2 0.704E+01   1.51    29.66     2.44     0.93
.53013E+03
    131.89     10.97     2.44     14.6 0.684E+01   1.54    30.08     2.44     0.90
.54631E+03
    135.97     10.97     2.44     15.0 0.665E+01   1.56    30.49     2.44     0.88
.56248E+03
    140.05     10.97     2.44     15.5 0.646E+01   1.58    30.90     2.44     0.85
.57865E+03
    144.13     10.97     2.44     15.9 0.627E+01   1.61    31.31     2.44     0.83
.59482E+03
    148.21     10.97     2.44     16.4 0.610E+01   1.63    31.72     2.44     0.80
```

```
.61100E+03
    152.29    10.97     2.44     16.9 0.593E+01   1.66     32.13     2.44     0.78
.62717E+03
    156.37    10.97     2.44     17.4 0.576E+01   1.69     32.53     2.44     0.75
.64334E+03
    160.44    10.97     2.44     17.9 0.560E+01   1.71     32.93     2.44     0.72
.65951E+03
    164.52    10.97     2.44     18.4 0.545E+01   1.74     33.32     2.44     0.70
.67569E+03
    168.60    10.97     2.44     18.9 0.530E+01   1.77     33.72     2.44     0.67
.69186E+03
    172.68    10.97     2.44     19.4 0.515E+01   1.80     34.11     2.44     0.64
.70803E+03
    176.76    10.97     2.44     19.9 0.501E+01   1.83     34.50     2.44     0.61
.72420E+03
    180.84    10.97     2.44     20.5 0.488E+01   1.86     34.89     2.44     0.58
.74038E+03
    184.92    10.97     2.44     21.1 0.475E+01   1.89     35.27     2.44     0.55
.75655E+03
    189.00    10.97     2.44     21.6 0.462E+01   1.92     35.66     2.44     0.52
.77272E+03
    193.08    10.97     2.44     22.2 0.450E+01   1.95     36.04     2.44     0.49
.78889E+03
    197.16    10.97     2.44     22.8 0.438E+01   1.98     36.42     2.44     0.46
.80506E+03
    201.24    10.97     2.44     23.4 0.427E+01   2.01     36.80     2.44     0.42
.82124E+03
    205.32    10.97     2.44     24.1 0.415E+01   2.05     37.17     2.44     0.39
.83741E+03
    209.40    10.97     2.44     24.7 0.405E+01   2.08     37.55     2.44     0.36
.85358E+03
    213.48    10.97     2.44     25.4 0.394E+01   2.11     37.92     2.44     0.32
.86975E+03
    217.55    10.97     2.44     26.0 0.384E+01   2.15     38.29     2.44     0.29
.88593E+03
    221.63    10.97     2.44     26.7 0.375E+01   2.18     38.66     2.44     0.26
.90210E+03
    225.71    10.97     2.44     27.4 0.365E+01   2.22     39.03     2.44     0.22
.91827E+03
    229.79    10.97     2.44     28.1 0.356E+01   2.25     39.39     2.44     0.19
.93444E+03
    233.87    10.97     2.44     28.8 0.347E+01   2.29     39.75     2.44     0.15
.95062E+03
    237.95    10.97     2.44     29.5 0.339E+01   2.33     40.12     2.44     0.11
.96679E+03
    242.03    10.97     2.44     30.2 0.331E+01   2.36     40.48     2.44     0.08
.98296E+03
    246.11    10.97     2.44     31.0 0.323E+01   2.40     40.83     2.44     0.04
.99913E+03
    250.19    10.97     2.44     31.8 0.315E+01   2.44     41.19     2.44     0.00
.10153E+04
 Cumulative travel time =        1015.3074 sec  (     0.28 hrs)

END OF MOD241: BUOYANT AMBIENT SPREADING
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 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".
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BEGIN MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
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 Vertical diffusivity (initial value)   = 0.118E-01 m^2/s
 Horizontal diffusivity (initial value) = 0.295E-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
    250.19     10.97     2.44     31.8 0.315E+01     2.44     41.19      2.44      0.00
.10153E+04
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
    445.19     10.97     2.44     32.4 0.308E+01     2.44     42.05      2.44      0.00
.17884E+04
    640.18     10.97     2.44     33.1 0.302E+01     2.44     42.90      2.44      0.00
.25614E+04
    835.18     10.97     2.44     33.7 0.297E+01     2.44     43.72      2.44      0.00
.33345E+04
   1030.17     10.97     2.44     34.4 0.291E+01     2.44     44.53      2.44      0.00
.41076E+04
   1225.17     10.97     2.44     35.0 0.286E+01     2.44     45.33      2.44      0.00
.48806E+04
   1420.17     10.97     2.44     35.6 0.281E+01     2.44     46.12      2.44      0.00
.56537E+04
   1615.16     10.97     2.44     36.2 0.277E+01     2.44     46.89      2.44      0.00
.64268E+04
   1810.16     10.97     2.44     36.7 0.272E+01     2.44     47.64      2.44      0.00
.71999E+04
   2005.16     10.97     2.44     37.3 0.268E+01     2.44     48.39      2.44      0.00
.79729E+04
   2200.15     10.97     2.44     37.9 0.264E+01     2.44     49.12      2.44      0.00
.87460E+04
   2395.15     10.97     2.44     38.5 0.260E+01     2.44     49.85      2.44      0.00
.95191E+04
   2590.14     10.97     2.44     39.0 0.256E+01     2.44     50.56      2.44      0.00
.10292E+05
   2785.14     10.97     2.44     39.5 0.253E+01     2.44     51.27      2.44      0.00
.11065E+05
   2980.14     10.97     2.44     40.1 0.250E+01     2.44     51.96      2.44      0.00
.11838E+05
   3175.13     10.97     2.44     40.6 0.246E+01     2.44     52.65      2.44      0.00
.12611E+05
   3370.13     10.97     2.44     41.1 0.243E+01     2.44     53.32      2.44      0.00
.13384E+05
   3565.12     10.97     2.44     41.6 0.240E+01     2.44     53.99      2.44      0.00
.14157E+05
   3760.12     10.97     2.44     42.2 0.237E+01     2.44     54.65      2.44      0.00
.14931E+05
   3955.12     10.97     2.44     42.7 0.234E+01     2.44     55.30      2.44      0.00
.15704E+05
   4150.11     10.97     2.44     43.2 0.232E+01     2.44     55.94      2.44      0.00
.16477E+05
   4345.11     10.97     2.44     43.6 0.229E+01     2.44     56.58      2.44      0.00
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```
.17250E+05
   4540.10     10.97      2.44      44.1 0.227E+01    2.44      57.21      2.44      0.00
.18023E+05
   4735.10     10.97      2.44      44.6 0.224E+01    2.44      57.83      2.44      0.00
.18796E+05
   4930.10     10.97      2.44      45.1 0.222E+01    2.44      58.45      2.44      0.00
.19569E+05
   5125.09     10.97      2.44      45.6 0.220E+01    2.44      59.06      2.44      0.00
.20342E+05
   5320.09     10.97      2.44      46.0 0.217E+01    2.44      59.66      2.44      0.00
.21115E+05
   5515.08     10.97      2.44      46.5 0.215E+01    2.44      60.26      2.44      0.00
.21888E+05
   5710.08     10.97      2.44      46.9 0.213E+01    2.44      60.85      2.44      0.00
.22661E+05
 The passive diffusion plume becomes LATERALLY FULLY MIXED over the channel
     width during the current prediction interval.
 The x-coordinate of bank attachment is    5745.67 m.
   5905.08     10.97      2.44      47.4 0.211E+01    2.44      60.96      2.44      0.00
.23434E+05
 Effluent is FULLY MIXED over the entire channel cross-section.
 Except for possible far-field decay or reaction processes, there are
     NO FURTHER CHANGES with downstream direction.
   6100.07     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.24207E+05
   6295.07     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.24980E+05
   6490.07     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.25753E+05
   6685.06     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.26527E+05
   6880.06     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.27300E+05
   7075.05     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.28073E+05
   7270.05     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.28846E+05
   7465.05     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.29619E+05
   7660.04     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.30392E+05
   7855.04     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.31165E+05
   8050.03     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.31938E+05
   8245.03     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.32711E+05
   8440.03     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.33484E+05
   8635.02     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.34257E+05
   8830.02     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.35030E+05
   9025.01     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.35803E+05
   9220.01     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.36576E+05
   9415.01     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.37350E+05
   9610.00     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.38123E+05
   9805.00     10.97      2.44      47.0 0.213E+01    2.44      60.96      2.44      0.00
.38896E+05
```

```
 10000.00    10.97    2.44    47.0 0.213E+01   2.44    60.96    2.44    0.00
.39669E+05
 Cumulative travel time =       39668.7344 sec  (   11.02 hrs)

 Simulation limit based on maximum specified distance =  10000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
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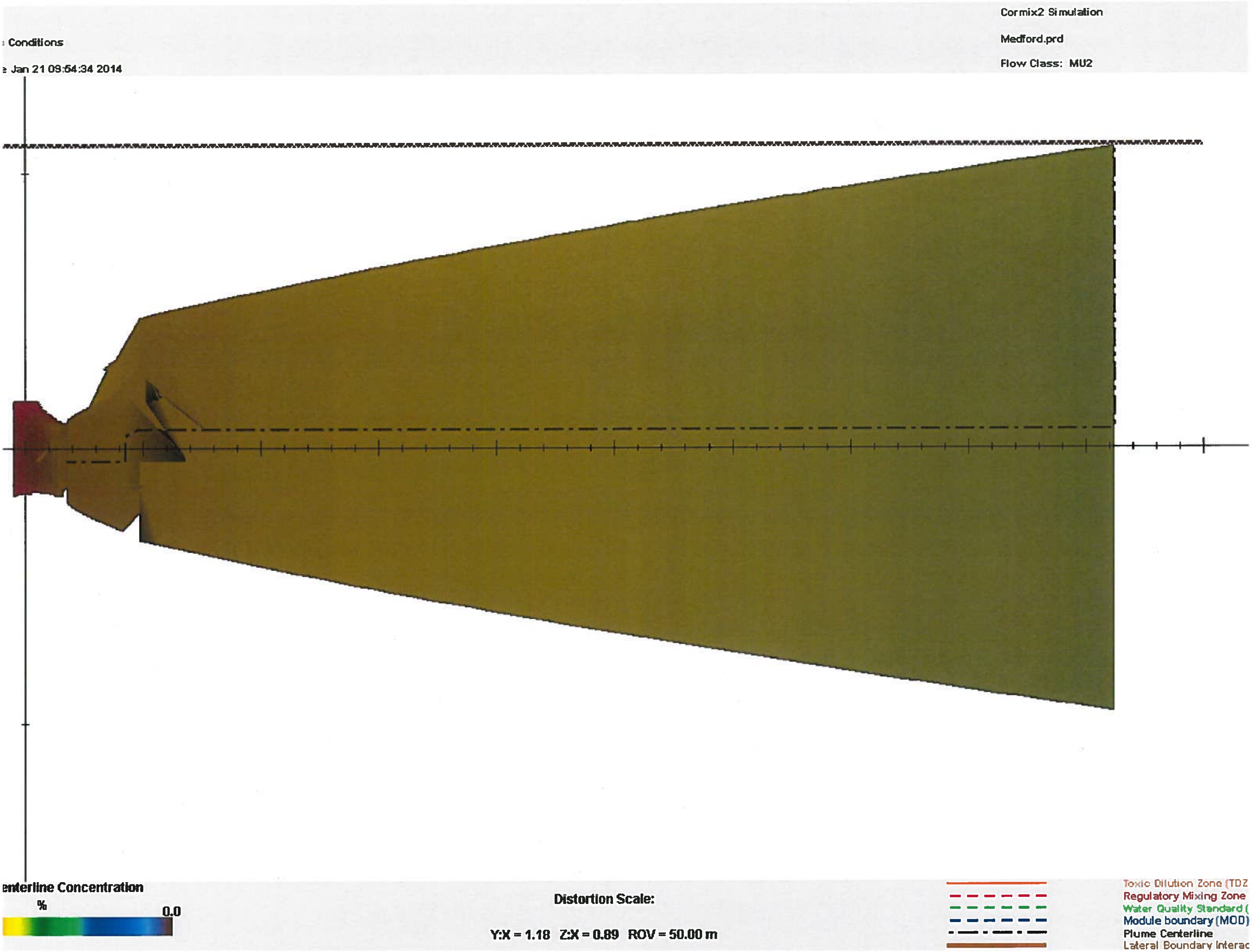
CORMIX2: Multiport Diffuser Discharges       End of Prediction File
22222222222222222222222222222222222222222222222222222222222222222222222222222222222
22222222222
```



Conditions
Jan 21 09:54:34 2014
Cormix2 Simulation
Medford.prd
Flow Class: MU2
enterline Concentration
%
0.0
Distortion Scale:
Y:X = 1.18 Z:X = 0.89 ROV = 50.00 m
Toxic Dilution Zone (TDZ
Regulatory Mixing Zone
Water Quality Standard (
Module boundary (MOD)
Plume Centerline
Lateral Boundary Interac

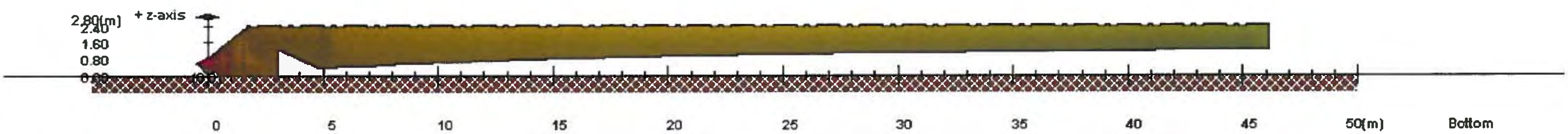
Conditions

: Jan 21 09:54:34 2014

Cormix2 Simulation

Medford.prd

Flow Class: MU2



enterline Concentration

%

0.0

Distortion Scale:

Y:X = 1.18 Z:X = 0.89 ROV = 50.00 m

Toxic Dilution Zone (TDZ

Regulatory Mixing Zone

Water Quality Standard (

Module boundary (MOD)

Plume Centerline

Lateral Boundary Interac

Appendix O: DEQ Municipal RPA Spreadsheet Calculations

Reasonable Potential Analysis - Aquatic Toxicity - Domestic Facility

RPA Run Information

Facility Name:	Medford RWRF
DEQ File Number:	
Permit Writer Name:	
Outfall Number:	001
Date of RPA Run:	Nov-13
RPA Run Notes:	

KEY:		
KEY:	--	Intermediate calc.s
* Enter data here	--	Calculated results

Please complete the following General Facility Information

1. Do I have dilution values from a mixing zone study? (Y/N)		Y
2. Is the receiving waterbody fresh water? (Y/N)		Y
3. If answered "N" to *Question 1*, then fill in the following table		
Eff. Flow Rate	MGD	*
Stream Flow: 7Q10	CFS	*
Stream Flow: 1Q10	CFS	*
% dilution at ZID	%	10%
% dilution at MZ	%	25%
Calculated dilution Factors		
Dilution @ ZID		na
Dilution @ MZ		na

4. If answered "Y" to *Question 1*, then fill in dilution factors from mixing zone study		
Dilution @ ZID (from study)		4.9
Dilution @ MZ (from study)		10.2
5. Please enter *Water Hardness Data* below to reflect critical conditions (values from 25 to 400 mg/l)		
Effluent	mg/L $CaCO_3$	115.1
Up-stream	mg/L $CaCO_3$	25
ZID boundary	mg/L $CaCO_3$	43
MZ boundary	mg/L $CaCO_3$	34
6. Please enter statistical *Confidence* and *Probablity* values (note: defaults already entered)		
Confidence Level	%	99%
Probability Basis	%	95%

Determine Monitoring Reqs.		Identify Pollutants of Concern					Determine In-Stream Conc.			Determine Reasonable Potential			
Pollutant Parameter	Evaluation Required?	# of Samples	Highest Effluent Conc.	Coefficent of Variation	Estimated Max Eff. Conc.	RP at end of pipe?	Ambient Conc.	Max Total Conc. at ZID	Max Total Conc. at RMZ	WQ CRITERIA 1 Hour (CMC)	WQ CRITERIA 4 Day (CCC)	Is there Reasonable Potential to Exceed? (Y/N) Acute	Chronic
	(Y/N)		µg/l	Default=0.6	µg/l	(Y/N)	µg/l	µg/l	µg/l	µg/l	µg/l	Acute	Chronic
Table 1 Effluent Parameters for all POTWs w/a Flow > 0.1 MGD													
Ammonia (as N)	*	Evaluation occurs on Ammonia (NH3) spreadsheet page, No HH criteria											
Chlorine (total residual, TRC)	*	Evaluation occurs on Chlorine (-Cl) spreadsheet page, no HH criteria											
Dissolved oxygen	*	Evaluation occurs on Dissolved Oxygen (DO) spreadsheet page											
Oil and Grease	*	Compare to Effluent limits in permits or Federal Effluent Limit Guidelines											
Total dissolved solids	*	Compare to Effluent limits in permits or Federal Effluent Limit Guidelines											
Table 2 Effluent Parameters for Selected POTWs													
Hardness (Total as CaCO3)	Must be collected for metals criteria calculation. Submit data to the fields at the top of the spreadsheet												
Table 2: Metals (total recoverable), cyanide and totoal phenols													
Arsenic (Total)	*	9	1.65		No Water Quality Criteria		0.00						
ARSENIC III	*	9	1.65	0.21	2.15	No	0	0.44	0.21	360.0	190.0	NO	NO
Cadmium	*	9	0.11	0.23	0.15	Yes	0.00	0.03	0.02	1.5	0.12	NO	NO
Chromium (total)	*	9	1.87		No Water Quality Criteria		0.00						
Chromium III	*	9	1.87	0.36	2.99	No	0.00	0.61	0.29	287.5	30.5	NO	NO
Chromium VI	*	9	1.87	0.36	2.99	No	0.00	0.61	0.29	15.7	10.6	NO	NO
Copper	*	9	25.53	0.20	33.19	Yes	1.00	7.57	4.16	8.1	4.7	NO	NO
Iron	*	3	41.80	0.60	163.02	No	0.00	33.27	15.98	--	1000.0	--	NO
Lead	*	9	0.66	0.16	0.79	Yes	0.52	0.576	0.55	25.7	0.76	NO	NO
Mercury	*	9	0.06	0.48	0.11	Yes	0.00	0.02	0.011	2.4	0.012	NO	NO
Nickel	*	9	5.04	0.30	7.56	No	0.00	1.54	0.74	231.0	20.8	NO	NO
Selenium	*	6	2.58	0.60	6.71	No	0.00	1.37	0.66	260.0	35.0	NO	NO
Silver	*	9	0.16	0.27	0.22	Yes	0.03	0.07	0.05	0.77	0.09	NO	NO
Zinc	*	9	46.83	0.16	56.20	Yes	5.00	15.45	10.02	57.8	47.2	NO	NO
Cyanide (Free)	*	9	3.07	0.26	4.30	No	1.50	2.07	1.77	22.0	5.2	NO	NO
Cyanide (Total)	*	9	3.07		No Water Quality Criteria		1.50						

Reasonable Potential Analysis - Aquatic Toxicity - Domestic Facility

Determine Monitoring Reqs.		Identify Pollutants of Concern					Determine In-Stream Conc.			Determine Reasonable Potential			
Pollutant Parameter	Evaluation Required?	# of Samples	Highest Effluent Conc.	Coefficent of Variation	Estimated Max Eff. Conc.	RP at end of pipe?	Ambient Conc.	Max Total Conc. at ZID	Max Total Conc. at RMZ	WQ CRITERIA 1 Hour (CMC)	WQ CRITERIA 4 Day (CCC)	Is there Reasonable Potential to Exceed? (Y/N) Acute	Is there Reasonable Potential to Exceed? (Y/N) Chronic
	(Y/N)		µg/l	Default=0.6	µg/l	(Y/N)	µg/l	µg/l	µg/l	µg/l	µg/l	Acute	Chronic
Table 2: Volatile organic compounds													
Table 2: Acid-extractable compounds													
pentachlorophenol	*	*	*	0.60	--	--	*	--	--	27.8	21.3	--	--
Table 2: Base-neutral compounds													
Table 3: Pesticides & PCBs													
Aldrin	*	*	*	0.60	--	--	*	--	--	3.0	--	--	--
gamma-BHC (Lindane)	*	*	*	0.60	--	--	*	--	--	1.0	0.1	--	--
Chlordane	*	*	*	0.60	--	--	*	--	--	2.4	0.0	--	--
Chloropyrifos	*	*	*	0.60	--	--	*	--	--	0.1	0.0	--	--
Demeton	*	*	*	0.60	--	--	*	--	--	--	0.1	--	--
DDD 4,4'	*	*	*	--	No Water Quality Criteria								
DDE 4,4'	*	*	*	--	No Water Quality Criteria								
DDT 4,4' (DDT+DDE+DDD)	*	*	*	0.60	--	--	*	--	--	1.1	0.0	--	--
Dieldrin	*	*	*	0.60	--	--	*	--	--	0.2	0.0	--	--
Endosulfan alpha-	*	*	*	0.60	--	--	*	--	--	0.2	0.1	--	--
Endosulfan beta-	*	*	*	0.60	--	--	*	--	--	0.2	0.1	--	--
endosulfan	*	*	*	0.60	--	--	*	--	--	0.2	0.1	--	--
Endrin	*	*	*	0.60	--	--	*	--	--	0.1	0.0	--	--
Guthion	*	*	*	0.60	--	--	*	--	--	--	0.0	--	--
Heptachlor	*	*	*	0.60	--	--	*	--	--	0.5	0.0	--	--
Heptachlor Epoxide	*	*	*	0.60	--	--	*	--	--	0.5	0.0	--	--
Malathion	*	*	*	0.60	--	--	*	--	--	--	0.1	--	--
Methoxychlor	*	*	*	0.60	--	--	*	--	--	--	0.0	--	--
Mirex	*	*	*	0.60	--	--	*	--	--	--	0.0	--	--
Parathion	*	*	*	0.60	--	--	*	--	--	0.1	0.0	--	--
Toxaphene	*	*	*	0.60	--	--	*	--	--	0.7	0.0	--	--
PCB- Aroclor 1254	No	*	*		No Water Quality Criteria								
PCB- Aroclor 1232	No	*	*		No Water Quality Criteria								
PCB- Aroclor 1260	No	*	*		No Water Quality Criteria								
PCB- Aroclor 1242	No	*	*		No Water Quality Criteria								
PCB- Aroclor 1221	No	*	*		No Water Quality Criteria								
PCB- Aroclor 1248	No	*	*		No Water Quality Criteria								
PCB- Aroclor 1016	No	*	*		No Water Quality Criteria								
Total PCBs	*	*	*	0.60	--	--	*	--	--	2.0	0.0	--	--
Other parameters with state water quality criteria													
Sulfide-Hydrogen Sulfide	*	*	*	0.60	--	--	*	--	--	--	2.0	--	--
Phosphorus, Elemental	*	*	*	0.60	--	--	*	--	--	--	--	--	--

Reasonable Potential Analysis - Human Health - Domestic Facility

RPA Run Information	
Facility Name:	Medford RWRF
DEQ File Number:	0
Permit Writer Name:	0
Outfall Number:	001
Date of RPA Run:	Nov-13
RPA Run Notes:	

Please complete the following General Facility Information

1. Do I have dilution value from a mixing zone study? (Y/N)		Y
2. Is the receiving waterbody fresh water? (Y/N)		Y
3. If answered "N" to *Question 1*, then fill in the following table		
Eff. Flow Rate	MGD	*
Stream Flow: Harmonic Mean	CFS	*
Stream FLow: 30Q5	CFS	*
% dilution at MZ	%	25%
Calculated dilution factors		
Dilution @ Harmonic Mean Flow		na
Dilution @ 30Q5		na

4. If answered "Y" to *Question 1*, then fill in dilution factors from mixing zone study		
Dilution @ RMZ under harmonic mean flow		15.5
Dilution @ RMZ under 30Q5 flow		10.9
5. Please enter statistical *Confidence* and *Probablity* values (note: defaults already entered)		
Confidence Level	%	95%
Probability Basis	%	95%

Determine Monitoring Reqs.			Identify Pollutants of Concern					In-stream Conc.		Determine Reasonable Potential			
Pollutant Parameter	Carcinogen Status	Evaluation required?	# of Samples	Effluent Conc.	Coefficent of Variation	Estimated Max Eff. Conc.	RP at end of pipe?	Ambient Conc.	Max Total Conc. at RMZ	WQ Criteria Water + Fish	WQ Criteria Fish	Is there Reasonable Potential to Exceed? (Y/N)	
Pollutant Type	(Y/N)	(Yes/No)		µg/l	default=0.6	µg/l	(Y/N)	µg/l	µg/l	µg/l	µg/l	Water + Fish	Fish
Table 1 Effluent Parameters for all POTWs w/a Flow > 0.1 MGD													
Nitrates-Nitrite	N	*	*	*	0.60	--	--	*	--	10000	na	--	--
Table 2 Effluent Parameters for Selected POTWs													
Table 2: Metals (total recoverable), cyanide and totoal phenols													
Antimony	N	*	3	0.42	0.60	1.26	No	0.00	0.1156	5.1	64	NO	NO
Arsenic (Total)	Y	*	9	1.65	No Human Health Water Quality Criteria			0.59					
Arsenic (Inorganic)	Y	*	9	1.65	0.21	2.06	No	0.59	0.6849	2.1	2.1	NO	NO
Copper	N	*	9	25.53	0.20	31.56	No	1.00	3.8040	1300	na	NO	--
Mercury	N	Yes	9	0.06	No Human Health Water Quality Criteria			0.00					
Methyl Mercury	N	Yes	9	0.06	--	--	MMP Req'd	na	na	na	.040 mg/kg	MMP Req'd	MMP Req'd
Nickel	N	*	9	5.04	0.30	6.90	No	0.10	0.7241	140	170	NO	NO
Selenium	N	*	6	2.58	0.60	5.53	No	0.00	0.5069	120	420	NO	NO
Thallium	N	*	3	0.07	0.60	0.21	Yes	0.00	0.0193	0.043	0.047	NO	NO
Zinc	N	*	9	46.83	0.16	55.53	No	5.00	9.6354	2100	2600	NO	NO
Cyanide (Total)	N	*	9	3.07	0.26	4.04	No	1.50	1.7328	130	130	NO	NO
Table 2: Volatile organic compounds													
acrolein	N	*	*	*	0.60	--	--	*	--	0.88	0.93	--	--
acrylonitrile	Y	*	*	*	0.60	--	--	*	--	0.018	0.025	--	--
benzene	Y	*	*	*	0.60	--	--	*	--	0.44	1.4	--	--
bromoform	Y	*	*	*	0.60	--	--	*	--	3.3	14	--	--
carbon tetrachloride	Y	*	*	*	0.60	--	--	*	--	0.10	0.16	--	--
chlorobenzene	N	*	*	*	0.60	--	--	*	--	74	160	--	--

Reasonable Potential Analysis - Human Health - Domestic Facility

Determine Monitoring Reqs.			Identify Pollutants of Concern					In-stream Conc.		Determine Reasonable Potential			
Pollutant Parameter	Carcinogen Status	Evaluation required?	# of Samples	Effluent Conc.	Coefficent of Variation	Estimated Max Eff. Conc.	RP at end of pipe?	Ambient Conc.	Max Total Conc. at RMZ	WQ Criteria		Is there Reasonable Potential to Exceed? (Y/N)	
										Water + Fish	Fish		
Pollutant Type	(Y/N)	(Yes/No)		µg/l	default=0.6	µg/l	(Y/N)	µg/l	µg/l	µg/l	µg/l	Water + Fish	Fish
chlorodibromomethane	Y	*	*	*	0.60	--	--	*	--	0.31	1.3	--	--
chloroform	N	*	6	1.00	0.60	2.14	No	0.10	0.2873	260	1100	NO	NO
dichlorobromomethane	Y	*	*	*	0.60	--	--	*	--	0.42	1.7	--	--
1,2-dichloroethane	Y	*	*	*	0.60	--	--	*	--	0.35	3.7	--	--
1,2-trans-dichloroethylene	N	*	*	*	0.60	--	--	*	--	120	1000	--	--
1,1-dichloroethylene	N	*	*	*	0.60	--	--	*	--	230	710	--	--
1,2-dichloropropane	Y	*	*	*	0.60	--	--	*	--	0.38	1.5	--	--
1,3-dichloropropylene	Y	*	*	*	0.60	--	--	*	--	0.30	2.1	--	--
ethylbenzene	N	*	*	*	0.60	--	--	*	--	160	210	--	--
methyl bromide	N	*	*	*	0.60	--	--	*	--	37	150	--	--
methylene chloride	Y	*	6	0.20	0.60	0.43	No	0.00	0.0276	4.3	59	NO	NO
1,1,2,2-tetrachloroethane	Y	*	*	*	0.60	--	--	*	--	0.12	0.4	--	--
tetrachloroethylene	Y	*	*	*	0.60	--	--	*	--	0.24	0.33	--	--
toluene	N	*	6	0.20	0.60	0.43	No	0.00	0.0393	720	1500	NO	NO
1,1,2-trichloroethane	Y	*	*	*	0.60	--	--	*	--	0.44	1.6	--	--
trichloroethylene	Y	*	*	*	0.60	--	--	*	--	1.4	3	--	--
vinyl chloride	Y	*	*	*	0.60	--	--	*	--	0.023	0.24	--	--
Table 2: Acid-extractable compounds													
2-chlorophenol	N	*	*	*	0.60	--	--	*	--	14	15	--	--
2,4-dichlorophenol	N	*	*	*	0.60	--	--	*	--	23	29	--	--
2,4-dimethylphenol	N	*	*	*	0.60	--	--	*	--	76	85	--	--
2,4-dinitro-o-cresol	N	*	*	*	0.60	--	--	*	--	9.2	28	--	--
dinitrophenols	N	*	*	*	0.6	--	--	*	--	62	530	--	--
2,4-dinitrophenol	N	*	*	*	0.60	--	--	*	--	62	530	--	--
pentachlorophenol	Y	*	*	*	0.60	--	--	*	--	0.15	0.30	--	--
phenol	N	*	*	*	0.60	--	--	*	--	9400	86000	--	--
2,4,5-trichlorophenol	N	*	*	*	0.60	--	--	*	--	330	360	--	--
2,4,6-trichlorophenol	Y	*	*	*	0.60	--	--	*	--	0.23	0.24	--	--
Table 2: Base-neutral compounds													
acenaphthene	N	*	*	*	0.60	--	--	*	--	95	99	--	--
anthracene	N	*	*	*	0.60	--	--	*	--	2900	4000	--	--
azobenzene	na	No	*	*	No Water Quality Criteria								
benzidine	Y	*	*	*	0.60	--	--	*	--	0.000018	2E-05	--	--
benzo(a)anthracene	Y	*	*	*	0.60	--	--	*	--	0.0013	0.0018	--	--
benzo(a)pyrene	Y	*	*	*	0.60	--	--	*	--	0.0013	0.0018	--	--
3,4-benzofluoranthene	Y	*	*	*	0.60	--	--	*	--	0.0013	0.0018	--	--
benzo(k)fluoranthene	Y	*	*	*	0.60	--	--	*	--	0.0013	0.0018	--	--
bis(2-chloroethyl)ether	Y	*	*	*	0.60	--	--	*	--	0.020	0.050	--	--
bis(2-chloroisopropyl)ether	N	*	*	*	0.60	--	--	*	--	1200	6500	--	--
Bis (Chloromethyl) ether	Y	No	na	na	--	--	--	--	--	0.000024	3E-05	--	--
bis (2-ethylhexyl)phthalate	Y	*	6	1.40	0.60	3.00	Yes	0.00	0.1934	0.20	0.22	NO	NO
butylbenzyl phthalate	N	*	6	2.60	0.60	5.57	No	0.00	0.5109	190	190	NO	NO
2-chloronaphthalene	N	*	*	*	0.60	--	--	*	--	150	160	--	--

Reasonable Potential Analysis - Human Health - Domestic Facility

Determine Monitoring Reqs.			Identify Pollutants of Concern					In-stream Conc.		Determine Reasonable Potential			
Pollutant Parameter	Carcinogen Status	Evaluation required?	# of Samples	Effluent Conc.	Coefficent of Variation	Estimated Max Eff. Conc.	RP at end of pipe?	Ambient Conc.	Max Total Conc. at RMZ	WQ Criteria Water + Fish	WQ Criteria Fish	Is there Reasonable Potential to Exceed? (Y/N) Water + Fish	Is there Reasonable Potential to Exceed? (Y/N) Fish
Pollutant Type	(Y/N)	(Yes/No)		µg/l	default=0.6	µg/l	(Y/N)	µg/l	µg/l	µg/l	µg/l	Water + Fish	Fish
chrysene	Y	*	*	*	0.60	--	--	*	--	0.0013	0.0018	--	--
di-n-butyl phthalate	N	*	6	1.20	0.60	2.57	No	0.00	0.2358	400	450	NO	NO
dibenzo(a,h)anthracene	Y	*	*	*	0.60	--	--	*	--	0.0013	0.0018	--	--
Dichlorobenzene (o) 1,2-	N	*	*	*	0.60	--	--	*	--	110	130	--	--
Dichlorobenzene (m) 1,3-	N	*	*	*	0.60	--	--	*	--	80	96	--	--
Dichlorobenzene (p) 1,4-	N	*	*	*	0.60	--	--	*	--	16	19	--	--
3,3'-dichlorobenzidine	Y	*	*	*	0.60	--	--	*	--	0.0027	0.0028	--	--
diethyl phthalate	N	*	6	0.70	0.60	1.50	No	0.00	0.1375	3800	4400	NO	NO
dimethyl phthalate	N	*	6	0.60	0.60	1.29	No	0.00	0.1179	84000	110000	NO	NO
2,4-dinitrotoluene	Y	*	*	*	0.60	--	--	*	--	0.084	0.34	--	--
1,2-diphenylhydrazine	Y	*	*	*	0.60	--	--	*	--	0.014	0.02	--	--
fluroranthene	N	*	*	*	0.60	--	--	*	--	14	14	--	--
fluorene	N	*	*	*	0.60	--	--	*	--	390	530	--	--
hexachlorobenzene	N	*	*	*	0.60	--	--	*	--	0.000029	3E-05	--	--
hexachlorobutadiene	Y	*	*	*	0.60	--	--	*	--	0.36	1.8	--	--
hexachlorocyclopentadiene	N	*	*	*	0.60	--	--	*	--	30	110	--	--
hexachloroethane	Y	*	*	*	0.60	--	--	*	--	0.29	0.33	--	--
indeno(1,2,3-cd)pyrene	Y	*	*	*	0.60	--	--	*	--	0.0013	0.0018	--	--
isophorone	N	*	*	*	0.60	--	--	*	--	27	96	--	--
nitrobenzene	N	*	*	*	0.60	--	--	*	--	14	69	--	--
N-nitrosodimethylamine	Y	*	*	*	0.60	--	--	*	--	0.00068	0.3	--	--
N-nitrosodi-n-propylamine	Y	*	*	*	0.60	--	--	*	--	0.0046	0.051	--	--
N-nitrosodiphenylamine	Y	*	*	*	0.60	--	--	*	--	0.55	0.6	--	--
Pentachlorobenzene	N	*	*	*	0.60	--	--	*	--	0.15	0.15	--	--
pyrene	N	*	*	*	0.60	--	--	*	--	290	400	--	--
1,2,4-trichlorobenzene	N	*	*	*	0.60	--	--	*	--	6.4	7	--	--
Tetrachlorobenzene,1,2,4,5	N	*	*	*	0.60	--	--	*	--	0.11	0.11	--	--
Table 3: Pesticides & PCBs													
Aldrin	Y	*	*	*	0.60	--	--	*	--	0.000005	5E-06	--	--
BHC (Technical)	Y	*	*	*	0.60	--	--	*	--	0.0014	0.0015	--	--
BHC-alpha	Y	*	*	*	0.60	--	--	*	--	0.00045	0.0005	--	--
BHC-beta	Y	*	*	*	0.60	--	--	*	--	0.0016	0.0017	--	--
BHC-delta		No	*	*	No Water Quality Criteria			*					
BHC-gamma (Lindane)	N	*	*	*	0.60	--	--	*	--	0.17	0.18	--	--
Chlordane	Y	*	*	*	0.60	--	--	*	--	0.000081	8E-05	--	--
DDD 4,4'	Y	*	*	*	0.60	--	--	*	--	0.000031	3E-05	--	--
DDE 4,4'	Y	*	*	*	0.60	--	--	*	--	0.000022	2E-05	--	--
DDT 4,4'	Y	*	*	*	0.60	--	--	*	--	0.000022	2E-05	--	--
Dieldrin	Y	*	*	*	0.60	--	--	*	--	5.3E-06	5E-06	--	--
Endosulfan alpha-	N	*	*	*	0.60	--	--	*	--	8.5	8.9	--	--
Endosulfan beta-	N	*	*	*	0.60	--	--	*	--	8.5	8.9	--	--
Endosulfan Sulfate	N	*	*	*	0.60	--	--	*	--	8.5	8.9	--	--

Reasonable Potential Analysis - Human Health - Domestic Facility

Determine Monitoring Reqs.			Identify Pollutants of Concern					In-stream Conc.		Determine Reasonable Potential			
Pollutant Parameter	Carcinogen Status	Evaluation required?	# of Samples	Effluent Conc.	Coefficent of Variation	Estimated Max Eff. Conc.	RP at end of pipe?	Ambient Conc.	Max Total Conc. at RMZ	WQ Criteria Water + Fish	WQ Criteria Fish	Is there Reasonable Potential to Exceed? (Y/N) Water + Fish	Is there Reasonable Potential to Exceed? (Y/N) Fish
Pollutant Type	(Y/N)	(Yes/No)		µg/l	default=0.6	µg/l	(Y/N)	µg/l	µg/l	µg/l	µg/l	Water + Fish	Fish
Endrin	N	*	*	*	0.60	--	--	*	--	0.024	0.024	--	--
Endrin Aldehyde	N	*	*	*	0.60	--	--	*	--	0.03	0.03	--	--
Heptachlor	Y	*	*	*	0.60	--	--	*	--	7.9E-06	8E-06	--	--
Heptachlor Epoxide	Y	*	*	*	0.60	--	--	*	--	3.9E-06	4E-06	--	--
Methoxychlor	N	*	*	*	0.60	--	--	*	--	100	na	--	--
Toxaphene	Y	*	*	*	0.60	--	--	*	--	0.000028	3E-05	--	--
PCB- Aroclor 1254		No	*	*	No Water Quality Criteria			*					
PCB- Aroclor 1232		No	*	*	No Water Quality Criteria			*					
PCB- Aroclor 1260		No	*	*	No Water Quality Criteria			*					
PCB- Aroclor 1242		No	*	*	No Water Quality Criteria			*					
PCB- Aroclor 1221		No	*	*	No Water Quality Criteria			*					
PCB- Aroclor 1248		No	*	*	No Water Quality Criteria			*					
PCB- Aroclor 1016		No	*	*	No Water Quality Criteria			*					
Total PCBs	Y	*	*	*	0.60	--	--	*	--	6.4E-06	6E-06	--	--
Other parameters with state water quality criteria													
Barium, Total	N	*	*	*	0.60	--	--	*	--	1000	na	--	--
Manganese, Total	N	*	*	*	0.60	--	--	*	--	Withdrawn	na	--	--
2,4,5-TP [2-(2,4,5-Trichlorophenoxy) propanoic acid	N	*	*	*	0.60	--	--	*	--	10	na	--	--
2,4-D (2,4-Dichlorophenoxy acetic acid)	N	*	*	*	0.60	--	--	*	--	100	na	--	--
Dioxin 2,3,7,8-TCDD	Y	*	*	*	0.60	--	--	*	--	5.1E-10	5E-10	--	--
Nitrosamines	Y	*	*	*	0.60	--	--	*	--	0.00079	0.046	--	--
N-Nitrosodibutylamine	Y	*	*	*	0.60	--	--	*	--	0.005	0.022	--	--
N-Nitrosodiethylamine	Y	*	*	*	0.60	--	--	*	--	0.00079	0.046	--	--
N-Nitrosopyrrolidine	Y	*	*	*	0.60	--	--	*	--	0.016	3.4	--	--

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