Idaho Department of Environmental Quality

FINAL §401 Water Quality Certification

July 25, 2014

Permit Name/Number: Groundwater Remediation Discharge Facilities General Permit IDG-911000

Pursuant to the provisions of Section 401(a)(1) of the Federal Water Pollution Control Act (Clean Water Act), as amended, 33 USC Section 1341 (a)(1), and Idaho Code §§ 39-101 et.seq., and 39-3601 et.seq., the Idaho Department of Environmental Quality (DEQ) has authority to review National Pollutant Discharge Elimination System (NPDES) permits and issue water quality certification decisions.

Based upon its review of the above-referenced permit, associated fact sheet and supporting information, DEQ certifies that if the permittee complies with the terms and conditions imposed by the permit along with the conditions set forth in this water quality certification, then there is reasonable assurance the discharge will comply with the applicable requirements of Sections 301, 302, 303, 306, and 307 of the Clean Water Act, including the Idaho Water Quality Standards (WQS) (IDAPA 58.01.02) and other appropriate water quality requirements of State law.

This certification does not constitute authorization of the permitted activities by any other state or federal agency or private person or entity. This certification does not excuse the permit holder from the obligation to obtain any other necessary approvals, authorizations or permits, including without limitation, the approval from the owner of a private or public water conveyance system, if one is required, to use the system in connection with the permitted activities.

Antidegradation Review

The WQS contain an antidegradation policy providing three levels of protection to water bodies in Idaho (IDAPA 58.01.02.051).

- Tier 1 Protection. The first level of protection applies to all water bodies subject to Clean Water Act jurisdiction and ensures that existing uses of a water body and the level of water quality necessary to protect those existing uses will be maintained and protected (IDAPA 58.01.02.051.01; 58.01.02.052.01). Additionally, a Tier 1 review is performed for all new or reissued permits or licenses (IDAPA 58.01.02.052.07).
- Tier 2 Protection. The second level of protection applies to those water bodies considered high quality and ensures that no lowering of water quality will be

allowed unless deemed necessary to accommodate important economic or social development (IDAPA 58.01.02.051.02; 58.01.02.052.08).

- Tier 3 Protection. The third level of protection applies to water bodies that have been designated outstanding resource waters and requires that activities not cause a lowering of water quality (IDAPA 58.01.02.051.03; 58.01.02.052.09).

DEQ is employing a water body by water body approach to implementing Idaho's antidegradation policy. This approach means that any water body fully supporting its beneficial uses will be considered high quality (IDAPA 58.01.02.052.05.a). Any water body not fully supporting its beneficial uses will be provided Tier 1 protection for that use, unless specific circumstances warranting Tier 2 protection are met (IDAPA 58.01.02.052.05.c). The most recent federally approved Integrated Report and supporting data are used to determine support status and the tier of protection (IDAPA 58.01.02.052.05).

Pollutants of Concern

A variety of conventional, non-conventional, and toxic pollutants are expected to be present in discharges authorized under the Groundwater Remediation General Permit (GWGP). See EPA's Fact Sheet for a complete list of pollutants associated with ground water remediation facilities covered by this permit, and for how the effluent limits were calculated.

Receiving Water Body Level of Protection

The GWGP provides coverage to facilities throughout the entire State of Idaho. Because of the statewide applicability, all of the jurisdictional waters within Idaho could potentially receive discharges either directly or indirectly from facilities covered under the GWGP. As previously mentioned, DEQ uses a water body by water body approach when determining the level of antidegradation protection a water body will receive.

All waters in Idaho that receive discharges from facilities authorized in the GWGP will receive, at minimum, Tier 1 antidegradation protection because Idaho's antidegradation policy applies to all Waters of the State. Water bodies that fully support their aquatic life or recreational uses are considered to be "high quality waters" and receive Tier 2 antidegradation protection, in addition to Tier 1 protections. Although Idaho does not currently have any outstanding resource waters (ORWs) designated, it is possible that a water body could be designated as an ORW during the life of this permit. Because of this potential, this antidegradation review will also assess whether the permit complies with the outstanding resource water requirements of Idaho's antidegradation policy.

To determine the support status of the affected water body, the permitee must use the most current EPA-approved Integrated Report, available on Idaho DEQ's website: http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report.aspx. Impaired waters are identified in Categories 4 and 5 of the Integrated Report. Category 4(a) contains impaired waters for which a TMDL has been approved by EPA. Category 5 contains waters which have been identified as "impaired", for which a TMDL is needed.

DEQ's webpage also has a link to the state's map-based Integrated Report which presents information from the Integrated Report in a searchable, map-based format: http://mapcase.deq.idaho.gov/wq2012/.

If you need assistance in using these tools or for information/clarification regarding the support status of the water body you are discharging to, contact Nicole Deinarowicz, DEQ's Integrated Report Coordinator, at nicole.deinarowicz@deq.idaho.gov or by phone, at 208-373-0591.

Protection and Maintenance of Existing Uses (Tier 1 Protection)

As noted above, a Tier 1 review is performed for all new or reissued permits or licenses, applies to all waters subject to the jurisdiction of the CWA, and requires a showing that existing uses and the level of water quality necessary to protect existing uses shall be maintained and protected. In order to protect and maintain designated and existing beneficial uses, a permitted discharge must comply with narrative and numeric criteria of the Idaho WQS, as well as other provisions of the WQS such as Section 055, which addresses water quality limited waters.

Water bodies not supporting existing or designated beneficial uses must be identified as water quality limited ("impaired"), and a total maximum daily load (TMDL) must be prepared for those pollutants causing the impairment. A central purpose of TMDLs is to establish wasteload allocations for point source discharges, which are set at levels designed to help restore the water body to a condition that supports existing and designated beneficial uses. Discharge permits must contain limitations that are consistent with wasteload allocations in the approved TMDL. A permit with effluent limitations consistent with TMDL wasteload allocations will provide the level of water quality necessary to support existing and designated uses and therefore satisfies Tier 1 antidegradation requirements.

EPA has excluded from permit coverage, any facility proposing to discharge pollutants to a water body which has been identified as "impaired" for the specific pollutant(s) present in the discharge. The new GWGP will provide coverage to four existing facilities and one new facility which discharge to water quality impaired waters (see Table 1 below). None of these facilities, however, discharge pollutants associated with the listed impairment, and therefore, none of these facilities are excluded from permit coverage. In addition, none of these facilities have been given wasteload allocations in the associated TMDL because they do not discharge pollutants associated with the listed impairment(s).

Where technology-based limits (TBELs) were not protective enough to meet water quality standards, EPA set water quality-based effluent limits (WQBELs); these limits were calculated using the methods described in the *Technical Support Document for Water Quality-based Toxics Control* [TSD] (EPA-505-2-90-001, March 1991)]. EPA calculated WQBELs for both aquatic life and human health criteria. Where a water body is used as a drinking water supply source, the water + organism criteria were used, which

is the more protective criteria. The new limits were verified by DEQ and have been determined to be in compliance with Idaho's WQS.

Table 1. Existing (E) and New (N) Facilities covered under the GWGP which discharge to impaired waters

Facility Owner	*Facility Name and Location by City*	*Receiving Water*	*Assessment Unit*	*Beneficial Uses*	*Pollutants causing impairment*
Univar USA, Inc.	Boise Towne Square Mall (E), Boise Westpark Shopping Center (E), Boise North Five Mile Road (E), Boise	Lower Boise River via Finch Lateral and storm drain system	17050114SW005_06b	• CWAL[1] • SS[2] • PCR[3]	• Low flow alterations • Physical substrate habitat alterations • Temperature • Sedimentation/Siltation • Total Phosphorus
McCall Oil	McCall Oil and Chemical Co. (E), Nampa	Lower Boise River via Mason Creek	17050114SW006_02	• CWAL[1] • SCR[4]	• Cause Unknown: (Chlorpyrifos suspected) • Sedimentation/Siltation • Temperature
Boise State University	Boise State University (N), Boise	Lower Boise River	17050114SW011a_06	• CWAL[1] • SS[2] • PCR[3]	• Low flow alterations • Physical substrate habitat alterations • Temperature

[1]CWAL = cold water aquatic life; [2]SS = salmonid spawning; [3]PCR = primary contact recreation; [4]SCR = secondary contact recreation

In general, the proposed draft GWGP sets more stringent effluent limits than the previous permit; twenty-seven (27) of the water quality based effluent limits (WQBELs) are more stringent than in the previous permit. Some effluent limits are less stringent than in the previous permit; however, EPA conducted an anti-backsliding analysis and provided the justification for setting less stringent limits for a handful of pollutants. DEQ concurs with the conclusions drawn by EPA that these limits will still be protective of water quality and beneficial uses and will meet WQS.

In addition to increasing the frequency of discharge monitoring, EPA is requiring monitoring for an additional list of contaminants until it is sufficiently demonstrated that such contaminants are not present in the discharge. EPA has also added a requirement for the submission of a best management practices (BMP) plan by the facility.

The limitations and requirements contained in the GWGP will ensure compliance with the narrative and numeric criteria in the Idaho WQS. Therefore, DEQ has determined the permit will protect and maintain existing and designated beneficial uses in compliance with the Tier 1 provisions of Idaho's WQS (IDAPA 58.01.02.051.01 and 58.01.02.052.07).

Protection of High-Quality Waters (Tier 2 Protection)

As indicated previously, water bodies that fully support their beneficial uses will be provided Tier 2 protection. As such, the quality of these waters must be maintained and protected, unless a lowering of water quality is deemed necessary to accommodate important economic or social development. For a reissued permit or license, the effect on water quality is determined by looking at the difference in water quality that would result from the activity or discharge as authorized in the current permit and the water quality that would result from the activity or discharge as proposed in the reissued permit or license. For a new permit or license, the effect on water quality is determined by reviewing the difference between the existing receiving water quality and the water quality that would result from the activity or discharge as proposed in the new permit or license (IDAPA 58.01.02.052.06.a).

The GWGP, as is currently written, allows coverage for discharges to Tier 2 waters. DEQ cannot ensure compliance with the Tier 2 antidegradation provisions for such discharges. As a result, DEQ has included as a condition to this 401 certification, that the permit may authorize discharges to those waters that are identified in the most recent EPA-approved Integrated Report as "fully supporting" it's assessed uses, only if the facility receives an individual certification from DEQ that the discharge meets WQS, including the antidegradation provisions.

There is one existing facility (Table 2, below) that discharges to a high-quality water and that had coverage under the previous permit and whose discharge will be granted under the new permit. The Idaho Falls Pole Yard discharges to a Snake River assessment unit which is included in Category 3 ("unassessed waters") of the 2012 Integrated Report. Unassessed waters are provided an appropriate level of protection on a case-by-case basis using available information (IDAPA 58.01.02.052.05.b). Based on available information, DEQ has determined that this Snake River assessment unit is a high-quality water body. The permit limits in the new GWGP are the same or more stringent than the limits in the previous GWGP. Therefore, there will be no degradation as a result of coverage under the GWGP for this facility.

Given the 401 certification condition which prohibits coverage for facilities that discharge to high-quality waters unless DEQ certifies through an individual certification that the discharge meets WQS, DEQ believes the GWGP meets the antidegradation provisions concerning high-quality water bodies (58.01.02.051.02; 58.01.02.052.08).

Table 2. Facilities covered under the GWGP which discharge to High-Quality waters

Facility Owner	*Facility Name and Location by City*	*Receiving Water*	*Assessment Unit*	*Designated Uses*
Pacificorp, Inc.	Idaho Falls Pole Yard	Snake River	17040201SK001_04	• Cold Water Aquatic Life • Salmonid Spawning • Primary Contact Recreation • Drinking Water Supply

Protection of Outstanding Resource Waters (Tier 3 Protection)

Idaho's antidegradation policy requires that the quality of outstanding resource waters be maintained and protected from the impacts of point source discharges. No water bodies in Idaho have been designated as outstanding resource waters to date; however, it is possible that waters may become designated during the term of the GWGP. Because of this possibility, DEQ has evaluated whether the proposed final GWGP complies with the ORW antidegradation provision.

The GWGP does not authorize discharges to ORWs; EPA is requiring any applicant proposing to discharge to an ORW, should one become designated during the life of this permit, to obtain an individual permit from EPA and thus, an individual certification from DEQ. This requirement complies with Idaho's antidegradation provisions concerning ORWs (IDAPA 58.01.02.051.03; 58.01.02.052.09).

Conditions Necessary to Ensure Compliance with Water Quality Standards or Other Appropriate Water Quality Requirements of State Law

High-Quality Waters

The GWGP may authorize discharges to waters identified in the most recent EPA-approved Integrated Report as "fully supporting" assessed uses, if DEQ certifies, through an individual certification, that such discharge complies with WQS, including the Tier 2 antidegradation provisions.

Use of 2006 Human Health Criteria for Toxic Pollutants

On May 10, 2012, EPA disapproved DEQ's human health criteria for toxic pollutants that were submitted to EPA for review on July 7, 2006. EPA's disapproval means that DEQ's previous human health criteria that were approved by EPA in 1996 are the WQS effective for Clean Water Act purposes. States are authorized, however, to include conditions in certifications necessary to assure compliance with other appropriate requirements of State law. The 2006 human health criteria continue to be effective under state law, and are an appropriate water quality requirement of state law. Therefore, the GWGP shall use the 2006 human health criteria for toxic pollutants to determine WQBELs.

Mixing Zones

Mixing zones are authorized on a case-by-case basis by DEQ to facilities subject to WQBELs who request a mixing zone in their NOI. Mixing zones cannot be authorized to facilities for toxic pollutants which are identified as the cause of impairment in any water body not supporting its beneficial uses. Mixing zones also do not apply where TBELs have been established as the basis for the effluent limits, as they are not water quality related limits. Maximum daily limits and average monthly limits have been added to the permit for dischargers who are granted a mixing zone by DEQ; thus, a mixing zone

which would allow for an exceedance of the TBELs cannot be granted, since the TBELs are the maximum effluent limits established by EPA.

The use of mixing zones to determine effluent limits other than the WQBELs established in the permit *must be authorized by DEQ* (IDAPA 58.01.02.060). The GWGP only allows the use of mixing zones if DEQ authorizes the mixing zone through an individual 401 certification, and is therefore, consistent with state WQS.

Pursuant to IDAPA 58.01.02.060, DEQ authorizes a 3% mixing zone for Tetrachloroethylene (PCE) to Boise State University (BSU) for the ground water discharge proposed under this permit. The authorization letter, granting this mixing zone, is included as Attachment A. The mixing zone analysis is included in this certification as Attachment B. The CORMIX models are included as Appendix C.

Right to Appeal Final Certification

The final Section 401 Water Quality Certification may be appealed by submitting a petition to initiate a contested case, pursuant to Idaho Code § 39-107(5), and the Rules of Administrative Procedure Before the Board of Environmental Quality, IDAPA 58.01.23, within 35 days of the date of the final certification.

Questions regarding the actions taken in this certification should be directed to Barry Burnell, DEQ State Office, at (208) 373-0194 or barry.burnell@deq.idaho.gov.

Barry N. Burnell

Barry N. Burnell
Administrator
DEQ Water Quality Division

Attachment A. Mixing Zone Authorization for Boise State University

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 North Hilton • Boise, Idaho 83706 • (208) 373-0502

C.L. "Butch" Otter, Governor
Curt Fransen, Director

July 25, 2014

Mr. Michael J. Lidgard
NPDES Unit Manager
US EPA Region 10
Attn: OWW-130
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

Subject: Mixing Zone Authorization for Boise State University

Dear Mr. Lidgard:

Boise State University (BSU) has applied for coverage under EPA's NPDES Groundwater Remediation General Permit (GWGP) to discharge pumped ground water that contains Tetrachloroethylene (PCE) to the Boise River. EPA established both water quality-based effluent limits (WQBELs) and technology-based limits (TBELs) in the GWGP. Based on past data collection and laboratory analysis, BSU cannot meet the WQBELs without treating the ground water prior to discharging to the river and thus, has requested a mixing zone from DEQ. DEQ conducted a mixing zone analysis and CORMIX modeling analysis and has concluded that a mixing zone is appropriate and that BSU should be given the TBELs as their effluent limits. These are the maximum allowable limits as set forth by EPA; BSU should able to meet these end-of-pipe limits and comply with water quality standards, as demonstrated by the mixing zone analysis conducted by DEQ. This analysis demonstrates that if BSU discharges the maximum allowable limits (TBELs), only a very small mixing zone is needed (roughly 3%) to meet the in-stream criterion for PCE. Because less than five percent of the harmonic mean flows of the river are needed to meet the PCE criterion, DEQ recommends that BSU be allowed to discharge at the maximum allowed limits as set forth in the permit.

Based on the above information, and pursuant to IDAPA 58.01.02.060, DEQ hereby authorizes a mixing zone and the use of TBELs as effluent limits for BSU.

If you have any questions or concerns regarding this authorization, please contact me at 208-373-0194 or via email at barry.burnell@deq.idaho.gov.

Sincerely,

Barry N. Burnell

Barry N. Burnell
Water Quality Division Administrator

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Attachment B. Tetrachloroethylene Plume and Mixing Zone Analysis: Boise State University Ground Water Discharge to the Boise River

Background

DEQ Technical Services was asked to examine the plume dynamics through CORMIX modeling of a Tetrachloroethylene (PCE) discharge from Boise State University (BSU) sump pumping through outfalls to the Boise River. We examined the discharge outfall locations in the field and determined that discharge configurations were likely side channel discharges. After water left the outfall pipe it probably traveled over land variable distances through small channels to the Boise River. We also examined sampling data of the discharges from previous years to derive an expected discharge concentration of PCE. These data (Figure 1) suggest that while concentration appears to be decreasing in recent years, the concentration is variable from year to year. This is likely due to varying high flow/low flow water years of the Boise River (the likely principle source of ground water) and perhaps the variable dynamics of the ground water pollution itself.

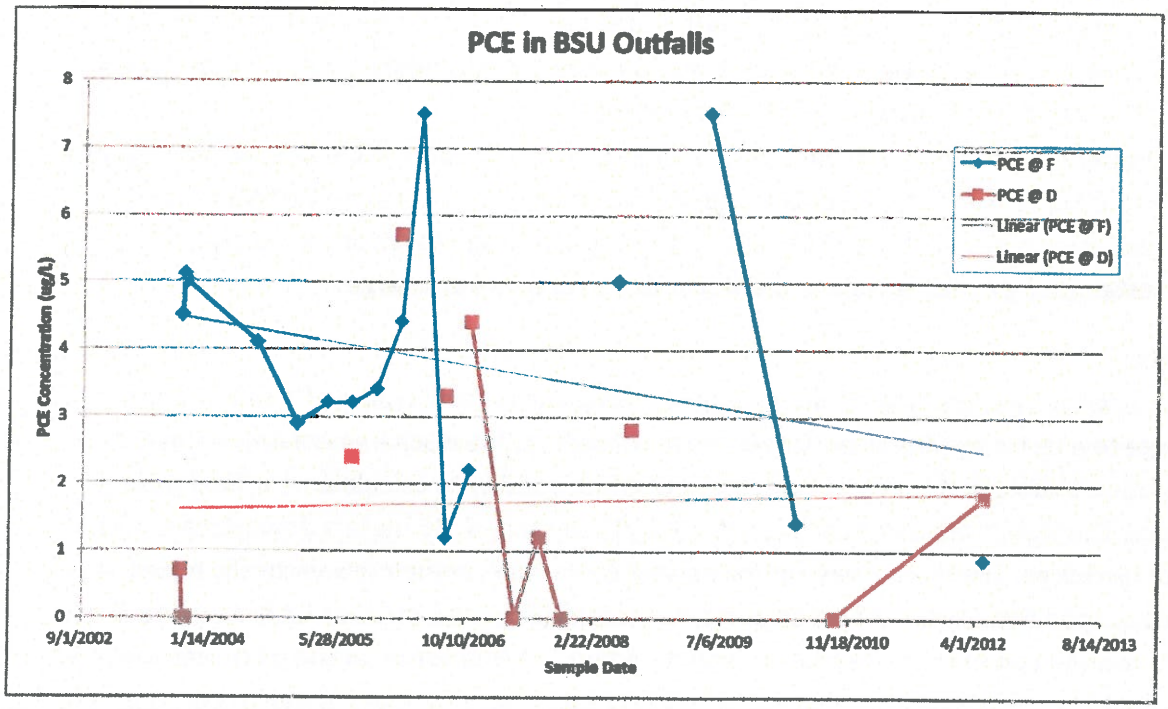

Figure 1. PCE concentrations in BSU outfall sampling, 2003 – 2012

It is important to note that low flow years in the future may allow the PCE concentrations to build up in the ground water beneath BSU buildings due to lower amounts of pumping. Such low flow years may cause discharge concentrations to spike during high flow years when increased pumping is necessary, as has occurred in the past.

CORMIX Modeling

For modeling purposes, we set the discharge concentration equivalent to the technology based limits (TBELs) as set forth in the NPDES Groundwater Remediation General Permit (Average

Monthly Limit [AML] = 3.4 ug/L; Maximum Daily Limit [MDL] = 5.0 ug/L). These limits represent the maximum limits allowed for PCE at end-of-pipe. These are the limits that BSU must comply with in order to be in compliance with the permit.

According to the City of Boise Lander Street NPDES Permit recently issued by EPA, the harmonic mean flow of the Boise River as calculated using data collected at the Glenwood Bridge gaging station (October 1-April 30), is 240 cubic feet per second (cfs). We modeled the plume using this harmonic mean flow.

The CORMIX model input parameters are as follows:

- Boise River harmonic mean flow (ambient) – 240 cfs, 100 feet (30.48 meters) wide uniform bounded, 1.3 feet (0.4 meters) average depth, 12°C, Manning's n = 0.03, wind speed = 2 meters/second.
- Discharge (effluent) – 1.2 cfs, 5.0 ug/L and 3.4 ug/L, 12°C, flush side channel discharge 10 feet (3 meters) wide and 0.5 feet (0.15 meters) deep, Sigma = 30°, bottom slope = 10%, depth at discharge = 1 feet (0.3 meters)
- Water Quality Human Health criteria for PCE: organism only = 3.3 ug/L, water+organism = 0.69 ug/L. The Boise River is designated for domestic water supply (DWS), thus the water+organism criteria (0.69 ug/L) is the applicable standard for the purpose of establishing a mixing zone and effluent limits for BSU's discharge.

Results

MDL (5.0 ug/L): The resulting discharge plume is long and narrow typical of a side channel discharge to a faster moving river. Under these conditions, the discharge created a small recirculation bubble that tends to complicate CORMIX's ability to calculate near field mixing distances. The water+organism criterion (0.69 ug/L) was met at 36 meters downstream of the point of discharge. The plume was approximately 2.2 m wide, completely vertically mixed, and had a corresponding dilution of seven and three tenths (7.3). This means that it would take over seven times the volume of the effluent to dilute down to the criterion at the distances specified here. The plume's width at the edge of the mixing zone, where the human health criterion was met, occupied about 7% of the width of the river. Drift time, which is the amount of time it takes to travel from the discharge point to the end of the mixing zone at harmonic mean flow velocity, through the plume is approximately two (2) minutes.

AML (3.4 ug/L): The resulting discharge plume is similar to the one above. Under these conditions, the discharge created a small recirculation bubble that tends to complicate CORMIX's ability to calculate near field mixing distances. The water+organism criterion was met at 17 meters downstream of the point of discharge. The plume was approximately 1.5 m wide, completely vertically mixed, and had a corresponding dilution of five (5). This means that it

would take five times the volume of the effluent to dilute down to the criteria in-stream at the distances specified here. The plume's width at the edge of the mixing zone, where the water + organism human health criterion was met, occupied about 5% of the width of the river. Drift time through the plume is approximately 1 minute.

The mass balance equation for determining an appropriate mixing zone is:

$$C_d = (C_e \times Q_e) + (Cu \times (Q_u \times MZ\%) / Q_e (Q_u \times MZ\%)$$

where:

C_d = receiving water concentration of PCE at the edge of the mixing zone
C_e = maximum effluent limit allowed for PCE according to permit (TBEL)
Q_e = maximum effluent flow (discharge) from BSU discharge
C_u = upstream (background) concentration of pollutant
Q_u = Boise River flow (harmonic mean)
MZ = mixing zone percentage

Table 1. Mixing Zone percentages and corresponding PCE concentrations at the edge of the mixing zone

Mixing Zone %	PCE concentration at edge of mixing zone where C_e = AML (3.4 ug/L)	PCE concentration at edge of mixing zone where C_e = MDL (5.0 ug/L)	Idaho Human Health criterion for PCE
25	0.067 ug/L	0.098 ug/L	0.69 ug/L
10	0.162 ug/L	0.238 ug/L	
5	0.309 ug/L	0.455 ug/L	
3	0.486 ug/L	0.714 ug/L	

Conclusions

As demonstrated in the CORMIX modeling results, discharging PCE at the maximum allowed limits in the Groundwater Remediation General Permit (3.4 and 5.0 ug/L) does not pose an unacceptable risk to human health or aquatic life. An adequate zone of passage would be provided and cumulative travel time through the plume for passive drift is approximately one to two (1 – 2) minutes. The 36 meter-long plume downstream of the discharge is in an entirely wooded riparian corridor with no public features (designated public beaches, water intakes, boat launches, etc.); this minimizes the risk of human exposure.

As is further demonstrated in Table 1 (above), if BSU discharges at the maximum allowed limits (TBELs) as set forth in the permit, the in-stream PCE concentrations will be in compliance with the state's human health criterion (0.69 ug/L) with a mixing zone size of roughly 3% of the volume of the Boise River even during low flow months. For this reason, DEQ has concluded

that BSU should be given the maximum discharge concentrations for PCE allowed (TBELs), with this mixing zone analysis and authorization from DEQ, under the NPDES permit limits. The modeling results demonstrate that these maximum allowable discharge limits are more than adequate to meet water quality standards and to protect beneficial uses of the Boise River.

Attachment C. CORMIX Model output files

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                    CORMIX MIXING ZONE EXPERT SYSTEM
                        CORMIX Version 8.0GTD
                    HYDRO3:Version-8.0.0.0  April,2012
SITE NAME/LABEL:                Outfall  D or F
  DESIGN CASE:                  BSU - Perc plume
  FILE NAME:                    C:\data\ALLTECH\WATER\401certs\BSU 2013\BSU perc runharmonic3 4.prd
  Using subsystem CORMIX3:      Buoyant Surface Discharges
  Start of session:             02/26/2014--11:27:48
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = bounded
  Width                         BS        = 30.48 m
  Channel regularity            ICHREG    = 1
  Ambient flowrate              QA        = 6.80 m^3/s
  Average depth                 HA        = 0.40 m
  Depth at discharge            HD        = 0.30 m
  Ambient velocity              UA        = 0.5627 m/s
  Darcy-Weisbach friction factor F        = 0.0961
    Calculated from Manning's n           = 0.03
  Wind velocity                 UW        = 2 m/s
  Stratification Type           STRCND    = U
  Surface temperature                     = 12 degC
  Bottom temperature                      = 12 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density               RHOAS     = 999.4994 kg/m^3
  Bottom density                RHOAB     = 999.4994 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Surface Discharge
  Discharge located on                    = left bank/shoreline
  Discharge configuration                 = flush discharge
  Distance from bank to outlet  DISTB     = 0 m
  Discharge angle               SIGMA     = 30 deg
  Depth near discharge outlet   HD0       = 0.30 m
  Bottom slope at discharge     SLOPE     = 0 deg
  Rectangular discharge:
    Discharge cross-section area A0       = 0.464515 m^2
    Discharge channel width     B0        = 3.048 m
    Discharge channel depth     H0        = 0.1524 m
    Discharge aspect ratio      AR        = 0.05
  Discharge flowrate            Q0        = 0.033980 m^3/s
  Discharge velocity            U0        = 0.07 m/s
  Discharge temperature (freshwater)      = 12 degC
  Corresponding density         RHO0      = 999.4994 kg/m^3
  Density difference            DRHO      = 0 kg/m^3
  Buoyant acceleration          GP0       = 0 m/s^2
  Discharge concentration       C0        = 3.4 ppb
  Surface heat exchange coeff.  KS        = 0 m/s
  Coefficient of decay          KD        = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.68 m        Lm  = 0.09 m        Lbb = 0 m
  LM  = 99999 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Densimetric Froude number     FR0       = 99999 (based on LQ)
  Channel densimetric Froude no. FRCH     = 99999 (based on H0)
  Velocity ratio                R         = 0.13
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = yes
  CMC concentration             CMC       = 3.3 ppb
  CCC concentration             CCC       = 0.69 ppb
  Water quality standard specified        = given by CCC value
  Regulatory mixing zone                  = no
  Region of interest                      = 305 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS   = SA1 |
  *-------------------------*
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
Origin is located at water surface and at centerline of discharge channel:
    0 m from the left bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge   c = 1.7557 ppb
  Dilution at edge of NFR               s = 1.9
  NFR Location:                         x = 2.26 m
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@3.4 ug/L

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    (centerline coordinates)            y = 0 m
                                        z = 0 m
  NFR plume dimensions:  half-width (bh) = 1.91 m
                        thickness (bv) = 0.30 m
Cumulative travel time:        31.9294 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is equal or about about equal to the surrounding
  ambient water density at the discharge level.
  Therefore, the effluent behaves essentially as NEUTRALLY BUOYANT.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 17.46 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section contacts one bank only at 0 m downstream.
************************ TOXIC DILUTION ZONE SUMMARY *************************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 3.3  ppb
Corresponding dilution                   = 1.030303
The CMC was encountered at the following plume position:
  Plume location:                        x = 3.54 m
    (centerline coordinates)             y = 0 m
                                         z = 0 m
  Plume dimension:       half-width (bh) = 1.98 m
                        thickness (bv) = 0.30 m

 Computed distance from port opening to CMC location = 3.54 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
              Lq = 0.68 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 3.54 m.
 CRITERION 2: This location is beyond 5 times the ambient water depth of
              HD = 0.30 m.
 ++++++++++ The ambient depth TEST for the TDZ has FAILED. ++++++++++

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

 The diffuser discharge velocity is equal to 0.07 m/s.
 This is below the value of 3.0 m/s recommended in the TSD.

 *** This discharge DOES NOT SATISFY all three CMC criteria for the TDZ. ****
 **** This MAY be caused by the low discharge velocity for this design. *****
********************** REGULATORY MIXING ZONE SUMMARY ************************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                    = 0.69  ppb
Corresponding dilution                   = 5.0
  Plume location:                        x = 17.06 m
    (centerline coordinates)             y = 0 m
                                         z = 0 m
  Plume dimensions:      half-width (bh) = 0.76 m
                        thickness (bv) = 0.40 m
********************* FINAL DESIGN ADVICE AND COMMENTS ***********************
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX3 PREDICTION FILE:
3333333333333333333333333333333333333333333333333333333333333333333333333333333333
                    CORMIX MIXING ZONE EXPERT SYSTEM
            Subsystem CORMIX3: Buoyant Surface Discharges
                         CORMIX Version 8.0GTD
                   HYDRO3 Version 8.0.0.0 April 2012
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   Outfall  D or F
 Design case:       BSU - Perc plume
 FILE NAME:         C:\...TER\401certs\BSU 2013\BSU perc runharmonic3_4.prd
 Time stamp:        Wed Feb 26 11:27:48 2014

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =     30.48  AS    =     12.08  QA    =      6.80  ICHREG= 1
 HA    =      0.40  HD    =      0.30
 UA    =     0.563  F     =     0.096 USTAR =0.6167E-01
 UW    =     2.000 UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U         RHOAM =  999.4994

DISCHARGE PARAMETERS (metric units)
 BANK  =  LEFT      DISTB =      0.00  Configuration: flush_discharge
 SIGMA =     30.00  HDO   =      0.30  SLOPE =    0.00 deg.
 Rectangular channel geometry:
 B0    =     3.048 H0    =     0.152 A0    =0.4645E+00  AR    =      0.050
 U0    =     0.073 Q0    =     0.034       =0.3398E-01
 RHO0  =  999.4994  DRHO0 =0.0000E+00  GP0   =0.0000E+00
 C0    =0.3400E+01  CUNITS=  ppb
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.3398E-01  M0    =0.2486E-02  J0    =0.0000E+00
 Associated length scales (meters)
 LQ    =      0.68  LM    =  99999.00  Lm    =      0.09  Lb    =      0.00

NON-DIMENSIONAL PARAMETERS
 FR0   =  99999.00  FRCH  =  99999.00  R     =      0.13

FLOW CLASSIFICATION
 3333333333333333333333333333333333333333333
 3  Flow class (CORMIX3)      =    SA1    3
 3  Applicable layer depth HS =     0.30  3
 3333333333333333333333333333333333333333333

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.3400E+01  CUNITS=  ppb
 NTOX  =  1         CMC   =0.3300E+01  CCC   =  CSTD
 NSTD  =  1         CSTD  =0.6900E+00
 REGMZ =  0
 XINT  =    305.00  XMAX  =    305.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the WATER SURFACE and at center of discharge
      channel/outlet:      0.00 m  from the LEFT  bank/shore.
    X-axis points downstream
    Y-axis points to left as seen by an observer looking downstream
    Z-axis points vertically upward (in CORMIX3, all values Z = 0.00)
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
BEGIN MOD301: DISCHARGE MODULE

 Efflux conditions:
       X        Y        Z        S        C        BV       BH        TT
     0.00     0.00     0.00      1.0 0.340E+01   0.15     1.52 .00000E+00

END OF MOD301: DISCHARGE MODULE
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
BEGIN MOD302: ZONE OF FLOW ESTABLISHMENT

 Control volume inflow:
       X        Y        Z        S        C        BV       BH        TT
     0.00     0.00     0.00      1.0 0.340E+01   0.15     1.52 .00000E+00

 Profile definitions:
  BV = Gaussian 1/e (37%) vertical thickness
  BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
  S  = hydrodynamic centerline dilution
  C  = centerline concentration (includes reaction efects, if any)
  TT = Cumulative travel time

 Control volume outflow:                                SIGMAE=    353.94
       X        Y        Z        S        C        BV       BH        TT
     1.40    -0.28     0.00      1.0 0.340E+01   0.15     0.28 .19549E+02
 Cumulative travel time =          19.5489 sec  (    0.01 hrs)

END OF MOD302: ZONE OF FLOW ESTABLISHMENT
```

```
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
BEGIN CORSURF (MOD310): BUOYANT SURFACE JET - NEAR-FIELD REGION

 Surface jet in deep crossflow with shoreline-attachment.

 Profile definitions:
   BV = Gaussian 1/e (37%) vertical thickness
   BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction efects, if any)
   TT = Cumulative travel time

       X        Y        Z        S        C        BV       BH        TT
     1.40    -0.28     0.00     1.0 0.340E+01   0.15     0.28 .19549E+02
  Maximum lateral extent of recirculation bubble.
  Jet/plume becomes VERTICALLY FULLY MIXED over the local ambient water depth.
     BV = water depth (vertically mixed)
     1.41    -0.28     0.00     1.5 0.232E+01   0.52     0.94 .19549E+02
     1.41    -0.28     0.00     1.5 0.232E+01   0.30     0.94 .19549E+02
  End of recirculation bubble at the above position.
   Dilution in recirculation bubble =    1.4
   Corresponding concentration      =    0.237E+01
  Flow continues as WALL JET/PLUME.
** CMC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below CMC value of 0.330E+01
   in the current prediction interval.
 This is the extent of the TOXIC DILUTION ZONE.
     1.45     0.00     0.00     2.1 0.163E+01   0.30     1.89 .19915E+02
     1.50     0.00     0.00     2.1 0.166E+01   0.30     1.89 .20236E+02
     1.54     0.00     0.00     2.0 0.168E+01   0.30     1.89 .20573E+02
     1.58     0.00     0.00     2.0 0.170E+01   0.30     1.89 .20927E+02
     1.62     0.00     0.00     2.0 0.171E+01   0.30     1.89 .21301E+02
     1.67     0.00     0.00     2.0 0.173E+01   0.30     1.89 .21695E+02
     1.71     0.00     0.00     2.0 0.174E+01   0.30     1.90 .22113E+02
     1.75     0.00     0.00     1.9 0.175E+01   0.30     1.90 .22556E+02
     1.80     0.00     0.00     1.9 0.175E+01   0.30     1.90 .23028E+02
     1.84     0.00     0.00     1.9 0.176E+01   0.30     1.90 .23532E+02
     1.88     0.00     0.00     1.9 0.176E+01   0.30     1.90 .24073E+02
     1.92     0.00     0.00     1.9 0.177E+01   0.30     1.90 .24655E+02
     1.97     0.00     0.00     1.9 0.177E+01   0.30     1.90 .25284E+02
     2.01     0.00     0.00     1.9 0.177E+01   0.30     1.90 .25969E+02
     2.05     0.00     0.00     1.9 0.177E+01   0.30     1.91 .26718E+02
     2.10     0.00     0.00     1.9 0.177E+01   0.30     1.91 .27546E+02
     2.14     0.00     0.00     1.9 0.176E+01   0.30     1.91 .28467E+02
     2.18     0.00     0.00     1.9 0.176E+01   0.30     1.91 .29506E+02
     2.22     0.00     0.00     1.9 0.176E+01   0.30     1.91 .30694E+02
     2.26     0.00     0.00     1.9 0.176E+01   0.30     1.91 .31929E+02
 Cumulative travel time =          31.9294 sec  (    0.01 hrs)

END OF CORSURF (MOD310): BUOYANT SURFACE JET - NEAR-FIELD REGION
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
-----------------------------------------------------------------------------

 WAKE FLOW CONDITIONS: The discharge velocity (U0) is less than or equal to the
 ambient velocity (Ua) and results in wake flow conditions. There is no discharge
 momentum induced mixing. The mixing characteristics are UNDESIRABLE.

 The initial plume WIDTH/THICKNESS VALUE in the next far-field module will be
  CORRECTED by a factor  0.45 to conserve the mass flux in the far-field!

 Some bank/shore interaction occurs at end of near-field.

 In the next prediction module, the jet/plume centerline will be set
   to follow the bank/shore.
-----------------------------------------------------------------------------
BEGIN MOD341: BUOYANT AMBIENT SPREADING

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

 Plume condition is non-buoyant or weakly buoyant, or, at the end of the NFR
   it is governed by full vertical mixing over the ambient depth,
   or by complete lateral mixing over the channel width.
 Thus, the BUOYANT SPREADING REGIME is ABSENT.

END OF MOD341: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
BEGIN MOD361: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)   = 0.489E-02 m^2/s
  Horizontal diffusivity (initial value) = 0.611E-02 m^2/s

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

```
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction efects, if any)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X        Y        Z        S        C        BV       BH        TT
      2.26     0.00     0.00     1.9 0.176E+01   0.40     0.29 .31929E+02
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.690E+00 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
     17.40     0.00     0.00     5.1 0.666E+00   0.40     0.77 .58696E+02
     32.54     0.00     0.00     7.0 0.488E+00   0.40     1.06 .85462E+02
     47.67     0.00     0.00     8.4 0.404E+00   0.40     1.28 .11223E+03
     62.81     0.00     0.00     9.7 0.352E+00   0.40     1.46 .13899E+03
     77.95     0.00     0.00    10.7 0.316E+00   0.40     1.63 .16576E+03
     93.08     0.00     0.00    11.7 0.290E+00   0.40     1.78 .19253E+03
    108.22     0.00     0.00    12.7 0.269E+00   0.40     1.92 .21929E+03
    123.36     0.00     0.00    13.5 0.252E+00   0.40     2.05 .24606E+03
    138.49     0.00     0.00    14.3 0.238E+00   0.40     2.17 .27283E+03
    153.63     0.00     0.00    15.1 0.226E+00   0.40     2.29 .29959E+03
    168.77     0.00     0.00    15.8 0.215E+00   0.40     2.40 .32636E+03
    183.90     0.00     0.00    16.5 0.206E+00   0.40     2.50 .35312E+03
    199.04     0.00     0.00    17.2 0.198E+00   0.40     2.60 .37989E+03
    214.18     0.00     0.00    17.8 0.191E+00   0.40     2.70 .40666E+03
    229.32     0.00     0.00    18.4 0.185E+00   0.40     2.79 .43342E+03
    244.45     0.00     0.00    19.0 0.179E+00   0.40     2.88 .46019E+03
    259.59     0.00     0.00    19.6 0.174E+00   0.40     2.97 .48696E+03
    274.73     0.00     0.00    20.1 0.169E+00   0.40     3.06 .51372E+03
    289.86     0.00     0.00    20.7 0.164E+00   0.40     3.14 .54049E+03
    305.00     0.00     0.00    21.2 0.160E+00   0.40     3.22 .56726E+03
 Cumulative travel time =          567.2554 sec  (     0.16 hrs)

 Simulation limit based on maximum specified distance =     305.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD361: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
CORMIX3: Buoyant Surface Discharges                    End of Prediction File
333333333333333333333333333333333333333333333333333333333333333333333333333333
```

```
    (centerline coordinates)              y = 0 m
                                          z = 0 m
  NFR plume dimensions:   half-width (bh) = 1.91 m
                          thickness (bv) = 0.30 m
Cumulative travel time:          31.9294 sec
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is equal or about about equal to the surrounding
  ambient water density at the discharge level.
  Therefore, the effluent behaves essentially as NEUTRALLY BUOYANT.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 17.40 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section contacts one bank only at 0 m downstream.
************************ TOXIC DILUTION ZONE SUMMARY *************************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 3.3  ppb
Corresponding dilution                   = 1.515152
The CMC was encountered at the following plume position:
  Plume location:                        x = 2.22 m
    (centerline coordinates)             y = 0 m
                                         z = 0 m
  Plume dimension:        half-width (bh) = 1.92 m
                           thickness (bv) = 0.30 m

 Computed distance from port opening to CMC location = 2.22 m.
 CRITERION 1: This location is within 50 times the discharge length scale of
              Lq = 0.68 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 Computed horizontal distance from port opening to CMC location = 2.22 m.
 CRITERION 2: This location is beyond 5 times the ambient water depth of
              HD = 0.30 m.
 ++++++++++ The ambient depth TEST for the TDZ has FAILED. ++++++++++

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

 The diffuser discharge velocity is equal to 0.07 m/s.
 This is below the value of 3.0 m/s recommended in the TSD.

 *** This discharge DOES NOT SATISFY all three CMC criteria for the TDZ. ****
 **** This MAY be caused by the low discharge velocity for this design. *****
********************** REGULATORY MIXING ZONE SUMMARY ************************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  Plume position:
  CCC                                    = 0.59  ppb
Corresponding dilution                   = 7.3
  Plume location:                        x = 35.99 m
    (centerline coordinates)             y = 0 m
                                         z = 0 m
  Plume dimensions:       half-width (bh) = 1.11 m
                           thickness (bv) = 0.40 m
******************** FINAL DESIGN ADVICE AND COMMENTS ************************
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

Water + organism criterion

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                        CORMIX MIXING ZONE EXPERT SYSTEM
                            CORMIX Version 8.0GTD
                         HYDRO3:Version-8.0.0.0  April,2012
SITE NAME/LABEL:                 Outfall F or D
  DESIGN CASE:                   BSU - Perc plume
  FILE NAME:                     C:\data\ALLTECH\WATER\401certs\BSU 2013\BSU perc runharmonic5.prd
  Using subsystem CORMIX3:      Buoyant Surface Discharges
  Start of session:              02/26/2014--11:30:02
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = bounded
  Width                          BS      = 30.48 m
  Channel regularity             ICHREG  = 1
  Ambient flowrate               QA      = 6.80 m^3/s
  Average depth                  HA      = 0.40 m
  Depth at discharge             HD      = 0.30 m
  Ambient velocity               UA      = 0.5627 m/s
  Darcy-Weisbach friction factor F       = 0.0961
    Calculated from Manning's n          = 0.03
  Wind velocity                  UW      = 2 m/s
  Stratification Type            STRCND  = U
  Surface temperature                    = 12 degC
  Bottom temperature                     = 12 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                RHOAS   = 999.4994 kg/m^3
  Bottom density                 RHOAB   = 999.4994 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Surface Discharge
  Discharge located on                   = left bank/shoreline
  Discharge configuration                = flush discharge
  Distance from bank to outlet   DISTB   = 0 m
  Discharge angle                SIGMA   = 30 deg
  Depth near discharge outlet    HD0     = 0.30 m
  Bottom slope at discharge      SLOPE   = 0 deg
  Rectangular discharge:
    Discharge cross-section area A0      = 0.464515 m^2
    Discharge channel width      B0      = 3.048 m
    Discharge channel depth      H0      = 0.1524 m
    Discharge aspect ratio       AR      = 0.05
  Discharge flowrate             Q0      = 0.033980 m^3/s
  Discharge velocity             U0      = 0.07 m/s
  Discharge temperature (freshwater)     = 12 degC
  Corresponding density          RHO0    = 999.4994 kg/m^3
  Density difference             DRHO    = 0 kg/m^3
  Buoyant acceleration           GP0     = 0 m/s^2
  Discharge concentration        C0      = 5 ppb
  Surface heat exchange coeff.   KS      = 0 m/s
  Coefficient of decay           KD      = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.68 m        Lm  = 0.09 m        Lbb = 0 m
  LM  = 99999 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Densimetric Froude number      FR0     = 99999 (based on LQ)
  Channel densimetric Froude no. FRCH    = 99999 (based on H0)
  Velocity ratio                 R       = 0.13
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration              CMC     = 3.3 ppb
  CCC concentration              CCC     = 0.69 ppb
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 305 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS   = SA1 |
  *-------------------------*
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
Origin is located at water surface and at centerline of discharge channel:
    0 m from the left bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 2.5819 ppb
  Dilution at edge of NFR              s = 1.9
  NFR Location:                        x = 2.26 m
```

25.0 ug/L

```
CORMIX3 PREDICTION FILE:
333333333333333333333333333333333333333333333333333333333333333333333333333333
                    CORMIX MIXING ZONE EXPERT SYSTEM
            Subsystem CORMIX3: Buoyant Surface Discharges
                          CORMIX Version 8.0GTD
                  HYDRO3 Version 8.0.0.0 April 2012
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:    Outfall F or D
 Design case:        BSU - Perc plume
 FILE NAME:          C:\...WATER\401certs\BSU 2013\BSU perc runharmonic5.prd
 Time stamp:         Wed Feb 26 11:30:02 2014

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =     30.48  AS    =     12.08  QA    =      6.80  ICHREG= 1
 HA    =      0.40  HD    =      0.30
 UA    =     0.563  F     =     0.096  USTAR =0.6167E-01
 UW    =     2.000  UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U          RHOAM =  999.4994

DISCHARGE PARAMETERS (metric units)
 BANK  =  LEFT       DISTB =      0.00  Configuration: flush_discharge
 SIGMA =     30.00   HDO   =      0.30  SLOPE =    0.00 deg.
 Rectangular channel geometry:
 B0    =     3.048   H0    =     0.152  A0    =0.4645E+00  AR    =      0.050
 U0    =     0.073   Q0    =     0.034        =0.3398E-01
 RHO0  =  999.4994  DRHO0 =0.0000E+00  GP0   =0.0000E+00
 C0    =0.5000E+01  CUNITS=  ppb
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.3398E-01  M0    =0.2486E-02  J0    =0.0000E+00
 Associated length scales (meters)
 LQ    =      0.68  LM    =  99999.00  Lm    =      0.09  Lb    =      0.00

NON-DIMENSIONAL PARAMETERS
 FR0   =  99999.00  FRCH  =  99999.00  R     =      0.13

FLOW CLASSIFICATION
 333333333333333333333333333333333333333333
 3  Flow class (CORMIX3)      =    SA1    3
 3  Applicable layer depth HS =     0.30  3
 333333333333333333333333333333333333333333

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.5000E+01  CUNITS=  ppb
 NTOX  =  1         CMC   =0.3300E+01  CCC   =  CSTD
 NSTD  =  1         CSTD  =0.6900E+00
 REGMZ =  0
 XINT  =    305.00  XMAX  =    305.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the WATER SURFACE and at center of discharge
      channel/outlet:       0.00 m  from the LEFT  bank/shore.
    X-axis points downstream
    Y-axis points to left as seen by an observer looking downstream
    Z-axis points vertically upward (in CORMIX3, all values Z = 0.00)
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
BEGIN MOD301: DISCHARGE MODULE

 Efflux conditions:
      X        Y        Z        S        C        BV       BH        TT
    0.00     0.00     0.00      1.0 0.500E+01    0.15     1.52 .00000E+00

END OF MOD301: DISCHARGE MODULE
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
BEGIN MOD302: ZONE OF FLOW ESTABLISHMENT

 Control volume inflow:
      X        Y        Z        S        C        BV       BH        TT
    0.00     0.00     0.00      1.0 0.500E+01    0.15     1.52 .00000E+00

 Profile definitions:
  BV = Gaussian 1/e (37%) vertical thickness
  BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
  S  = hydrodynamic centerline dilution
  C  = centerline concentration (includes reaction efects, if any)
  TT = Cumulative travel time

 Control volume outflow:                                SIGMAE=    353.94
      X        Y        Z        S        C        BV       BH        TT
    1.40    -0.28     0.00      1.0 0.500E+01    0.15     0.28 .19549E+02
 Cumulative travel time =          19.5489 sec  (    0.01 hrs)

END OF MOD302: ZONE OF FLOW ESTABLISHMENT
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BEGIN CORSURF (MOD310): BUOYANT SURFACE JET - NEAR-FIELD REGION

 Surface jet in deep crossflow with shoreline-attachment.

 Profile definitions:
   BV = Gaussian 1/e (37%) vertical thickness
   BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction efects, if any)
   TT = Cumulative travel time

       X        Y        Z        S        C        BV       BH        TT
      1.40    -0.28     0.00     1.0 0.500E+01   0.15     0.28 .19549E+02
  Maximum lateral extent of recirculation bubble.
  Jet/plume becomes VERTICALLY FULLY MIXED over the local ambient water depth.
     BV = water depth (vertically mixed)
      1.41    -0.28     0.00     1.5 0.342E+01   0.52     0.94 .19549E+02
      1.41    -0.28     0.00     1.5 0.342E+01   0.30     0.94 .19549E+02
  End of recirculation bubble at the above position.
   Dilution in recirculation bubble =     1.4
   Corresponding concentration      =     0.348E+01
  Flow continues as WALL JET/PLUME.
** CMC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below CMC value of 0.330E+01
   in the current prediction interval.
 This is the extent of the TOXIC DILUTION ZONE.
      1.45     0.00     0.00     2.1 0.240E+01   0.30     1.89 .19915E+02
      1.50     0.00     0.00     2.1 0.244E+01   0.30     1.89 .20236E+02
      1.54     0.00     0.00     2.0 0.247E+01   0.30     1.89 .20573E+02
      1.58     0.00     0.00     2.0 0.250E+01   0.30     1.89 .20927E+02
      1.62     0.00     0.00     2.0 0.252E+01   0.30     1.89 .21301E+02
      1.67     0.00     0.00     2.0 0.254E+01   0.30     1.89 .21695E+02
      1.71     0.00     0.00     2.0 0.256E+01   0.30     1.90 .22113E+02
      1.75     0.00     0.00     1.9 0.257E+01   0.30     1.90 .22556E+02
      1.80     0.00     0.00     1.9 0.258E+01   0.30     1.90 .23028E+02
      1.84     0.00     0.00     1.9 0.259E+01   0.30     1.90 .23532E+02
      1.88     0.00     0.00     1.9 0.259E+01   0.30     1.90 .24073E+02
      1.92     0.00     0.00     1.9 0.260E+01   0.30     1.90 .24655E+02
      1.97     0.00     0.00     1.9 0.260E+01   0.30     1.90 .25284E+02
      2.01     0.00     0.00     1.9 0.260E+01   0.30     1.90 .25969E+02
      2.05     0.00     0.00     1.9 0.260E+01   0.30     1.91 .26718E+02
      2.10     0.00     0.00     1.9 0.260E+01   0.30     1.91 .27546E+02
      2.14     0.00     0.00     1.9 0.259E+01   0.30     1.91 .28467E+02
      2.18     0.00     0.00     1.9 0.259E+01   0.30     1.91 .29506E+02
      2.22     0.00     0.00     1.9 0.259E+01   0.30     1.91 .30694E+02
      2.26     0.00     0.00     1.9 0.258E+01   0.30     1.91 .31929E+02
 Cumulative travel time =          31.9294 sec  (     0.01 hrs)

END OF CORSURF (MOD310): BUOYANT SURFACE JET - NEAR-FIELD REGION
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** End of NEAR-FIELD REGION (NFR) **
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 WAKE FLOW CONDITIONS: The discharge velocity (U0) is less than or equal to the
 ambient velocity (Ua) and results in wake flow conditions. There is no discharge
 momentum induced mixing. The mixing characteristics are UNDESIRABLE.

 The initial plume WIDTH/THICKNESS VALUE in the next far-field module will be
  CORRECTED by a factor  0.45 to conserve the mass flux in the far-field!

 Some bank/shore interaction occurs at end of near-field.

 In the next prediction module, the jet/plume centerline will be set
   to follow the bank/shore.
-----------------------------------------------------------------------------
BEGIN MOD341: BUOYANT AMBIENT SPREADING

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

 Plume condition is non-buoyant or weakly buoyant, or, at the end of the NFR
   it is governed by full vertical mixing over the ambient depth,
   or by complete lateral mixing over the channel width.
 Thus, the BUOYANT SPREADING REGIME is ABSENT.

END OF MOD341: BUOYANT AMBIENT SPREADING
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BEGIN MOD361: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)   = 0.489E-02 m^2/s
  Horizontal diffusivity (initial value) = 0.611E-02 m^2/s

 Profile definitions:
   BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
      = or equal to water depth, if fully mixed
   BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
        measured horizontally in Y-direction
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   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction efects, if any)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X        Y        Z        S        C        BV       BH        TT
     2.26     0.00     0.00      1.9 0.258E+01   0.40     0.29 .31929E+02
 Plume interacts with BOTTOM.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
    17.40     0.00     0.00      5.1 0.979E+00   0.40     0.77 .58696E+02
    32.54     0.00     0.00      7.0 0.718E+00   0.40     1.06 .85462E+02
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.690E+00 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
    47.67     0.00     0.00      8.4 0.594E+00   0.40     1.28 .11223E+03
    62.81     0.00     0.00      9.7 0.518E+00   0.40     1.46 .13899E+03
    77.95     0.00     0.00     10.7 0.465E+00   0.40     1.63 .16576E+03
    93.08     0.00     0.00     11.7 0.426E+00   0.40     1.78 .19253E+03
   108.22     0.00     0.00     12.7 0.395E+00   0.40     1.92 .21929E+03
   123.36     0.00     0.00     13.5 0.370E+00   0.40     2.05 .24606E+03
   138.49     0.00     0.00     14.3 0.349E+00   0.40     2.17 .27283E+03
   153.63     0.00     0.00     15.1 0.332E+00   0.40     2.29 .29959E+03
   168.77     0.00     0.00     15.8 0.316E+00   0.40     2.40 .32636E+03
   183.90     0.00     0.00     16.5 0.303E+00   0.40     2.50 .35312E+03
   199.04     0.00     0.00     17.2 0.291E+00   0.40     2.60 .37989E+03
   214.18     0.00     0.00     17.8 0.281E+00   0.40     2.70 .40666E+03
   229.32     0.00     0.00     18.4 0.272E+00   0.40     2.79 .43342E+03
   244.45     0.00     0.00     19.0 0.263E+00   0.40     2.88 .46019E+03
   259.59     0.00     0.00     19.6 0.255E+00   0.40     2.97 .48696E+03
   274.73     0.00     0.00     20.1 0.248E+00   0.40     3.06 .51372E+03
   289.86     0.00     0.00     20.7 0.242E+00   0.40     3.14 .54049E+03
   305.00     0.00     0.00     21.2 0.236E+00   0.40     3.22 .56726E+03
 Cumulative travel time =          567.2554 sec  (     0.16 hrs)

 Simulation limit based on maximum specified distance =     305.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD361: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT
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CORMIX3: Buoyant Surface Discharges                    End of Prediction File
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