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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

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May 2, 2018

18-NWP-072

Mr. Doug Shoop, Manager
Richland Operations Office
United States Department of Energy
PO Box 550, MSIN: H5-20
Richland, Washington 99352

Re: Final Approval Order DE12NWP-001, Rev. 2

Reference: Letter 17-ESQ-0084 dated July 27, 2017, U.S. Department of Energy, Richland Operation Office Submits: *Transmittal of Notice of Construction Application for Off-Permit Change Request, Permit Number 00-05-006, Renewal 2, To Request Modification to DE12NWP-001, 200 West Area Lagoon Treatment System.*

Dear Mr. Shoop:

The Department of Ecology is hereby issuing the enclosed **Approval Order, DE12NWP-001, Rev.2** (enclosure 1), with an effective date of **May 1, 2018**. A Statement of Basis is also enclosed which is not enforceable but serves as information purposes (enclosure 2).

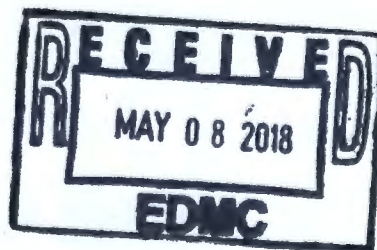
Please contact me at dheu461@ecy.wa.gov or (509) 372-7895 if you have any questions.

Sincerely,

Daniel Jon Heuston, PE
Waste Management Section
Nuclear Waste Program

am
Enclosures (2)

cc: See page 2



Mr. Shoop
May 1, 2018
Page 2

18-NWP-072

cc: electronic w/enc:

- Dave Einan, EPA
- Katie McClintock, EPA
- Christopher Kemp, USDOE-ORP
- Bryan Trimberger, USDOE-ORP
- Brian Vance, USDOE-ORP
- Eric Faust, USDOE-RL
- Reed Kaldor, MSA
- Jon Perry, MSA
- ERWM Program, YN
- Ken Niles, ODOE
- Philip Gent, Ecology
- Daniel Heuston, Ecology
- Lilyann Murphy, Ecology
- Ron Skinnerland, Ecology
- Environmental Portal
- Hanford Facility Operating Record
- MSA Correspondence Control
- USDOE-ORP Correspondence Control
- USDOE-RL Correspondence Control

cc w/enc

- Robin Priddy, BCAA
- Matt Johnson, CTUIR
- Jack Bell, NPT
- Rose Longoria, YN
- Susan Leckband, HAB
- Administrative Record, AIR Permits
- NWP Central File



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**NON-RADIOACTIVE AIR EMISSIONS
NOTICE OF CONSTRUCTION APPROVAL ORDER
CONDITIONS AND RESTRICTIONS
DE12NWP-001, REVISION 2**

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1 **REGULATORY AUTHORITY:**

2 Pursuant to the Washington State Department of Ecology (Ecology) General Regulations for Air Pollution
3 Sources, Chapter 173-400 Washington Administrative Code (WAC), and Controls for New Sources of Toxic Air
4 Pollutants, Chapter 173-460 WAC, Ecology now finds the following:

5 **FINDINGS:**

- 6 1. The United States Department of Energy (USDOE) proposes to modify their existing facility (Hanford)
7 located in Richland, Washington.
- 8 2. The original Notice of Construction (NOC) application was submitted on December 15, 2011. The
9 application was found to be complete on December 21, 2011. Approval Order DE12NWP-001 was
10 issued January 12, 2012.
- 11 3. A NOC application to modify Approval Order DE12NWP-001 was submitted April 4, 2013.
- 12 4. Approval Order DE12NWP-001, Revision 1 was issued July 24, 2013.
- 13 5. A NOC application to modify Approval Order DE12NWP-001, Revision 1 was submitted August 3,
14 2017.
- 15 6. Hanford is an existing major stationary source that has the potential to emit more than 250 tons of a
16 regulated pollutant per year
- 17 7. The proposed project consists of constructing a wastewater treatment system, referred to as the Lagoon
18 Treatment System (LTS), to provide domestic waste treatment services for the Hanford Site.
- 19 8. The proposed project under Revision 2 consists of constructing a sewer collection system that will tie in
20 various locations from the 200 East Area to the LTS via forcemains, gravity lines and lift stations.
21 Emissions from lift stations, manholes and air release valves were not analyzed or included as part of the
22 NOC application.
- 23 9. The proposed project emissions are based on assumed influent wastewater concentrations and an flow rate
24 of 110,000 gpd coupled with WATER9 and AERMOD modeling. Using the assumed influent
25 wastewater concentrations and flow rate of 110,000 gpd, the WATER9 model was used to determine
26 expected emissions from the LTS. The resultant emissions from the WATER9 model were then used in
27 AERMOD to determine dispersed concentrations at the ambient air boundary.
- 28 10. Emissions of criteria pollutants from the proposed project are below the Prevention of Significant
29 Deterioration Significant Emission Rates.
- 30 11. Hanford is located in a Class II Area designated as "attainment" for the purpose of NOC permitting for all
31 pollutants.
- 32 12. The air pollutants analyzed as part of the application were ammonia, chloroform, 1,4-dichlorobenzene,
33 hydrogen sulfide, toluene, and methylene chloride. The emissions from the proposed project are below
34 the *de minimis* levels in WAC 173-400-110(5)(d) with the exception of ammonia, chloroform,
35 1,4-dichlorobenzene, and hydrogen sulfide.
- 36 13. Ammonia, chloroform, 1,4-dichlorobenzene, and hydrogen sulfide were found to be above the Small
37 Quantity Emission Rate (SQER).
- 38 14. As proposed, the project would emit no Toxic Air Pollutants (TAPs) exceeding the acceptable source
39 impact levels (ASILs).
- 40 15. Best Available Control Technology (BACT) for this project has been determined to be operation of the
41 LTS in conformance with good operating principles, standard industry practices, and conformance with
42 an Operations and Maintenance (O&M) program as approved under WAC 173-240.
- 43 16. The proposed project, if constructed and operated as herein required, will provide BACT.

- 1 17. The proposed project, if operated as herein required, will be in accordance with applicable rules and
2 regulations, as set forth in Chapter 173-400 WAC and Chapter 173-460 WAC, and the operation thereof
3 will not result in ambient air quality standards being exceeded.
4 18. The project will have no significant impact on ambient air quality.

5
6 **THEREFORE, IT IS ORDERED** that the project as described in said NOC application, and as detailed in
7 emissions estimates and impact and control technology assessments submitted to Ecology in reference thereto, is
8 approved for construction, installation, and operation, provided compliance with the conditions and restrictions
9 described below are met. This ORDER shall be identified as NOC APPROVAL ORDER **DE12NWP-001,**
10 **Revision 2.**

1 **1.0 APPROVAL CONDITIONS**

2 **1.1 Effective Date**

3 The effective date of this authorization shall be that as signed in Section 5.0. All references to procedures or test
4 methods shall be to those in effect as of the effective date of this ORDER.

5 **1.2 Emission Limits**

6 **1.2.1** All TAPs, as provided below in Table 1, shall be below their respective ASILs.
7

8 **Table 1: Toxic Air Pollutants from the Lagoon Treatment System (DE12NWP-001, Rev 2)**

| Chemical Name | CAS # | ASIL ($\mu\text{g}/\text{m}^3$) |
|---------------------|-----------|-----------------------------------|
| 1,4-Dichlorobenzene | 106-46-7 | 0.0909 |
| Chloroform | 67-66-3 | 0.0435 |
| Ammonia | 7664-41-7 | 70.8 |
| Hydrogen Sulfide | 7783-06-4 | 2 |

9
10 **1.3 Compliance Demonstration**

11 **1.3.1** Compliance with the ASILs as provided in Table 1 of Approval Condition 1.2.1 shall be demonstrated
12 through surrogate wastewater sampling as described in Section 3.0. The surrogate wastewater values
13 provided in Table 2 of Section 3.0 represent the maximum allowable wastewater concentrations that can
14 be reached without exceeding the respective ASIL provided in Table 1. Therefore, if Table 2 values of
15 Section 3.0 are exceeded, it is also deemed that the respective ASIL provided in Table 1 are also
16 exceeded. Sampling of surrogate wastewater constituents provided in Table 2 shall be conducted at the
17 frequency and location as described in Section 3.0.

18 **1.3.2** Compliance with Approval Conditions 1.2.1 shall be demonstrated through operational record keeping
19 provisions of Section 2.3.

20 **2.0 NOTIFICATIONS AND SUBMITTALS**

21 **2.1 Addressing**

22 Any required notifications and submittals required under these Approval Conditions shall be sent to the address
23 below or to where Ecology directs them to be sent:

24 Washington State Department of Ecology
25 Nuclear Waste Program
26 3100 Port of Benton Boulevard
27 Richland, Washington 99354

28 **2.2 Operational Notice**

29 Notification will be made at least ten (10) days prior to physical tie-in of the upstream wastewater collection
30 system to the discharge vault located at the Lagoon Treatment System. Notification will also be made at least ten
31 (10) days prior to the start of full system operations which is marked by the introduction of sewage into the
32 wastewater collection system. These notifications may be sent by email to the Nuclear Waste Program and/or to
33 the address listed in section 2.1.

1 **2.3 Recordkeeping**

2 Specific records shall be kept on the Hanford Site by the Permittee and made available for inspection by Ecology
3 upon request. The records shall be organized in a readily accessible manner and cover a minimum of the most
4 recent sixty (60) month period. The records to be kept shall include the following:

- 5 1. Records of maintenance activities performed in accordance with the Operations and Maintenance (O&M)
6 program as approved under WAC 173-240.
- 7 2. Laboratory analysis result summaries taken in accordance with these approval conditions for wastewater
8 concentrations for pollutants listed in Table 2.
- 9 3. Records of calculations, as provided in in Section 3, to demonstrate compliance with ASILs as provided
10 in Table 1 through surrogate wastewater sampling of constituents provided in Table 2.
- 11 4. Laboratory analysis result summaries taken in accordance with these approval conditions of any samples
12 undertaken after the effective date of this ORDER from the LTS which are examined for organic species
13 or other TAPS.
- 14 5. Annual sampling and analysis plan (SAP). The SAP may be subject to review and approval by Ecology.

15 **2.4 Reporting**

16 Results of wastewater sampling conducted pursuant to Section 3.0 shall be submitted to Ecology within ninety
17 (90) days of completion of validated laboratory analysis results of such assessment if any pollutant concentration
18 exceeds Table 2 values.

19 Notification of identification of any TAP that is found to exceed de minimus values provided in WAC 173-460
20 shall be submitted to Ecology within ninety (90) days of completion of validated laboratory analyses and shall
21 verify/quantify emissions of that toxic air pollutant from the project.

22 **3.0 EMISSION MONITORING**

23 The following sampling and monitoring are required in order to verify compliance with Section 1.2.1, above.

24 **3.1 TAPs Emission Assessment using Surrogate Wastewater Concentrations**

25 Compliance assessments for hydrogen sulfide with the ASIL (Table 1) will be performed through surrogate
26 wastewater influent sampling for both sulfate (SO_4^{2-}) and sulfide (S^{2-} as S), in accordance with United States
27 Environmental Protection Agency (EPA) approved method in 40 Code of Federal Regulations (CFR) Part 136.
28 The resultant concentrations for sulfate and sulfide (as S) will be converted to hydrogen sulfide concentrations by
29 using the appropriate conversions as provided below. The sum of the two hydrogen sulfide concentrations
30 obtained through the conversions will be used to demonstrate compliance by determining if Table 2 values were
31 exceeded. The hydrogen sulfide value provided in Table 2 represents the maximum concentration in the influent
32 wastewater that can be reached without exceeding the ASIL for the respective TAP as provided in Table 1.

34
$$\frac{X \mu g H_2S}{L} = \frac{X mg SO_4^{2-}}{L} * \frac{1 mmol SO_4^{2-}}{96 mg SO_4^{2-}} * \frac{1 mmol H_2S}{1 mmol SO_4^{2-}} * \frac{34 mg H_2S}{1 mmol H_2S} * \frac{1000 \mu g}{1 mg}$$

36
$$\frac{X \mu g H_2S}{L} = \frac{X mg S^{2-} (as S)}{L} * \frac{1 mmol S}{32 mg S} * \frac{1 mmol H_2S}{1 mmol S} * \frac{34 mg H_2S}{1 mmol H_2S} * \frac{1000 \mu g}{1 mg}$$

1 Compliance assessments for ammonia, chloroform, and 1,4-dichlorobenzene will also be performed through
2 surrogate wastewater influent sampling for the respective parameters in accord with an EPA approved method in
3 40 CFR Part 136. The resultant concentrations will be used to demonstrate compliance by determining if Table 2
4 values were exceeded for the respective pollutant. The values in Table 2 represent the maximum allowable
5 concentrations in the influent wastewater that can be reached without exceeding the ASIL for the respective TAPs
6 as provided in Table 1.

7
8 **Table 2: Lagoon Treatment System Wastewater Influent Concentrations**

| Pollutant | Wastewater Influent | |
|---------------------|---------------------|-------|
| | Concentration | Units |
| Ammonia | 6,200 | mg/L |
| Chloroform | 21,700 | µg/L |
| 1,4-dichlorobenzene | 168,000 | µg/L |
| Hydrogen sulfide | 33,200 | µg/L |

9
10 **3.2 Sampling Frequency and Location**

11 **3.2.1 Sampling Location**

12 Permittee will develop and implement an annual SAP which may be subject to Ecology review and approval. The
13 SAP shall address the collection of representative samples of the influent wastewater at the discharge vault
14 located at the head of the LTS.

15 **3.2.2 Sampling Frequency**

16 Sampling frequency for ammonia, chloroform, and 1,4-dichlorobenzene will be performed **annually**.

17 Sampling frequency for sulfate and sulfide (as S) will be performed **quarterly** for the first year of operation after
18 the sewer collection system is tied into the LTS and operational. After the first year, or thereafter, the permittee
19 can request (in writing) a lesser sampling frequency for sulfate and sulfide (as S) if respective concentrations
20 remain statistically consistent. If a lesser sampling frequency is not requested by the permittee and granted by
21 Ecology, the quarterly sampling frequency will remain in effect. The annual sampling frequency will remain in
22 effect as long as the conditions of this permit are being met and the concentrations remain statistically consistent.

23 **4.0 APPROVAL ORDER AND RESTRICTIONS**

24 Operation of the subject LTS is only intended for domestic waste treatment services for the Hanford Site. For the
25 purposes of this authorization, "domestic waste treatment services" includes two waste streams:

- 26 • Primary waste stream consisting of raw wastewater piped through the sewer collection system to the LTS.
- 27 • Secondary waste stream consisting of hauled septage from outside of the LTS and sludge solids diverted
28 from the LTS settling lagoons.

29 **5.0 GENERAL CONDITIONS**

30 All plans, specifications, and other information submitted to Ecology relative to this project and any
31 authorizations or approvals or denials in relation thereto shall be incorporated herein and made a part thereof.

1 **5.1 Availability of Order and O&M Manual**

2 Legible copies of this APPROVAL ORDER and O&M manual shall be available to employees in direct operation
3 of the LTS, and be available for review upon request by Ecology.

4 **5.2 Discontinuing Construction or Operations**

5 It shall be grounds for rescission of this approval if physical construction or operation is discontinued for a period
6 of eighteen (18) months or more. Ecology may extend the 18-month period upon request.

7 **5.3 Compliance Assurance Access**

8 Access to the source by representatives of Ecology or the EPA shall be permitted upon request. Failure to allow
9 such access is grounds for enforcement action under the federal Clean Air Act or the Washington State Clean Air
10 Act, and may result in revocation of this APPROVAL ORDER.

11 **5.4 Equipment Operation**

12 Operation of the LTS and related equipment shall be conducted in compliance with all data and specifications
13 submitted as part of the NOC application and in accordance with the O&M manual, unless otherwise approved in
14 writing by Ecology.

15 **5.5 Activities Inconsistent with the NOC Application and this Approval Order**

16 Any activity undertaken by the permittee or others, in a manner that is inconsistent with the NOC application and
17 this determination, shall be subject to Ecology enforcement under applicable regulations.

18 **5.6 Obligations under Other Laws or Regulations**

19 Nothing in this APPROVAL ORDER shall be construed to relieve the permittee of its obligations under any local,
20 state or federal laws or regulations.

21 **5.7 Modifications**

22 Any modifications to the LTS system's O&M procedures, contrary to information in the NOC application, shall
23 be reported to Ecology at least 60 days before such modification. Such modification may require a new or
24 amended NOC APPROVAL ORDER.

1 **YOUR RIGHT TO APPEAL**

2 You have a right to appeal this Order to the Pollution Control Hearing Board (PCHB) within 30 days of the date
3 of receipt of this Order. The appeal process is governed by Chapter 43.21B RCW and Chapter 371-08 WAC.
4 "Date of receipt" is defined in RCW 43.21B.001(2).

5 To appeal you must do all of the following within 30 days of the date of receipt of this Order:

- 6 • File your appeal and a copy of this Order with the PCHB (See addresses below). Filing means actual
7 receipt by the PCHB during regular business hours.
- 8 • Serve a copy of your appeal and this Order on Ecology in paper form - by mail or in person (See
9 addresses below). E-mail is not accepted.

10 You must also comply with other applicable requirements in Chapter 43.21B RCW and Chapter 371-08

11 **ADDRESS AND LOCATION INFORMATION**

| Street Addresses | Mailing Addresses |
|---|---|
| <p data-bbox="191 836 558 1017">Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive SE Lacey, WA 98503</p> | <p data-bbox="789 836 1156 1017">Department of Ecology Attn: Appeals Processing Desk PO Box 47608 Olympia, WA 98504-7608</p> |
| <p data-bbox="191 1087 618 1268">Pollution Control Hearings Board 1111 Israel RD SW Suite 301 Tumwater, WA 98501</p> | <p data-bbox="789 1087 1214 1219">Pollution Control Hearings Board PO Box 40903 Olympia, WA 98504-0903</p> |

13

1 This Authorization may be modified, suspended, or revoked in whole, or in part, for cause including, but not
2 limited to, the following:

- 3 1. Violation of any terms or conditions of this authorization.
4 2. Obtaining this authorization by misrepresentation, or failure to fully disclose all relevant facts.

5 The provisions of this authorization are severable and, if any provision of this authorization, or application of any
6 provisions of this authorization to any circumstance, is held invalid, the application of such provision to their
7 circumstances, and the remainder of this authorization, shall not be affected thereby.

8

9 The New Source Review Fee has been assessed according to WAC 173-455. No approval of a permit or service
10 for any activity covered in this Order will be valid until the required fee is paid in full.

11

12

13 **DATED** at Richland, Washington, this 12th day of April 2018.

14

REVIEWED AND PREPARED BY:

Daniel Jon Heuston, P.E.
Daniel Jon Heuston, P.E.

APPROVED BY:

Alexandra K. Smith
Alexandra K. Smith
Program Manager
Nuclear Waste Program
Department of Ecology

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**NON-RADIOACTIVE AIR EMISSIONS
STATEMENT OF BASIS FOR
NOTICE OF CONSTRUCTION APPROVAL ORDER
DE12NWP-001, REVISION 2**

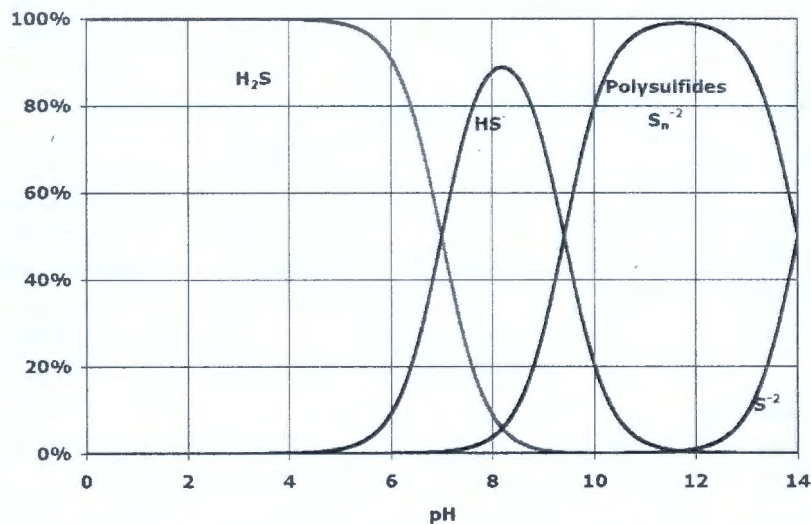
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1 Under previous revisions of APPROVAL ORDER DE12NWP-001, Revision 2, the Lagoon Treatment
2 System (LTS) was not tied into a conventional sewer collection system; but instead received its sole
3 influent via septic trucks hauled to the LTS located in the 200 West Area. Upgrades to the wastewater
4 collection systems have recently been performed which will direct a significant portion of on-site
5 wastewater directly to the LTS via gravity lines, forcemains, and lift stations from the 200 East Area. A
6 smaller portion of the on-site wastewater will continue to be hauled to the LTS via septic trucks to the
7 discharge vault.

8 DE12NWP-001, Revision 2 application analyzed six toxic air pollutants (TAPs) which are:
9 1,4-dichlorobenzene, ammonia, chloroform, toluene, methylene chloride, and hydrogen sulfide. Of those,
10 toluene and methylene chloride were found to be below the de minimis emission threshold values listed in
11 WAC 173-460-150. Ammonia, chloroform, and hydrogen sulfide were found to be above the small
12 quantity emission rate (SQER) listed in WAC 173-460-150. Hydrogen sulfide ($H_2S_{(g)}$) is the only newly
13 identified TAP under Revision 2.

14 Sulfide (S^{2-}) is a reduced species of sulfur which dissociates as sulfide, bisulfide (HS^-) and Hydrogen
15 Sulfide (H_2S) depending on the pH. Figure 1 below illustrates what reduced species of sulfide
16 predominates under various pH ranges. It is important to note that aqueous hydrogen sulfide ($H_2S_{(aq)}$)
17 predominates at lower pH ranges; under which there exists more potential to create hydrogen sulfide gas
18 ($H_2S_{(gas)}$) as the $H_2S_{(aq)}$ transfers into the gas phase according to Henry's Law and mass transfer
19 phenomenon. Technology based limitations are established for pH in domestic wastewater, which is from
20 6 to 9 (40 CFR 133 and WAC 173-220 and 221). At a pH of 6, $H_2S_{(aq)}$ predominates at approximately
21 100%; whereas, at a pH of 9, $H_2S_{(aq)}$ predominates at approximately 0%. A pH of 6 would be the worst
22 case scenario for the potential for hydrogen sulfide gas generation/off-gassing in the LTS.



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25
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Figure 1. Distribution of Sulfide Species with pH

27 The oxidized form of sulfur typically exists as sulfate (SO_4^{2-}). Under reducing (anaerobic) conditions
28 inherent to wastewater, SO_4^{2-} will get reduced to S^{2-} which will then dissociate as described above
29 depending on the pH. However, portions of the oxidized (SO_4^{2-}) and reduced (S^{2-} system) species of
30 sulfur can coexist in the system at the same time depending on the voltage potential/reduction potential
31 (E_b/pE), which is indicative of the oxidizing or reducing conditions of the system as illustrated in Figure 2
32 below.

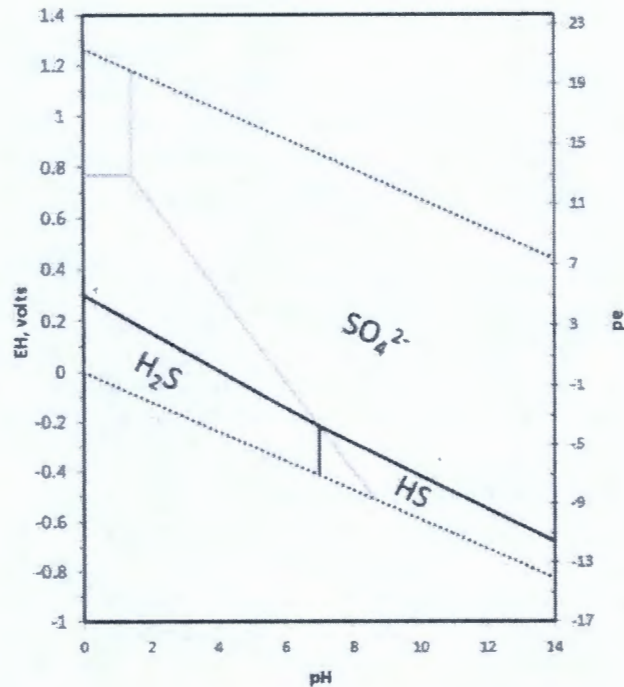


Figure 2. Redox Potential versus pH

No more hydrogen sulfide can be produced than available sulfate in the system as shown in the redox reaction below. Note, there is a 1:1 molar ratio between sulfate and hydrogen sulfide.



As stated in the permittee's Notice of Construction, Revision 2 application (17-ESQ-0084), sulfate in wastewater typically ranges from 20 mg/L to 50 mg/L. The production of hydrogen sulfide will increase with time under the anaerobic conditions inherent in the wastewater collection system (gravity lines, lift stations, forcemains) and certain treatment unit operations of the LTS. The LTS is an evaporative system with zero discharge and thus it is expected that most, if not all, of the sulfate will eventually become reduced to sulfide and dissociate and eventually off-gas as hydrogen sulfide in the LTS.

Using assumed influent wastewater concentrations and a flow rate of 110,000 gpd coupled with WATER9 and AERMOD modeling, the permittee proposed a maximum influent wastewater concentration for hydrogen sulfide that can be reached without exceeding the acceptable source impact level (ASIL). The proposed compliance point (sampling location) is the discharge vault located at the head of the LTS. Depending on the residence time (age of wastewater) and the pH in the collection system, the hydrogen sulfide concentration at the discharge vault could vary by a large margin. For example, if the hydrogen sulfide concentration at the sampling location is very large then the sulfate concentration would expect to be small and the potential to create more hydrogen sulfide downstream in the LTS past the compliance point could be negligible. However, if the hydrogen sulfide concentration at the sampling location is small then the sulfate concentration would expect to be large and could thus potentially create a considerable amount of hydrogen sulfide past the point of compliance. This can be accounted for by measuring sulfate at the discharge vault and using stoichiometry to convert sulfate to hydrogen sulfide concentration.

1 The age of the wastewater may vary as described in the General Sewage Plan (HNF-55909). On the
2 weekends, the wastewater will age in the lift stations for up to 90 hours when it is not being pumped. In
3 this scenario, the hydrogen sulfide concentration would expect to be higher and the sulfate concentration
4 lower. Whereas, during the weekdays, the wastewater detention time in the collection system is estimated
5 to be around 14 hours (HNF-55909). In this scenario, the hydrogen sulfide concentration would expect to
6 be lower with a higher sulfate concentration.

7 In the General Sewer Plan (HNF-55909, Rev. 1, pg. 49) it states: "It is difficult to quantify the amount of
8 H₂S that will be produced at the forcemain discharge location.....However, because actual levels may
9 vary from project to project and site to site, it is suggested that the actual levels should be measured post-
10 construction....." Therefore, given that the amount of hydrogen sulfide created in the collection system is
11 unknown, and as to provide a more accurate demonstration of compliance with the ASIL for hydrogen
12 sulfide from the LTS, sampling for sulfate and sulfide (as S) in the wastewater influent is mandated in the
13 APPROVAL ORDER DE12NWP-001, Revision 2 at the discharge vault. This sampling protocol needs
14 to continue until the behavior of the collection system can be better characterized.

15 The total hydrogen sulfide concentration in the wastewater influent can be determined from the two
16 samples (sulfate and sulfide (as S)) using the equations seen below. No method exists for measuring
17 aqueous hydrogen sulfide in the 'Guidelines Establishing Test Procedures for the Analysis of Pollutants'
18 (40 CFR 136 – Table 1B) and literature suggests hydrogen sulfide is hard to measure in aqueous solution.
19 In 40 CFR Part 136 – Table 1B there exists a method to measure sulfate and sulfide (as S) which can be
20 expressed as H₂S as described below.

21 The potential for aqueous hydrogen sulfide generation can be determined from the concentration of
22 sulfate using a stoichiometric conversion. Sulfate is converted to hydrogen sulfide using the
23 equation/conversion seen below. The 1:1 molar ratio between H₂S and SO₄²⁻ is used as provided in the
24 above redox reaction.

$$\frac{X \mu g H_2S}{L} = \frac{X mg SO_4^{2-}}{L} * \frac{1 mmol SO_4^{2-}}{96 mg SO_4^{2-}} * \frac{1 mmol H_2S}{1 mmol SO_4^{2-}} * \frac{34 mg H_2S}{1 mmol H_2S} * \frac{1000 \mu g}{1 mg}$$

28 Hydrogen sulfide can also be determined from the measurement of Sulfide (as S) using the stoichiometric
29 conversion seen below.

$$\frac{X \mu g H_2S}{L} = \frac{X mg S^{2-} (as S)}{L} * \frac{1 mmol S}{32 mg S} * \frac{1 mmol H_2S}{1 mmol S} * \frac{34 mg H_2S}{1 mmol H_2S} * \frac{1000 \mu g}{1 mg}$$

33 The amount of hydrogen sulfide can then be summed from the two equations and compared against the
34 surrogate wastewater influent concentrations limits provided in Table 2 of the APPROVAL ORDER
35 which represent the maximum concentration that can be reached without exceeding the ASIL.

36 Ammonia is also redox and pH sensitive; however, ammonia is expected to decrease as the wastewater
37 ages and get converted to nitrate (NO₃⁻) (which is not a TAP) or organically bound nitrogen in the LTS.
38 Ammonia behaves the opposite of the sulfide system in that ammonia has more potential for off-gassing
39 at higher pH ranges as illustrated below in Figure 3.

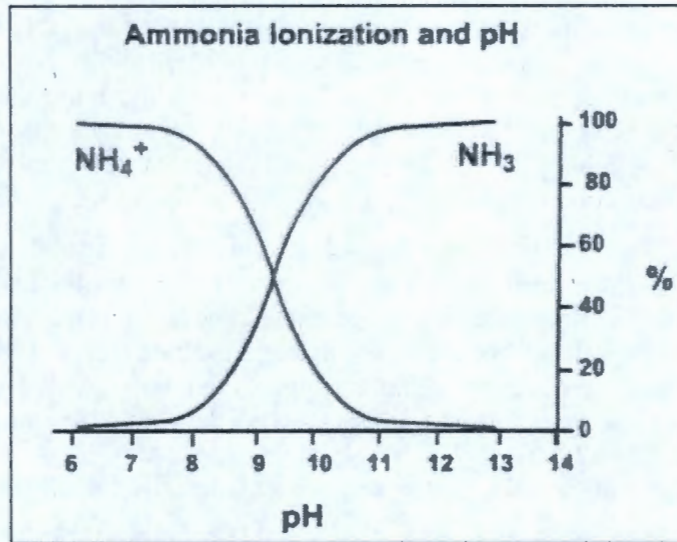


Figure 3. Ammonia Speciation versus pH

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REFERENCES

Figure 1

<http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=4982&context=etd>

Figure 2

<http://homepages.uc.edu/~maynarjb/Frontpage%20sites/482/Lecture8.htm>

Figure 3

<http://www.aqinfo.com/2016/06/managing-ammonia-levels-in-shrimp-ponds.html>