✓ 9-8-06 17.3.2.2.a.1

VARIANCE REQUEST

Iowa Department of Natural Resources

1. Date:	December 26, 2002	13. **Decision:**	Approved
2. Review Engineer:	Larry Bryant	Date:	1/2/03
3. Date Received:	November 12, 2002		
4. Facility Name:	City of Charles City	14. **Appeal:**	
5. County Number:	34 (Floyd)	Date:	
6. Program Area:	CP (Wastewater Construction)		
7. Facility Type :	C09 (Sludge Handling)		
8. Subject Area :	375 (Aerobic Digestion)		
9. Rule Reference:	567-64.2(9)a		
10. Design Stds Ref:	17.3.2.2.a.1 (Bottom Diffusers)		
11. Consulting Engr:	FOX Engineering Associates, Inc.		
12. Variance Rule:	567-64.2(9)c		

15. Description of Variance Request:

Design Standard 17.3.2.2.a.1 (Aerobic Sludge Digestion, Mixing and Air Requirements, Bottom Diffusers) requires that plants employing less than four independent tanks shall be designed to incorporate removable diffusers that can be serviced and/or replaced without dewatering the tank. This standard also requires that grid be designed such that the removable diffusers can be isolated without losing more than 25% of the total oxygen transfer capability.

The City of Charles City is in the process of designing plant improvements including additional solids handling capability. The City currently uses a single heated uncovered aerobic digester and a single covered sludge storage tank. Both units have approximately 200,000 gallon capacities and were originally designed as duplicate anaerobic digesters. The upgrade includes covering the existing digester, converting the existing storage tank to a duplicate heated aerobic digester with cover, and adding a new uncovered 800,000 gallon sludge storage tank.

The City is proposing fixed diffusers that are not removable without dewatering the tank for the conversion of the sludge storage tank to an aerobic digester. Dewatering of the digester would be necessary for replacement of diffusers.

16. Consulting Engineer's Justifications

- The improvements will effectively double the existing plant digestion capacity and provide approximately 3.5 times the sludge storage currently available.
- The City desires to utilize the dome cover currently on the existing sludge storage tank. Installation of a removable diffuser system will necessitate that the existing cover be scrapped and replaced with a new cover of different design, adding significant ($40,000 est.) cost to the project.
- A removable diffuser system will also require that a new support structure or bridge be added to the existing storage tank, also adding cost to the project.
- At the elevated aerobic digestion temperatures that will be utilized in combination with the additional sludge storage capacity that will be provided, PSRP and vector attraction reduction requirements can be met with one of the digesters off-line.

17. Department's Justifications

Recommend variance approval:

The purpose of 17.3.2.2.a.1 is to assure continuity of service if maintenance on the diffuser system is required. Based on current operational data and projected loadings, the improved solids handling configuration will be able to meet vector attraction reduction and PSRP requirements for Class II sludge with one of the digesters off-line. At future design

loadings, the proposed digestion/storage arrangement will be able to provide in excess of 900 °C – days with one digester out. 567 IAC 67.11(455B) requires 800 to 900 °C – days for aerobic digestion as a PSRP. A single digester itself will provide only 551 °C – days at future design conditions. However, the additional time/temperature provided by the new storage tank will enable PSRP requirements to be met via coliform testing and vector attraction reduction requirements to be met through volatile solids reduction. In addition, the City currently has the ability to land apply sludge year-round (the City owns some land but a local nursery accepts the majority of the sludge) and owns their own land application equipment with the capability of injecting as an alternative to meet vector attraction reduction requirements. Taking one of the digesters off-line for maintenance should not disrupt the ability of the plant to produce and land apply Class II biosolids.

18. Precedents Used

- City of Tama. Denied 4/93. One new aerobic digester and two new sludge storage tanks. Variance denied because an alternative means of sludge stabilization/disposal was not provided.
- City of Emmetsburg. Approved 4/98. Two new aerobic digester tanks and an existing storage structure. The existing storage structure had only two days storage capacity, however, the facility had lime storage and mixing facilities available to meet both PSRP and vector attraction reduction requirements.

19. Staff Reviewer: [signature] Date: 12/26/02

20. Supervisor: [signature] Date: 12/30/02

21. Authorized by: J Riessen Date: 1/2/03

Fields of Opportunities

STATE OF IOWA

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

December 26, 2002

Donald C. Lorsung, City Administrator
105 Milwaukee Mall
Charles City, IA 50616

RE: Charles City Wastewater Treatment Improvements - Variance Requests

Dear Mr. Lorsung:

The Iowa Department of Natural Resources, in accordance with subrule 567 IAC 64.2(9) has reviewed the variances requested on behalf of the City by FOX Engineering Associates, Inc. The variance requests and supporting information were submitted to the Department in letters dated November 12, 2002 and December 18, 2002.

A variance from the Iowa Wastewater Facilities Design Standards Section 17.3.2.2.a.1 to allow fixed diffusers for the proposed aerobic digester in lieu of diffusers that are removable without dewatering the tank is approved. From the information submitted, it is our understanding that the proposed digester and sludge storage capacity will be sufficient to meet both vector attraction reduction and PSRP requirements for Class II biosolids with one digester off-line.

In addition, a variance from the Iowa Wastewater Facilities Design Standards Section 17.3.4.3.b to allow a mechanical mixer for the proposed sludge holding tank providing 0.48 HP per 1,000 ft^3 of tank volume in lieu of 1.0 HP per 1,000 ft^3 is approved with the following condition:

> The City shall obtain a construction permit and install aeration equipment meeting the requirements of IA 17.3.4.3 and/or a tank cover within 18 months of written notification if the Department determines that the proposed storage tank is causing any odor or other operational problems due to the design variance.

These decisions are based on our review of justification presented to support your requests and our concurrence that the resulting project will provide substantially equivalent effectiveness as would be provided by technical compliance with the design standards.

If there are any questions, please contact Larry Bryant at 515/281-8847.

Sincerely,

Jack Riessen, P.E., Chief
Water Quality Bureau

c: Steven J. Troyer, P.E./FOX Engineering/Ames, IA
Daniel H. Barrett, P.E./City of Charles Ctiy
Field Office 2

FOX engineering

November 12, 2002

Larry Bryant
Iowa Dept. of Natural Resources
Wastewater Section
Wallace State Office Building
Des Moines, IA 50319
(515) 281 - 5918
Fax (515) 281 - 6794

Re: Charles City WPCP Improvements
Charles City, IA
FOX PN 2389-00A.410

Mr. Bryant:

We are working on the design for the Charles City WPCP Improvements, in particular the conversion of the existing sludge storage tank to an aerobic digester. We are considering the use of a fixed-grid fine bubble diffuser system to achieve higher oxygen transfer efficiency and keep the blower sizing down. This will also allow use of the existing low-profile aluminum dome cover. However, IDNR Design Standard 17.3.2.2.a.1 requires that, for plants with less than four digesters, the design incorporate "removable diffusers that can be serviced and/or replaced without dewatering the tank." We are hereby requesting a variance from this design standard.

If you'll recall, converting the existing sludge storage tank to an aerobic digester will double the existing digestion capacity and provide two independent digesters. Construction of a new 180 day sludge storage tank as part of this project will also add reliability to the solids handling facilities. The digesters will be heated to maintain higher temperatures and improve the digestion process. Covering the digesters is important to maintain energy efficiency and optimal performance.

If the diffusers are required to be removable without dewatering the tank, the existing aluminum dome cover will need to be removed and replaced with a flat aluminum cover. Additionally, a support structure or bridge would need to be constructed across the digester to provide support for and allow access to the removable sections of the diffuser grid. We do not feel the additional cost is warranted, nor will it significantly improve the project. We believe adequate reliability will be achieved by doubling the digester capacity, with two independent digesters, and providing 180 days sludge storage capacity.

If you have any question or concerns, please let us know. Thanks for reviewing this matter.

Sincerely,
FOX Engineering Associates, Inc.

Steven J. Troyer, P.E.

cc: Don Lorsung, City Administrator
Dale Watson

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From: Larry Bryant
To: stroyer@foxeng.com
Date: 12/10/02 10:07AM
Subject: Charles City variance request

Steven,

I'm currently processing your variance request, but would like to request some additional information from you.

- Could you describe how the solids handling process will operate (i.e. how PSRP requirements will be met) at future design loadings if the new digester needs to be dewatered and taken off-line for maintenance to the diffusers?

- Will the 25% requirement in 17.3.2.2.a.1 still be met? Along these lines, could the digester be dewatered, 25% of the grid taken out, and placed back in-service with the remaining 75% of the grid?

- Is division of the new sludge storage tank into two independent compartments a possibility?

- What type of mixing system will be used in the sludge storage tank (i.e. could it be used as an interim digester or provide additional aeration/time/temperature to meet PSRP requirements)?

- Does the City own its own application equipment and land application site(s)? Is there any reason why year-round application as currently practiced wouldn't be possible in the future?

- Is an alternative PSRP in an emergency situation a possibility, e.g. does the City have lime storage available?

As you have probably guessed from the above questions, I'm primarily concerned with justification of the variance on the basis of continuity of service in the event of a digester being taken off-line. Any considerations not covered by the above that you could provide would be appreciated.

Thanks.

Larry Bryant
IDNR Wastewater Section
515/281-8847
larry.bryant@dnr.state.ia.us

FOX engineering

December 18, 2002

Larry Bryant
Iowa Dept. of Natural Resources
Wastewater Section
Wallace State Office Building
Des Moines, IA 50319
(515) 281 - 5918
Fax (515) 281 - 6794

Re: Charles City WPCP Improvements
Charles City, IA
FOX PN 2389-00A.410

Mr. Bryant:

In response to your questions regarding our request for variance from IDNR Design Standard 17.3.2.2.a.1, we offer the following:

- At current operating conditions, the aerobic digestion system does not meet the requirements of a PSRP process (aerobic digestion with a MCRT between 40 days at 20° C and 60 days at 15° C). The heated digesters currently operate at an average temperature of about 85° F (29° C). The lowest monthly average temperature between April 1998 and April 2000 was 79° F (26° C). But with a MCRT of about 28 days, the City has had to test for fecal coliform to meet the PSRP requirement. Testing shows that under current conditions, typical fecal coliform densities are in the range of 235,000 to 1,200,000 MPN/g TS (based on data from 2000 to 2002).

  ← 800-900 degree days
  ← currently about 824 degree-days
  ↙ sampling still req'd?
  38 days @ design

  At design conditions, with one digester out of service, the MCRT will be approximately 19 days. With the addition of a cover to the existing digester, it is expected that the average temperature will be maintained at 85° F or higher. While this may or may not be adequate to achieve the fecal coliform requirements for Class II biosolids, the addition of the sludge storage tank should provide adequate additional detention time to meet this requirement.

  ← 551 degree-days
  V digesters = 200,000 gal each
  V storage = 800,000 gal

  In aerobic digestion, pathogen destruction is due to natural die off rather than the digestion process itself. The rates of pathogen die off are affected by time and temperature. With the relatively high digestion temperature (29° C avg.) and additional detention time in the sludge storage tank (up to 180 days), we believe the fecal coliform limit can be met even with one digester out of service.

  19 days @ 29°C
  + 60 days @ 15°C ✓

  As for vector attraction reduction (VAR) requirements, we believe the requirement of 38% volatile solids reduction (VSR) can be achieved with one digester out of service. Research suggests that VSR efficiencies can be plotted as a function of the product of SRT (days) and temperature (°C) and used to predict digester performance. A typical plot of this nature, based on research data,

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predicts under current conditions (803 deg. C-days) a VSR of about 44%. Actual VSR, using the Van Kleck Method, is about 57%. At design conditions with one digester out of service, the predicted VSR (at 563 deg. C-days) is about 41%. Even at 26° C, predicted VSR is about 40%. Based on this data, we believe the 38% VSR requirement can be met with one digester out of service. However, even if the 38% VSR requirement is not met, the City does own land application equipment with the capability of injecting.

We do agree that with one digester out of service sludge stabilization will not be as complete as it would be with two digesters. However, on a short term basis while maintenance or repairs are being done we believe that treatment will be adequate and will not adversely affect the overall system.

- We did not plan on allowing a portion of the diffuser grid to be removed from service. While provisions for this could be made, it seems more likely that a few diffusers would experience problems rather than a whole section of the grid. With the basin dewatered, repairs could be made to a few diffusers in a relatively short time frame if spare parts were readily available, rather than just isolating a portion of the grid. To that end, we would suggest that extra diffusers be provided, perhaps 5%, so that problem diffusers could be replaced in a timely manner.

- Division of the sludge storage tank into two separate compartments is possible, but it would result in significant additional cost and require two separate mixing systems.

- A floating mechanical mixer (50 hp) will be used. If need be, a floating mechanical aerator could be rented and installed to provide additional aeration on a temporary basis.

  The proposed mixing for the biosolids storage basin does not meet the requirements of Section 17.3.4.3 of one (1) HP per 1,000 cubic feet. The proposed 50 HP mixer provides 0.48 HP per 1,000 cubic feet when the basin is full. The proposed mixer has been designed on a rational basis to maintain a mixing velocity in the basin so uniform biosolids concentration can be achieved prior to and during biosolids withdrawal and application. A number of communities in Iowa have received similar variances from this rule and are operating very well. The biosolids stored in the tank should be very stable and not require additional treatment. The digested biosolids in the storage tank are expected to be in the 2% to 3% solids range and will only require mixing prior to loading and discharge. We also request a variance for the mixing requirement biosolids storage tank to allow a smaller mixer based upon mixing velocity criteria.

  except perhaps to meet PSRP equivalent time /temperature w/ one unit off-line

- The City does own some land, but the majority of the land they use is not owned by the City. However, there is no reason to believe that year-round application as currently practiced cannot continue.

The City does own land application equipment, which they use for both surface application and injection.

- While the City does not have lime facilities at the WPCP, it would be possible to use bagged lime and portable storage vessels on a short-term basis in an emergency situation. However, we do not feel this will be necessary with the additional sludge storage capacity available.

The Charles City WPCP currently has only one digester and about 220,000 gallons of sludge storage capacity. After completion of this project, the digestion capacity will be doubled and the sludge storage capacity will be about 3.5 times what is currently available. The additional reliability provided by the proposed facilities should be adequate. We do not believe the additional cost required to make these diffusers removable is warranted.

There is no doubt that periodically each digester will need to be removed from service for maintenance or repair (replacing diffusers, cleaning, etc.). However, we believe these maintenance activities can be scheduled at times to minimize adverse affects on the system. In the event of significant failure, we believe that with the relatively high digestion temperature and additional sludge storage capacity available the system will still be able to meet the PSRP and VAR requirements for Class II biosolids.

If you have any question or need additional information, please let us know. Thanks for reviewing this matter.

Sincerely,
FOX Engineering Associates, Inc.

Steven J. Troyer, P.E.

cc: Don Lorsung, City Administrator
Dale Watson, FOX Engineering

production rate of 1.5 pounds of dry solids per square foot per hour (7.4 kg/m^2/hr), a cake solids concentration of 16 percent, with a $FeCl_3$ dose of 140 pounds (63.5 kg), and a lime dose (CaO) of 240 pounds (109 kg). This assumes an aerobic solids concentration of 2.5 percent solids. For more detailed information on results of various types of dewatering systems, see Chapter 9.

6.3.4 Process Performance

6.3.4.1 Total Volatile Solids Reduction

Solids destruction has been shown to be primarily a direct function of both basin liquid temperature and the length of time during which the sludge was in the digester. Figure 6-42 is a plot of volatile solids reduction versus the parameter degree-days. Data were taken from both pilot and full-scale studies on several types of municipal wastewater sludges. Figure 6-42 indicates that, for these sludges, volatile solids reductions of 40 to 50 percent are obtainable under normal aeration conditions.

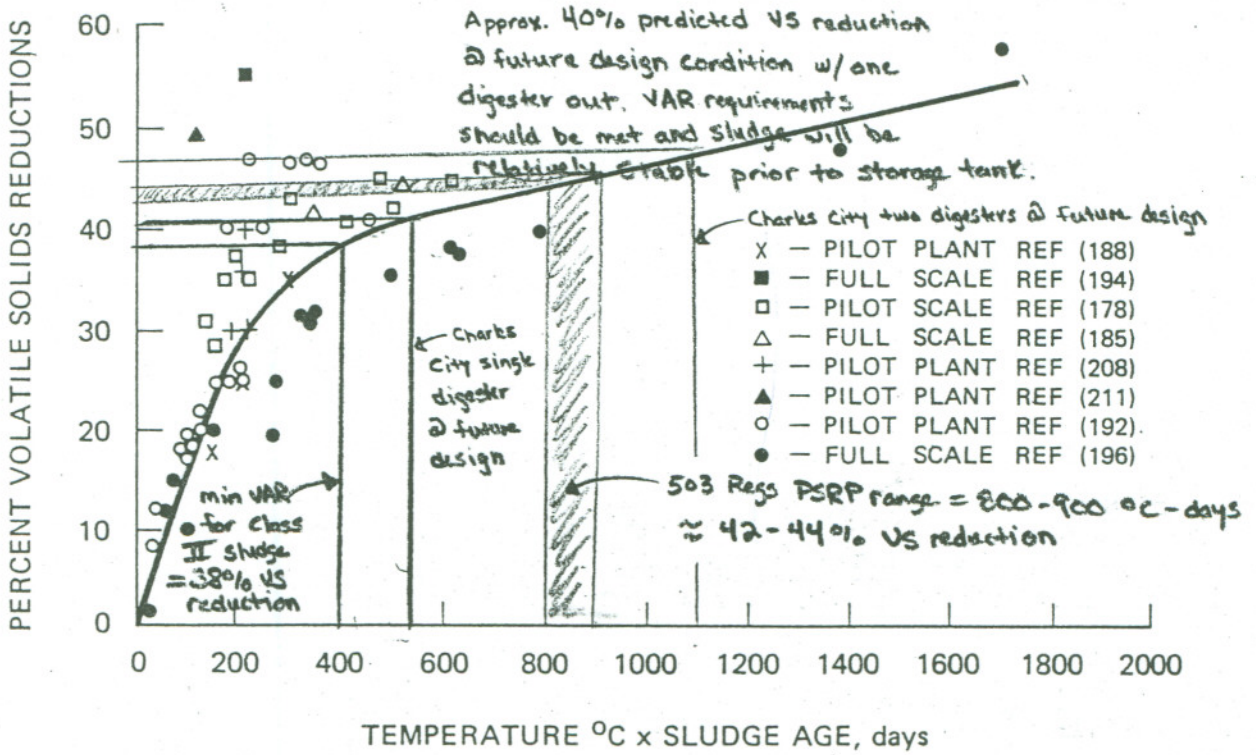

FIGURE 6-42

VOLATILE SOLIDS REDUCTION AS A FUNCTION OF DIGESTER LIQUID TEMPERATURE AND DIGESTER SLUDGE AGE

turbine or propeller-type aerators are often affected by very limited side boundaries, while brush-type aerators and aspirating pumps often have almost unlimited side boundaries but rather restricted vertical mixing capabilities. Submerged static aeration devices are excellent for vertical mixing but are always limited by very confined side boundaries. The designer should rely on a performance-type specification to achieve desired results. The equipment supplier should be given information about the configuration of the basin, its liquid level operating range, the maximum solids concentration expected, and the level of dissolved oxygen to be maintained. The designer is expected to have established the most cost-effective basin configuration based on loading, site-specific conditions and available aeration equipment requirements. A maximum horsepower limit should be established, and the specifications should include a bonus to be added to the bid price and a penalty to be subtracted from the bid price based on the energy costs involved when the equipment meets the required performance. A guarantee should be used to assure that the final installation will meet the performance requirement.

TABLE 15-12

1973/1974 SUPERNATANT-PRAIRIE PLAN RECLAMATION PROJECT, THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO[a]

Constituent	Mean value, mg/l	Range, mg/l
BOD - total	170	28 - 466
BOD - soluble	62	20 - 114
COD - total	951	325 - 2,120
COD - soluble	695	328 - 1,026
TSS	276	52 - 1,041

[a]Data supplied by The Metropolitan Sanitary District of Greater Chicago.

Oxygen Requirements

Oxygen requirements to maintain aerobic conditions within an aerobic storage basin will be considerably less than that required for aerobic digesters if the material being stored has been stabilized prior to its introduction to the basin. Minimum

measurable dissolved oxygen levels of about 0.5 mg/l are quite adequate to maintain a basin free from anaerobic activity, as long as it is provided with adequate mixing. If the basin influent is not sufficiently stabilized to minimize oxygen requirements, then the aerobic storage basin must be designed for oxygen requirements similar to aerobic digesters (see Chapter 6). Oxygen transfer capabilities are similar to mixing capabilities for the various types of applicable equipment. The design should therefore include oxygen transfer requirements as part of the performance requirement indicated in the preceding section on mixing specifications.

Level Variability

Often, aerated storage basins cannot be decanted, because solids settle when the aerator is turned off, and anaerobic decomposition may also occur, resulting in odor production. Attempts at in-basin decanting without aeration and mixer shutdown will usually result in the recycling of the concentrated solids back to the liquid process. Separate continuous decanting is usually possible either by sedimentation or dissolved air flotation. Evaporation will also quite often result in significant liquid removal. Aerobic storage basins that do not have separate decanting facilities must be operated on single-phase concentration or displacement storage concepts.

The single-phase concentration concept will function as described for aerobic digesters. The displacement concept, however, will require liquid level variability and make aerated storage basin equipment installation quite complicated. Under such conditions, this equipment must be capable of maintaining adequate mixing and oxygen transfer over the complete range of liquid level variation. This requirement may cause this equipment to have varying mixing and aeration capabilities, depending on the basin depth. Variable speed drives, multi-speed drives, or variation in the quantity of diffused air should be investigated. At no time should the equipment be operated under conditions that will waste energy. Mixing and aeration design requirements and layout details can be found in Chapter 6.

15.3.2 Facilities Provided Primarily for Storage of Dewatered Sludge

Dedicated dewatered sludge storage of wastewater solids can include the storage of easily managed dry solids (>60 percent solids) or hard to manage wet solids (15 to 60 percent solids). Dry solids are usually the product of heat-drying, high temperature conversion, or air-drying processes and can be stored by standard dry material storage techniques. Descriptions of these techniques are readily available in materials processing textbooks, and, if desired, more detailed data is available (20,21). The storage of wet solids is another matter, however. The successful application of common storage techniques to this