APPENDIX L
THERESA STREET WWTF ODOR ABATEMENT STUDY

CITY OF LINCOLN

THERESA STREET WWTP

ODOR ABATEMENT STUDY

SUMMARY REPORT

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Objective of Summary Report

This report is a summary for the City of Lincoln Theresa Street Wastewater Treatment Plant odor abatement study. This report is intended to summarize the activities performed, the methodology used and the conclusions reached from the study. This report summarizes the more detailed discussions presented in Technical Memoranda No. 1 and No. 2.

A complete set of modeling results has been provided under separate cover.

1.2 Objectives and Steps of Odor Study

The City of Lincoln has had complaints from surrounding neighborhoods relating to odors from the Theresa Street Wastewater Treatment Plant. Due to these complaints, the City requested that a detailed study be performed to:

1. Determine the sources of odors that could transport off site.
2. Determine the percent removals required to provide odor abatement.
3. Evaluate alternatives for odor abatement.

Based on the above objectives, the following steps were taken during the course of this study:

1. Determine potential odor release points.
2. Sample release points.
3. Analyze samples.
4. Evaluate analytical data and determine odor emission rates (OER).
5. Model data in order to determine transport distances for sources.
6. Prioritize odor sources in order of transport distance.
7. Determine required percent removals to minimize odors at the property boundaries.
8. Evaluate alternatives to achieve required percent removals.
9. Determine capital and operating costs for alternatives.
10. Provide a phasing plan for odor abatement.

2.0 INITIAL EVALUATION AND METHODOLOGY

2.1 Initial Survey

During the initial survey to determine potential odor release points, a total of 23 sample points were identified. These points generally included:

1. Emission points related to head works unit processes
2. Emission points related to east side unit processes
3. Emission points related to center unit processes (trickling filters)
4. Emission points related to west side unit processes
5. Emission points related to solids processing

2.2 Sampling Methodology

The identified emission points were sampled using American Society of Testing Materials (ASTM) procedures. Three types of samples were collected:

1. Point sources – These sources are related to fan discharges, vents, etc.
2. Area sources – These are sources such as clarifier surfaces, splitter boxes, etc.
3. Volume sources – These are similar to area sources, but have air introduced into the process such as aeration basins and aerated grit tanks.

Samples for point sources were sampled directly from the source using a peristaltic pump. Area and volume sources were sampled using an equilibrium flux chamber placed directly on the area surface. The air was removed from under the chamber using the peristaltic pump. All samples were collected in Tedlar bags.

2.3 Analytical Methodology

2.3.1 Field Measurements

During sample collection, all samples were evaluated for the following parameters:

1. Hydrogen sulfide (H_2S)
2. Mercaptans
3. Ammonia

2.3.2 Laboratory Measurements

All samples were sent to a sensory laboratory for analysis. All analyses were performed within 24 hours of collection. A panel of ten individuals, who had been previously screened for sensory acuteness, were used to determine the following:

1. Dilution to threshold ratio (D/T) – The D/T is the number of dilutions required to dilute the sample to a point where only 50% of the panel witnesses the odor.

2. Butanol intensity – This provides a determination of the relative intensity of each odor. This evaluation compares the intensity of the odor with a surrogate (butanol).

3. Dose response – The dose response of a sample is an indicator of an odor's pervasity. Pervasity is the lingering effect of the odor. The more lingering the odor, the more conservative the odor abatement strategy must be.

3.0 DATA INTERPRETATION AND MODELING

3.1 Data Review and Interpretation

The data were reviewed using two different criteria:

1. A regression analysis was performed to ensure that the data was reliable.
2. The data was compared with library data (Huber Environmental, Inc.) acquired from other similar facilities.

The data review indicated that the odor emissions from the east side unit processes were much higher than the west side and higher than found at similar facilities. Additionally, data for the West Aeration Basins were much lower than expected.

3.2 Transport Modeling

Prior to modeling, the following steps were taken:

1. Calculation of exhaust rates – The exhaust rate for all emission points was determined. The exhaust rate was based on the type of sample collected.

    - Point sources – The exhaust rate was determined from airflow data provided by the City.
    - Area sources – The exhaust rate for each area source was the expected evaporation rate for the areas. For turbulent sources, adjustment factors were used.
    - Volume sources – The exhaust rate from each volume source was equal to the rate of air being added to the unit process. Airflow rates were provided by the City.

2. Calculation of the odor emission rate (OER) – The OER is the product of the D/T and the exhaust rate. The OER is the mass emission of odor into the atmosphere.

3. Prioritization of odor sources – The sources were ranked according to:

    - D/T
    - Intensity
    - Odor emission rate

4. Determination of model endpoint – The modeling endpoint was determined by factoring in the dose-response data for each source. The more lingering the source, the lower the endpoint.

The modeling was performed using an EPA Screen 3 dispersion model. This model allows for the determination of radial transport distances from the odor source at selected meteorological conditions.

The model input included both average and peak conditions. Average conditions relate to an odor that remains in the environment for a period of time. Peak conditions (puff) relate to an instantaneous event.

Since expansion of the East Aeration Basins is possible in the future (from 12 MGD to 18 MGD), the impacts of the expansion were modeled. In addition, it is being considered by the City that the existing trickling filters will be abandoned and replaced by activated sludge similar to that now existing on the west side. This change was modeled as well.

Since odors transport the greatest distance during periods of stable air and low wind speeds, the following meteorological conditions were used in the modeling:

- Stability class F (very stable) with wind speeds of 1, 2 and 4 m/s. This would determine the "worst case" condition.

- Stability class D (stable) with wind speeds of 1, 2, and 4 m/s. If an odor transports off site during these conditions, it can be concluded that this source is a severe or high priority source.

4.0 PRELIMINARY EVALUATION

4.1 Conclusions from Transport Modeling

The transport modeling indicated that the following sources could travel off site (in order of priority):

1. East Primary Clarifiers and Splitter Box
2. East Aeration Basins
3. Exhaust from Solids Dewatering Building
4. West Primary Clarifiers
5. Zones 1, 2 and 3 of the West Aeration Basins

It was also determined that during "calm wind" conditions, the exhaust from the DAF Building could also be a problem source.

4.2 Follow-Up Activities

As described in Technical Memorandum No. 2, additional modeling was performed to determine the following:

1. The impact of the combining the odors from the west, proposed center and east unit processes.

2. The impact that would occur if the data for the east side could be reduced to that similar to the west.

Due to the fact that the data for the east unit processes (East Primary Clarifiers and East Aeration Basins) was much higher than expected, it was postulated that the retention time in the pipeline from the head works to the east side could be causing anaerobic conditions, and hydrogen sulfide formation. In addition, due to the low velocities in the line, deposition of solids could be occurring, adding to the problem. Theoretical calculations included in Technical Memorandum No. 2 support this theory.

Based on the above, the City of Lincoln attempted to clean the pipeline. After this cleaning, sources associated with the east side were re-sampled. The data from the second sampling indicated little change from the previous data. Possible reasons for these results include:

1. The deposition was not the cause of the increased odors.
2. The pipe was not entirely cleaned.

4.3 Other Conclusions

Addition of Iron Salts – The City of Lincoln is presently adding a ferrous salt at the influent. The purpose of this addition is to precipitate sulfide to minimize the formation of hydrogen sulfide. This addition, although expensive, is the primary reason that the unit processes associated with the head works are not problem sources. If this addition was discontinued, those sources associated with the head works could become problem sources.

East Aeration Basins – The existing East Aeration Basins are mechanically aerated. This equipment is being replaced by diffused aeration. In addition, Lincoln intends to operate the East Aeration Basins in a zone mode, similar to the west side. Whereas now, the biological system is completely mixed and aerated, the future system will be divided into zones with the first and second zones having no air added and the remaining zones being aerobic. Assuming the existing capacity of 12 MGD, only the first three zones of the East Aeration Basins would require control. However, if the east processes are expanded to 18 MGD, the entire aeration basins will require control.

Solids Dewatering Building – The primary reason for the Solids Dewatering Building being a major source is the location of the discharge louver. The louver is located close to the ground allowing for little dispersion. Also, ventilation in the Solids Dewatering Building is considered to be poorly balanced. Modification of the ventilation within the building should be considered.

Presently, some of the air from the Solids Dewatering Building is being diverted into the West Aeration Basins. This mode of operation can continue. However, if control is eventually required for the remaining exhaust from the Solids Dewatering Building, diverting this air to an odor control system would provide more complete control.

4.4 Required Percent Removals

Due to the proximity of the east unit processes to the property boundary, the required percent removals for these unit processes are very high (95 – 99%). The required percent removals for the west side processes are considerably lower. However, all of these percent removals require a structural solution (covering and treatment).

5.0 CONCLUSIONS AND ABATEMENT ALTERNATIVES

5.1 Conclusions

Based on the modeling and follow-up activities, the following were concluded:

1. The addition of ferrous salts must continue.

2. The priority odor sources are:

    - East Primary Clarifiers and Splitter Box.
    - East Aeration Basins (existing and future).
    - Exhaust from the Solids Dewatering Building.
    - West Primary Clarifiers.
    - West Aeration Basins.
    - Exhaust from the Dissolved Air Flotation Building.

5.2 Abatement Alternatives

Technology - The following technology alternatives were evaluated:

1. Wet scrubbing – This technology uses scrubbers to transfer the pollutant from the foul air to solution. Sodium hydroxide is used to aid in the transfer. Once in solution, the pollutant can be oxidized with the addition of sodium hypochlorite. The residual solution is then wasted. If an aerobic process exists, such as an aerated basin, the spent solution can be wasted to this process and only partial oxidation would be required.

2. Bio-filtration – Whereas wet scrubbing depends on chemicals for treatment, bio-filtration depends on a microbiological growth on a fixed media. The microorganisms that grow, utilize the pollutants in the air as a food source and thereby remove them from the air.

    For small systems, less than 10,000 cfm, packaged systems can be installed. These bio-filters are housed in towers. For larger systems, bed bio-filters are used.

    The media requires replacement after a period of time.

3. Carbon Adsorption – In these systems, foul air is passed through canisters containing activated carbon. The carbon adsorbs the pollutant from the foul air. The carbon has to be replaced periodically, the frequency of which is dependent on the mass loading of pollutants in the foul air.

4. Induced Dispersion – For the Solids Dewatering Building exhaust, induced dispersion was evaluated. This alternative does not provide complete control, but would help minimize odors into the surrounding area.

Options - The following major options were evaluated:

1. Immediate control of the East Primary Clarifiers, Splitter Box and Dissolved Air Flotation Building, with future control of the East Aeration Basins.

2. Immediate control of the East Primary Clarifiers, Splitter Box and Dissolved Air Flotation Building with capacity included for the East Aeration Basins.

3. Preliminary control of the Solids Dewatering Building via induced dispersion.

4. Control of the West Primary Clarifiers.

5. Control of the West Primary Clarifiers and the West Aeration Basins.

6. Control of the West Primary Clarifiers and the Solids Dewatering Building.

7. Control of the West Primary Clarifiers, the West Aeration Basins and the exhaust from the Solids Dewatering Building.

8. A centralized odor control system controlling all problem sources.

5.3 Recommendations

A centralized system, one that controls all odors from one location, is not recommended for Lincoln due to the cost and decreased ability to phase the project. The size of the potential project to minimize odors at the property boundaries is quite large so phasing could be considered for the priority odor sources:

Two potential phasing options include:

1. Cover the East Primary Clarifiers and install 2-stage wet scrubbing with a total parallel capacity of 60,113 cfm. Prior to connecting the exhaust from the East Aeration Basins, the system will operate in series. After the aeration basins are connected, the system can be converted to a parallel system. This includes control for the DAF Building because it is an odor source under calm conditions and its proximity to the proposed ductwork and scrubbers for the east side makes it economically advantageous to control in conjunction with other east side controls.

2. Provide Solids Dewatering Building control. However, if the ventilation within the building could be modified to allow for a vertical stack above the roof, odors from this source could be minimized. Total control will not be achieved. However, the results could be evaluated once the modification has been made. This would defer control of this source.

CITY OF LINCOLN

THERESA STREET WWTP

ODOR ABATEMENT STUDY

TECHNICAL MEMORANDUM NO.1

ODOR SAMPLING AND MODELING

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

The following is a technical memorandum summarizing the events, data and results of the odor abatement study for the Lincoln, Nebraska Theresa Street Wastewater Treatment Plant. The objective of this memo is to provide brief discussion of the data collected to date and preliminary conclusions derived from that data. The results will be presented in a series of tables. The discussion that is included is for clarification purposes since a final report will be prepared which will include significant discussion.

A secondary intent of this memo is to allow the opportunity for reviewing the basic assumptions used in this analysis. It is assumed that some of the assumptions may have to be changed, which may impact the conclusions. The requested review is extremely important, and, therefore, it is hoped that those familiar with the facility will review the assumptions and results carefully.

As can be seen from the tables and the following discussion, the basic odor data collection for the study has been completed for the facility.

1.1 Summary and Conclusions

This study included the following steps:

1. Potential odor release points at the facility were determined. Based on this review, twenty-three sample points were selected.

2. Sample points were sampled during the period of January 7 to 10, 2002 using both sensory sampling techniques and specific parameter analysis.

3. Using the data from above and the calculated air exhaust rates from each source, the odor emission rate (OER) was calculated. In addition the dose-response of each odor source was determined.

4. The information was then modeled using a radial screen model to determine odor transport distances at various meteorological conditions.

5. The individual sources were then prioritized with respect to transport distances.

6. In addition to the above, foul air capture was also evaluated.

The order of priority of the significant odor sources based on the initial sampling data is as follows:

- East Primary Clarifiers
- West Primary Clarifiers
- West Aeration Basins
- East Aeration Basins

In addition to the above, other sources could be a problem during very stable air conditions. These include:

- Solids Dewatering Building
- DAF Building exhaust
- Final Clarifier floc zone
- East Splitter Box
- West Splitter Box
- Influent Wet Well

Finally, it was also concluded that the Dewatering Building exhaust was very sensitive to a change in data or a change in modeling assumptions. This source could become a very significant source if the modeling assumptions are modified. It has been recommended that this source be more fully studied.

2.0 BASE DATA

2.1 Plant Data

Table 1 provides the assumptions related to the various unit processes that were sampled. Much of this information was determined from an inspection of the facility and a review of plans and specifications. The plant data indicates the following:

1. Assumed dimensions of the unit processes.

2. Related surface areas.

3. Air addition or release, where appropriate.

4. Assumed release height (above zero datum) that was used in the modeling.

2.2 Sample Locations

Table 1 also provides the locations sampled during the sampling activities, in addition to the sample type and date of the actual sample collection. Most of the locations were as proposed in the original proposal for this study. Additional explanation of some of the sample locations is as follows:

1. Ferrous addition – Since the facility adds ferrous salts based on influent hydrogen sulfide (H_2S) concentrations, some of the unit processes were sampled with and without the iron addition. These included:

    - Influent Wet Well
    - West Primary Clarifiers
    - East Splitter Box

Insert Table 1

- East Primary Clarifiers
- West Aeration Basins
- East Aeration Basins

2. West Aeration Basins – Since this unit process incorporates an anoxic zone, samples were collected from three zones:

   - Anoxic zone
   - 1st aerobic zone (zone 3A)
   - 3rd aerobic zone (zone 4)

3. Primary and secondary clarifiers – Sampling of these basins included sampling both the quiescent areas and the weir areas separately.

4. "Total unit processes" – As can be seen in Table 1, the data includes "Total" East Primary Clarifiers, West Primary Clarifiers and West Aeration. These were not actual samples, but an addition of the odor emission rates for the individual areas with the unit processes.

2.3 Sampling Methodology

Three types of samples are noted in the tables:

1. Point Source – Point sources were sampled by inserting the suction tubing of a peristaltic pump directly into the exhaust stream. Air was pumped directly into a Tedlar bag.

2. Area Source – Area sources were sampled by placing an equilibrium flux chamber directly over the water surface. The volume under the hood was allowed to reach equilibrium prior to sample collection.

3. Volume Sample – The sampling methodology for a volume sample is the same as for an area sample. The analysis differs, however, in that for volume samples, the air addition is applied.

2.4 Sensory Methodology

All samples collected were evaluated within the required 24-hour holding time. The evaluation included:

1. Forced Choice Triangular Olfactometry – A sensory panel was used to determine the dilution to threshold ratio (D/T) for each sample. The panel is comprised of 10 individuals whose sensory perception had previously been screened. The perception of the panel members varies from very acute perception to relatively poor perception, thereby simulating a randomly selected community. Recognition threshold was not determined. A D/T of 1 is a threshold where 50% of the sensory panel could witness the odor. The absolute threshold value is 0.1.

2. Surrogate Butanol Intensity – The sensory panel members also determined surrogate intensities via the use of a butanol wheel. The intensity of the specific odor was compared to the intensity of known concentrations of n-butanol. This data was also used to determine the dose-response relationship for each sample. Since some of the samples exceeded the normal dilutions typically used (27X and 7X), the dilution on some of the samples with higher intensity odors was increased to 567X and 189X.

2.5 Data

Table 2 provides the base sensory data derived from the sensory evaluation. The following summarizes some of the issues related to the data:

1. Data regression - Table 2 provides information relating to the regression of the data (r). The data regression for the data was generally good with one exception - the quiescent area of the East Primary Clarifier. This was possibly due to high intensity of odor from this source.

2. Dose - response slope (m) – When hydrogen sulfide is the principal odorant, the expected dose response slope approximates -0.5. As can be seen from the sensory data table, with the exception of the digester vent, the slopes found during the study were considerably flatter than this. This would tend to suggest that other more pervasive odorants are present. These could include:

    - Mercaptans
    - Reduced sulfur compounds
    - Aldehydes, ketones and amines

    The low dose-response slopes indicate more pervasive odorants that will tend to "linger" longer in the ambient environment. This also has significant ramifications on the desired end point for transport modeling (see later discussion).

3.0 DATA REVIEW

All D/T data collected was compared with library data. The only data points that significantly varied from the norm were the quiescent area of the East Primary Clarifiers and the anoxic zone of the West Aeration Basins. The data collected for the East Primary Clarifiers was much higher than expected and the data for the anoxic zone of the West Aeration Basins was lower than expected. The latter usually indicates a lack of true anoxic conditions. All other data appeared consistent with previously collected data.

Insert Table 2

4.0 EXHAUST RATES

Table 3 provides the information on the exhaust rates either assumed or calculated for the various unit processes. The following provides clarification:

1. Point sources – The exhaust rate used for point sources was calculated based on displacement or actual exhaust data.

2. Quiescent area sources – The exhaust rate (escape velocity) for a quiescent area was based on an evaporation rate of 0.17 inches per day. This pan evaporation rate is typical for the Lincoln area during the warmer summer months.

3. Turbulent area sources – Three exhaust factors were used for the more turbulent areas. The rate was dependent on the degree of turbulence assumed.

4. Area sources with air addition - The exhaust rate used for area sources which had air delivered (aeration tanks and aerated grit chamber) was the air delivered to the tankage divided by the surface area of the total tank surface area for the respective unit process.

5.0 ODOR EMISSION RATES

Table 4 provides the emission rate derivation. As can be seen from this table, two types of emission rates have been calculated:

1. Odor emission rate (OER) – The OER is a product of the D/T times the exhaust rate. It is expressed in terms of D/T – CFM X 10^6. The OER is derived for the purpose of ranking the odor sources and also to determine the end point in the modeling.

2. Butanol emission rate – This is also used in the modeling since it considers the dose-response data for the specific odor source.

In order to determine the OER for both the Solids Dewatering Building and the DAF Building, only one fan was operating during the sampling. It was assumed that this would provide the highest D/T, although the lowest exhaust rate. This assumption will be more completely discussed in following sections of this memorandum.

6.0 RANKING

Tables 5, 6 and 7 provide a ranking of the odor sources based on different criteria. The criteria used in the rankings are: (1) D/T; (2) odor emission rate (OER), and; (3) butanol intensity
Each of the rankings is important for the following reasons:

1. D/T Ranking – During calm wind conditions, the D/T, regardless of the actual odor emission rate could conclude in a significant odor source. Typically, any sample with a D/T greater than 100 and a determined OER could be significant.

Insert Table 3

Insert Table 4

Insert Table 5

Insert Table 6

Insert Table 7

2. OER Ranking – This ranking provides a comparison of the actual odor emission rates. In some cases, the emission rate is due to a high D/T and in others; it is due to a high exhaust rate. This ranking allows a determination of which factor controls.

3. Butanol Ranking – Although not as important as the first two ranking systems, the butanol ranking includes the dose-response relationships. This also is one of the factors used in the modeling.

Table 8 provides a comparison of the ranking systems. When evaluating this table, it is important to judge the consistency of the various odor sources. This comparison also allows a quick interpretation of the various modeling results.

7.0 MODELING

7.1 Model Used

The modeling was performed using an EPA Screen 3 dispersion model. The code was altered to provide for a 15-minute duration which is more conservative than the standard 60-minute duration. This model allows for the determination of radial transport distances from the odor source at selected meteorological conditions. This model differs from the ISCST3 model in the following ways:

1. This model does not use site-specific meteorological data. Therefore, frequency of odor excursions is not determined. If actual frequencies are required, ISCST3 modeling must be performed.

2. The model does not consider any specific receptor locations. This is probably obvious since the model results are in radial distances.

7.2 Modeling Assumptions

The following assumptions were made during the modeling runs:

1. Stability Classes: There are six vertical stability classes A through F (1 through 6). The most stable condition is class F (6), whereas the least stable is class A (1). The worst-case condition, therefore, is stability class F. For those sources modeled, the modeling runs were performed at stability classes F and D (6 and 4).

2. Wind Speed – In all cases, three wind speeds were modeled for each stability class: (1) 1 meter/second; (2) 2 meters/second, and; (3) 4 meters/second. As wind speed increases, the dispersion likewise increases.

Insert Table 8

3. Peaking Factors – Since area odor sources have little artificial dispersion, a peaking factor of 10 was assumed when considering peak conditions. A peaking factor of 3 was assumed for point sources. These peaking factors have been determined through other studies related to the ability to witness "puff" of odors. Therefore, the "peak" condition is synonymous with "puff".

4. Average Condition Endpoints – For average conditions, a D/T of 1 was assumed. Although not considered the absolute threshold, a D/T of 1 represents the ED_{50} for typical sensory response. Also, a dose – response correction was made to average data. This takes into account the presence of more pervasive odorants. The baseline slope assumed was –0.5. Therefore, any odor sources that had a slope less than this was corrected.

5. Peak Condition Endpoints – For peak conditions, a D/T of 5 was assumed. Whereas a D/T of 1 may not be experienced by every receptor, a D/T of 5 would be witnessed. No dose-response correction was made to the endpoints for peak conditions.

6. Input Data – Tables 9 and 10 provide the input data used in the modeling. One should note the difference the "slope correction" makes in determining the appropriate endpoint. This is due to the flatness of the dose-response curve, which was discussed earlier.

7.3 Modeling Results

Table 11 includes the modeling results for the hourly or average condition and Table 12 provides the results for the assumed peak conditions. In order to aid in the interpretation of these tables, the following is offered:

1. The off-gas concentration is the calculated surrogate emission rate from the unit process.

2. The receptor concentration (at a D/T of 1) is the calculated maximum concentration at any assumed receptor location. Above this, a receptor with average sensitivity will witness the odor.

3. Under the various meteorological scenarios, the first column indicates the maximum concentration that the model calculated and the associated distance from the source in meters that the maximum concentration would occur. The second column is the distance in meters from the source that the odor will theoretically travel before the allowable concentration is achieved.

Insert Table 9

Insert Table 10

Insert Table 11

Insert Table 12

7.4 Odor Priority

Table 13 indicates the priority of the sources that have the potential of being transported any significant distance. The priority of the sources is relatively the same for average and peak conditions. The table presents the priority based on two conditions:

1. Dispersion conditions (Class 1) – These conditions exist when the wind speed is greater than 1 meter/second. If an odor is transported off site during these conditions, it is considered a high priority odor source.

2. Calm wind conditions (Class 2) – When wind speeds are less than 1 meter/second, the condition is termed "calm". Odors that can be transported off site during dispersion conditions can also transport off site during calm conditions.

8.0 RESULTS

8.1 Sensory Modeling

The modeling indicates the following significant odor sources in order of their priority of potential of being transported any significant distance. **(There is no attempt to determine at this point whether odor from these sources is transported off property boundaries).**

1. East Primary Clarifiers
2. West Primary Clarifiers
3. West Aeration Basins
4. East Aeration Basins

During "calm" wind conditions, other sources could become significant:

1. Solids Dewatering Building (see later discussion)
2. DAF Building exhaust
3. Wet Well
4. East Splitter Box
5. West Splitter Box

8.2 Wet Chemistry

Wet Chemistry samples were collected on two consecutive days from the following locations:

- 78" interceptor
- East Splitter Box
- Main Splitter Box
- Wet Well

Insert Table 13

The following parameters were measured. All except COD were measured in the field.

- Temperature
- pH
- H_2S in solution
- Total sulfides
- Dissolved sulfides
- COD

During the first day iron salts were being fed to into one of the influent sewers to the treatment facility. There was an attempt to collect the samples at approximately the same time of the day.

Table 14 provides the results of the sampling. As can be seen, the results do not vary significantly for the two days of sampling. Even for the East Splitter Box, the concentration of dissolved sulfides was relatively low on both days.

9.0 DISCUSSION

9.1 General

The following section discusses each odor source and the relative characteristics of the odor. In general, however, the dose-response slope of the all sources (with the exception of the anaerobic digester) was extremely flat. This usually indicates the presence of reduced sulfur compounds, in addition to H_2S.

9.2 East Primary Clarifiers

The modeling indicates that the majority of the odors being emitted from the treatment facility are originating from the East Primary Clarifiers. As concluded in other studies, the H_2S being emitted from the weir area was especially high. However, the H_2S measured from the quiescent area was also significant. The odor emission rates for the two zones were:

- Quiescent zone – 1.549
- Weir zone – 0.659

The exhaust rate from the quiescent zone was established at the evaporation rate and that for the weir area was set high, based on turbulence factors. Therefore, the analysis is conservative and still indicates that the OER from the quiescent area is significant.

9.3 West Aeration Basins

The next source in priority is the West Aeration Basins. The analysis indicates, however, that this source is significantly less than the East Primary Clarifiers. This source is significant due to the relatively high D/T in the last aerobic zone (46). It would be expected that the D/T from this area should be less than 30 (see later recommendations).

Insert Table 14

The D/T of the anoxic zone was only 86. Based on studies of similar facilities, the expected D/T from an anoxic zone should exceed 800. The D/T from this zone would indicate that the zone is not entirely anoxic.

9.4 West Primary Clarifiers

Almost equal to the West Aeration Basins are the West Primary Clarifiers. The total OER was 0.187 compared to 2.21 for the east clarifiers. Therefore, the source is significantly less than the east clarifiers.

As in the case of the East Primary Clarifiers, the odor is being emitted from both the weir and the quiescent zones.

9.5 East Aeration Basins

The last significant odor source is the East Aeration Basins. However, compared to the primary clarifiers, the source is relatively insignificant. **However, this conclusion does not consider the proximity to the property boundary**.

9.6 Class 2 Sources

The class 2 sources could only be a problem during very calm meteorological conditions. However, if the class 1 sources are abated, these sources would rarely impact the surrounding neighborhood.

9.7 Ferrous Addition

Both the sensory data and the wet chemistry data suggests that the addition of ferrous is reducing the hydrogen sulfide concentration, but is not significantly impacting the odor emission rate from the various sources. This, at first, might seem improbable. However, if reduced sulfur compounds are present, their low threshold values dominate the total D/T of the sample. In addition, if the pH is lowered due to the iron salt addition, the problem can increase.

10.0 SENSITIVITY DISCUSSION

The data was reviewed for sensitivity to a change in data or modeling assumptions. Only one source was determined to be sensitive to a change, the Solids Dewatering Building. This source had the highest odor emission rate of all sources, due both to the D/T and the exhaust rate.

A velocity was assumed for the outlet from the primary exhaust fan. This velocity, approximately 50 fpm, allowed for adequate dispersion. However, if the velocity was lower than assumed, or the D/T increased, this source would move from a class 2 source to class 1.

In addition, no down wash was assumed for the various structures in the area, due to limited data. Should down wash occur, this source could impact the surrounding area.

11.0 FUTURE CONSTRUCTION

Projects are now being considered for upgrading the treatment facility. The projects that could impact odor from the site are:

- East side aeration project – The addition of fine bubble diffusers to these basins would only benefit odor reduction. No negative impacts should result from this change.

- Aerated grit improvements – Since the existing grit tanks were not found to be a significant odor source, improvements should not change this conclusion. If vortex type units are installed to replace the existing units, the odors from this process should be substantially reduced.

- Wet weather flows – It is unclear as to what will be installed to allow for treatment of wet weather flows. However, if raw wastewater equalization is being considered, this could have an extreme negative impact on odor emissions. For all facilities studied with raw waste equalization, it has been concluded that the equalization basins are a significant odor source.

- Nitrification/denitrification – It is assumed that this project will include the addition of anoxic zones followed by aerobic zones. Should this assumption be correct, a significant increase in odors could be experienced. Experience with other similar facilities, has concluded that two areas in this process contribute significant odors, the anoxic zone and the aerobic zone immediately following the anoxic zone. The construction of recent facilities in urban area has included the control of odors from the anoxic zone and the first third of the aerobic zone (assuming plug flow).

12.0 NEXT STEPS

It is recommended that the Solids Dewatering Building be further studied to determine the exhaust velocity and the related dispersion from this structure.

In addition, the conclusions presented in this Technical Memorandum No. 1 do not consider the distance to property boundaries or any stated objective. Therefore, the following next steps should occur:

1. Determine an abatement objective – this objective can be either based on a property boundary maximum D/T or a frequency of occurrence at a given receptor.

2. Once the objective is determined, the required percent removals for each significant odor source should be determined.

3. Based on the required percent, alternative abatement methods should be screened.

CITY OF LINCOLN

THERESA STREET WWTP

ODOR ABATEMENT STUDY

TECHNICAL MEMORANDUM No. 2

ALTERNATIVES EVALUATION

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

The following is an update to Technical Memorandum No. 1 in addition to a draft discussion of potential alternatives for abating the Class 1 odors from the Lincoln Theresa Street WWTP.

1.1 Technical Memorandum No. 1 Summary

Technical Memorandum No. 1 indicated the priority of significant odor sources as follows:

1. East Primary Clarifiers
2. West Aeration Basins
3. West Primary Clarifiers
4. East Aeration Basins

As indicated in Technical Memorandum No. 1, the significance of the exhaust from the Solids Dewatering Building was uncertain. In addition to the Solids Dewatering Building, the data for the West Aeration Basins was somewhat suspect. Finally, the future design of the East Aeration Basins was unknown.

2.0 UPDATE OF TECHNICAL MEMORANDUM NO. 1

Since drafting Technical Memorandum No. 1, updated information has been received and reviewed in addition to discussions at meetings held in Lincoln with City staff. The following updates Technical Memorandum No. 1 based on that information and those discussions.

2.1 Solids Dewatering Building

The previous modeling assumed that the entire air volume for the belt press room was being exhausted via roof ventilators and only the loading room was being exhausted through the side louver above the door in the garage. The updated information received is as follows:

1. The total exhaust from the belt press room is 19,200-22,200 cfm. A total of 9,700 cfm is being exhausted via the louver on the west wall of the building, and the remainder is being exhausted via roof ventilators. 3,500 cfm is being pulled from the room by the West Aeration Basin Blowers and directed to the Aeration Basins.

2. The loading room is being ventilated at 4,000 cfm and is being exhausted via the side louver.

This new information was modeled. Whereas the previous modeling indicated that adequate dispersion was occurring (via the roof vents), this modeling indicates that during low dispersion and calm conditions, the theoretical transport distance would approach 1,000 meters. The source, therefore, becomes a significant odor source.

2.2 East Aeration Basins

City staff has indicated that the East Aeration Basins will be converted to a four-zone system comprising the following area for each of 2 basins:

1. Zone 1 – 450 ft^2 – Anoxic
2. Zone 2 – 2,148 ft^2 – Anoxic
3. Zone 3 – 5,407 ft^2 – Aerobic
4. Zone 4 – 2,607 ft^2 – Aerobic

The mode of aeration in the aerobic zones will be diffused air and the anoxic zones will be mixed with submersible mixers.

Assumed data was used for the proposed four-zone system in lieu of the data collected from the West Aeration Basins because of the significant difference between the odor characteristics in the east side processes versus the west side processes. Based on the assumed data and the areas cited above, this source will become more significant in the future (see later discussion regarding required percent removals).

The above areas satisfy a design flow of 12 MGD. There is the potential that the East Aeration Basins will be expanded to 18 MGD. Assuming that this would occur, the following total areas would result.

1. Zone 1: 1,350 ft^2 – Anoxic
2. Zone 2: 6,444 ft^2 – Anoxic
3. Zone 3: 16,222 ft^2 – Aerobic
4. Zone 4: 7,821 ft^2 – Aerobic

This future possibility will be further discussed in following sections of this memorandum.

2.3 Future Center Biological Treatment System

In addition to the potential for increasing the capacity of the East Aeration Basins, it has been proposed that the existing center biological system (trickling filters) would be replaced with an aeration system. This system would be similar to the existing West Aeration Basins. The impacts of that change will also be addressed.

2.4 DAF Building

In addition to the above, the structure housing the dissolved air flotation (DAF) equipment is a problem source during “calm air” conditions.

3.0 REQUIRED PERCENT REMOVALS

Prior to discussing alternatives, the following indicates the required percent removals for meeting a D/T of both 1 and 5 at the property line from the significant odor sources. Table 1 provides the assumed D/T values and the corresponding odor emission rates (OER) for the following:

1. East Aeration Basins assuming existing D/T values based on a design flow of 12 MGD.

2. East Aeration Basins assuming existing D/T values based on a design flow of 18 MGD.

3. East Aeration Basins assuming modified D/T values comparable to the existing D/T values for the West Aeration Basins based on a design flow of 12 MGD.

4. East Aeration Basins assuming modified D/T values comparable to the existing D/T values for the West Aeration Basins based on a design flow of 18 MGD.

5. Combined West, Center and East Aeration Basins assuming existing D/T values for the East Aeration Basins and an east design flow of 12 MGD.

6. Combined West, Center and East Aeration Basins assuming existing D/T values for the East Aeration Basins and an east design flow of 18 MGD.

7. Combined West, Center and East Aeration Basins assuming modified D/T values for the East Aeration Basins and an east design flow of 12 MGD.

8. Combined West, Center and East Aeration Basins assuming modified D/T values for the East Aeration Basins and an east design flow of 18 MGD.

9. East Primary Clarifiers assuming existing and modified D/T values.

Table 1
Assumed D/T Values and Odor Emission Rates for East Primary Clarifiers, East Aeration Basins, and Combined Aeration Basins

Primary Area	Sub-Area	D/T	OER
East Primary Clarifiers – Existing D/T	-	1,051	1,042
East Primary Clarifiers – Modified D/T	-	175	585.5
East Aeration Basins [1]	Zones 1 and 2	1,800	110.45
	Zone 3	80	320.54
	Zone 4	30	57.96
Total	-	-	488.95
East Aeration Basins [2]	Zones 1 and 2	1,800	164.3
	Zone 3	80	480.8
	Zone 4	30	86.9
Total	-	-	732
East Aeration Basins [3]	Zones 1 and 2	86	5.3
	Zone 3	30	23
	Zone 4	46	17
Total	-	-	45.2
East Aeration Basins [4]	Zones 1 and 2	86	7.8
	Zone 3	30	34.5
	Zone 4	46	25.5
Total	-	-	67.8
Combined Systems[1]	-	248	677.9
Combined Systems[2]	-	248	921.0
Combined Systems[3]	-	54	234.2
Combined Systems[4]	-	54	256.7

[1] Existing D/T values and a design of 12 MGD.

[2] Existing D/T values and a design of 18 MGD.

[3] Modified D/T values and a design of 12 MGD.

[4] Modified D/T values and a design of 18 MGD.

Table 2 indicates the percent removal required for all of the above alternatives plus the DAF Building for meeting a D/T of both 5 and 1 at the property boundaries. Required percent removals for both average (lingering odors) and peak (puffs) occurrences are provided. Assumed distances to property boundaries are also indicated.

Table 2
Required Percent Removals

Source	Distance (ft)	Average		Peak	
		D/T = 5	D/T = 1	D/T = 5	D/T = 1
East Primary Clarifiers – Existing D/T[1]	120	78.9	95.7	90.4	98.1
East Primary Clarifiers – Modified D/T[1]	120	48.7	91.5	89.7	97.3
East Aeration – 12 MGD – Existing D/T	255	66.9	93.2	83.6	96.0
East Aeration – 12 MGD – Modified D/T	255	0.0	23.0	67.0	93.0
East Aeration – 18 MGD – Existing D/T	255	45.6	96.2	93.2	98.9
East Aeration – 18 MGD – Modified D/T	255	0.0	31.2	71.2	97.7
Combined Aeration – 18 MGD Existing D/T	255	45.8	96.9	94.8	99.1
Combined Aeration – 18 MGD – Modified D/T	255	0.0	34.2	74.2	98.3
West Aeration	315	0.0	12.8	57.7	91.5
West Primary Clarifiers	295	0.0	70.5	54.5	83.0
Solids Dewatering	220	20.1	52.9	31.2	77.4
DAF Building	Problem source during calm air conditions – Reduce OER to 0.2 O.U. $ft^3/min \times 10^6$				

[1] This assumes no additional primary clarifiers.

With the exception of the DAF Building, the percent removals in Table 2 are calculated based on a stability class of F (6) and a wind speed of 1 m/s. During "calm" air conditions, the theoretical could be greater and, therefore, the resultant required percent removals would also be higher.

In Technical Memorandum No. 1, peak removal percentages were not calculated. These are listed in the above table in order to recognize that if abatement is only planned for average conditions, odors can still be transported off site.

The East Primary Clarifiers were modeled using both the existing D/T data in addition to the data for the West Primary Clarifiers. As can be seen, the removal rates do not differ significantly due to the proximity to the property boundary. **It should be noted that the area assumed is the existing area – no additional primary clarifiers have been assumed.**

The revised percent removals for the Solids Dewatering Building reflect the change in assumptions as to the location of the exhaust.

The modeling also shows that the combination of aeration systems has little impact on the total odor emissions. The east aeration system controls, due to the proximity to the property boundaries.

If the East Aeration Basins are maintained at a capacity of 12 MGD, and assuming the existing D/T values, capture of zones 1, 2 and 3 would be required (excluding zone 4). However, if the facility is expanded to 18 MGD, it would be recommended that the entire aeration system be covered.

If the D/T values could be modified to compare with those from the West Aeration Basins, and assuming an objective D/T of 5, no control would be required for abatement of the average condition. However, peak occurrences would still require control. This will be more completely discussed in the following sections of this memorandum.

4.0 CAPTURE RATES

In order to discuss the various alternatives, capture rates have to be assumed for each significant source. At the present time the existing Solids Dewatering Building is being exhausted at the following rates:

Table 3
Existing Exhaust Rates for Solids Dewatering Building

Area	Volume (ft^3)	Ventilation Rate (cfm)	Air Changes (ac/h)
Belt Press Room	49,680	22,200	27
Loading Area	70,600	4,000	3.4
Total Building Ventilation	120,280	26,200	13.1

The total ventilation rate including both areas is marginal, but adequate. However, the ventilation rate for the loading area is much too low. Typically when low ventilation rates are used, doors and windows remain open during summer conditions, allowing fugitive odor emissions.

Table 4 provides the recommended capture rates for the significant sources.

Table 4
Recommended Capture Rates

Location	Area (ft^2)	Air Volume (cfm)	Design Criteria	Capture Rate (cfm)
East Primary Clarifiers[1]	28,456	-	6 ac/h, or 1 cfm/ft^2	11,382 28,456
East Aeration – Existing	16,028	12,009	6 ac/h + air, or Air + 0.5 cfm/ft^2	22,427 20,023
East Aeration – Future	31,836	26,700	6 ac/h + air, or Air + 0.5 cfm/ft^2	47,393 42,618
West Aeration	7,696	10,000	Air + 0.5 cfm/ft^2	13,848
West Primary Clarifiers	17,592	-	6 ac/h, or 0.5 cfm/ft^2	7,037 8,796
Solids Dewatering Bldg	-	-	-	26,200[2]
DAF Building	-	-	-	9,230

[1] Assumes no additional primary clarifiers.

[2] Assumes that the air can be redistributed.

Considering the East Aeration Basins, due to the distance of a potential cover to the water surface of 6.5 feet, the 6 ac/h plus air controls the capture rate for this unit process.

5.0 ABATEMENT ALTERNATIVES

In Technical Memorandum No. 1, the odor sources were ranked in order of priority based on sampling data without consideration of the potential of being transported any significant distance. In this Technical Memorandum, the odor sources are evaluated based on proximity to property boundaries and the City's odor abatement objectives.

5.1 General Discussion

East Primary Clarifiers: As indicated in Technical Memorandum No. 1, the most significant odor source is the East Primary Clarifiers. These primary clarifiers were also modeled using the data from the West Primary Clarifiers. However, required percent reduction does not differ greatly due to the proximity to the property boundary. Control will be required regardless.

Due to the proximity of the property boundary, a design to a D/T of 5 is not recommended. During low dispersion conditions, this source will continue to be a very significant odor source. Complete control is therefore recommended for this source.

The control requirements for the East Primary Clarifiers will vary based on whether the East Aeration Basins are also controlled.

East Aeration Basins: Due to the proximity of this unit process to the property boundary, and also due to the future biological nutrient removal (BNR) mode of operation, this unit process will have to be controlled. Previously, it was determined that if the odor levels could be reduced prior to the East Primary Clarifiers, this source may become less significant. This is true for the existing capacity of 12 MGD. However, if this side is increased in capacity to 18 MGD, control will be required.

Solids Dewatering Building: This source will require control if odors are to abated at the property boundary.

West Primary Clarifiers and Aeration Basins: These sources are less significant than the other sources. Control should only be provided after all other significant sources are abated.

DAF Building: This source should be controlled for abatement during "calm air" conditions.

5.2 Available Options - Technology

Four methods of odor control will be considered:

1. Wet scrubbing (packed bed)
2. Bio-filtration
3. Carbon
4. Induced dispersion

5.3 Control Options

5.3.1 East Side Unit Processes

- East Side Primary Clarifiers and Splitter Box – For odor control in the area of the East Primary Clarifiers, the only available option is two stage wet scrubbing. Bio-filtration could be considered. However, the bio-filter would have to be located away from the property boundary (due to the lower removal percentage). This would require ducting of foul air. Carbon is not considered due to the significant existing odor concentrations and the required high levels of removal.

  If the D/T values could be modified due to an alteration of the transfer sewer, the requirements would decrease. However, once again, due to the proximity to the property line, the required percent removals are still significant.

- East Aeration Basins – Even if the D/T can be reduced in the incoming wastewater, control of zones 1, 2 and 3 of the aeration tanks will be required in order to ensure no odor excursions from these unit processes.

Options considered for the east side are as follows:

1. Option E–1: Control only the primary clarifiers and splitter box – The control for this option would be covering the primary clarifiers and splitter box, and exhausting the foul air to a 2-stage wet scrubber.

2. Option E-1 (a): Same as E-1, but reduce D/T prior to entering the splitter box.

3. Option E-1 (b): Same as E-1, but include DAF Building exhaust.

4. Option E-2: Control of only the East Aeration Basins (zones 1, 2 and 3) – Exhaust to a wet scrubber.

5. Option E-2 (a): Same as option E-2, but exhaust to a bio-filter.

6. Option E-3: Same as option E-2, but assume expansion to 18 MGD – Exhaust to a wet scrubber.

7. Option E-3 (a): Same as option E-3, but exhaust to a bio-filter.

8. Option E-4: Control the primary clarifiers, the splitter box and zones 1, 2 and 3 of the aeration basins – If this option was selected, covering of these areas would be required with the foul air being exhausted to a single stage wet scrubber.

9. Option E-4 (a): Same as E-4, but assumes expansion to 18 MGD.

10. Option E-4 (b): Same as E-4, but assumes inclusion of the exhaust from the DAF Building.

5.3.2 Solids Dewatering Building

The reasons for this being a significant odor source are as follows:

1. High D/T
2. High exhaust rate
3. No dispersion (this is due to the location and exit velocity of the side wall louver).

The options for control of this source are **(it is assumed that the air balance would be reconfigured for this building)**:

1. Option SD-1: Exhaust air from both the belt press area and loading area to a single stage wet scrubber.

2. Option SD-1 (a): Exhaust air as above to a bed bio-filter.

3. Option SD-1 (b): Install a stack of sufficient height with adequate exit velocity. The recommended exit velocity is 60 fps. Based on a ventilation rate of 26,200 cfm, the maximum diameter of the stack should be 3 feet in diameter. The height of the stack should be 1½ times higher than the height of the building. This assumes that this structure is the highest structure in the immediate area. Assuming a building height of 50 feet, the stack height should be 25 feet above the roof line.

The last option provides the least control. This source with this control could still impact the neighborhood during calm air conditions.

5.3.3 West Primary Clarifiers and West Aeration Basins

Since these unit processes have the lowest priority, minimum control is required. It should be remembered, however, that the D/T values for the anoxic zone were considered low. If this process is truly going to be used for BNR in the future, these values could increase significantly.

Due to the lower required percent removals, single stage wet scrubbing (packed bed), bio-filtration and carbon can be considered for odor control.

Assuming that control is required, the following options are available:

1. Option W-1: Cover primary clarifiers and exhaust air to a single stage wet scrubber.

2. Option W-1 (a): Same W-1, but exhaust to a bio-filter (this could be the same bio-filter for the Solids Dewatering Building).

3. Option W-1 (b): Same as W-1, but exhaust to carbon.

4. Option W-2: Cover primary clarifiers and zones 1, 2 and 3 of the aeration basins and exhaust to a single stage wet scrubber.

5. Option W-2 (a): Same W-4, but exhaust to a bio-filter.

6. Option W-2 (b): Same as W-4, but exhaust to carbon.

7. Option W-3: Same as W-1, but add Solids Dewatering Building.

8. Option W-3 (a): Same as W-3, but exhaust to a bio-filter.

9. Option W-3 (b): Same as W-3, but exhaust to carbon.

10. Option W-4: Same as W-3, but add west side aeration.

11. Option W-4 (a): Same as W-3, but exhaust to a bio-filter.

12. Option W-4 (b): Same as W-3, but exhaust to carbon.

5.3.4 Centralized Facility

The following two options will be considered for a centralized facility:

1. Option C-1: Control all problem sources via wet scrubbing. This option assumes a 12 MGD aeration capacity for the East Aeration Basins.

2. Option C-1 (a): Same as C-1, but exhaust to a bio-filter.

5.4 Impact of Iron Salt Addition and Alternative Chemical Addition

This section relates to the increase in concentration of H_2S in the sewer transporting the wastewater to the east unit processes. The flow data would suggest a detention time of 51 minutes in the sewer. Under normal circumstances, this detention time should not result in the increased concentrations being experienced.

Based on the percent removals that are required for odor abatement for the east unit processes, odor control will be required regardless of what attempts are made to improve the waste characteristics (clean the pipe, pump the wastewater, oxidant addition or more iron addition) as described in the following paragraphs. However, the basis of design could change, impacting both the capital and operating costs of odor control.

The expected oxygen depletion (based on calculations presented in US EPA Design Manual for "Odor and Corrosion Control in Sanitary Sewerage Systems and Treatment Plants", EPA/625/1-85/018) in the pipeline, assuming no reaeration and a velocity of .5 ft/sec in the pipe would be:

$$\text{Drop} = 5.3 \times O_I \times (s \times v)^{.5} \times R^{-1}$$
$$\text{Drop} = 5.3 \times 3 \times (.001 \times 1.52)^{.5} \times .3048^{-1}$$
$$\text{Drop} = 15.9 \times .039 \times 3.28$$
$$\text{Drop} = 2.033 \text{ mg/L/Hr}$$

Assuming 51 minutes (.85 hrs), the drop expected would be 1.73 mg/L.

This depletion should not cause the increase in concentrations, unless something else was occurring in the pipeline such as solids accumulation.

The expected sulfide increase can be determined as follows using calculations from EPA's design manual cited previously. If it is assumed that the sulfate is not limited (it is rarely limited) and that the dissolved oxygen goes to zero half way down the pipe, the following sulfide increase can be predicted:

S_2-S_1 = M (Flux Constant) x time x (EBOD x (4/d+1.57))

Where:

- M = $1x10^{-3}$ m/hr
- Time = 30/60 = .5
- $EBOD_{15}$ = 200 x 1.07^{-5} = 143 mg/L (I have arbitrarily used 200 mg/L)
- $EBOD_{25}$ = 200 x 1.07^{5} = 281 mg/L.0
- d = 48" = 1.22 m

$(S_2\text{-}S_1)_{15}$ = 1.04 mg/L

$(S_2\text{-}S_1)_{25}$ = 2.04 mg/L

Based on the data that was collected in the field, the percent dissolved sulfide approximates 50%. Therefore, even during the cooler periods of the year, the dissolved sulfide concentration (increase) could be as high as 0.5 mg/L. Assuming a pH of 7.0 and a pK of 7.0, the concentration of H_2S in the liquid stream would be 0.25 mg/L. At 15 degrees C, the H_2S in the air (equilibrium) would approach 60 ppm(v). This is substantial.

The following questions are raised from this analysis:

1. Is the iron the best additive for this application?
2. Is it added at the most optimum point?
3. Are there alternatives?

Iron salts are excellent precipitators. Based on the data that was presented, it would appear that the H_2S concentrations entering the facility vary somewhat randomly throughout the day. Based on the H_2S data, it would appear that the addition of iron is lowering the concentrations in the head works portions of the facility. The addition is probably benefiting the odor potential from these areas.

Once the wastewater gets into the pipeline, however, the iron is ineffective. As anaerobic conditions occur and the pH drops due to CO_2 formation, the iron precipitates will tend to disassociate, adding additional iron in an attempt to maintain precipitation will not succeed.

If the existing iron feed point is eliminated, increased odors can be expected in the head works and aerated grit areas. In addition, other portions of the facility such as the west and middle areas, could also witness increased odors. Therefore, changing the feed point would not appear to be appropriate.

The following are options for addressing the chemical addition:

1. Clean the Pipe and Keep It Clean

It would appear that the solids deposition in the pipeline is causing a major problem. If the pipeline would be cleaned, a definite improvement should be witnessed. However, if the solids again accumulate, the same problem will occur. Cleaning the pipeline on a regular basis would be required.

a. Re-sampling

As indicated above, it was believed that the solids deposition in the pipeline was causing a major increase in odor. Due to this, the City attempted to clean the interceptor in order to determine the impacts of the solids accumulation.

After the sewer was cleaned, re-sampling occurred on October 16 and 17, 2002 at the following locations:

- East Splitter Box (two samples)
- East primary clarifier quiescent zone (two samples)
- Zone 1 of the East Aeration Basins

For the East Splitter Box and the primary clarifier, the two samples were collected on different days at different times of the day.

Table 5 provides a comparison of the previously collected data with that collected in October 2002.

Table 5
Re-sampling Data

Location	January, 2002		October, 2002	
	D/T	H_2S	D/T	H_2S
East Splitter	127	0.3 ppm(v)	2900 3400	2.0 ppm(v) 4.2 ppm(v)
East Primary Clarifier	1263 460	3.4 ppm(v)	490 670	2.4 ppm(v) 1.4 ppm(v)
Zone 1 Aeration	58	0.016 ppm(v)	50	0.004 ppm(v)

As can be seen, the new data for the splitter box increased significantly. This has little impact, since the exhaust rate is low compared to the other surrounding unit processes. Also, it should be noted that there was little change in the aeration basin D/T data.

Based on the above data, it would appear that little improvement occurred due to the cleaning of the interceptor. It would appear, therefore, that either:

- The deposition of solids is not a major factor in the elevated D/T values, or
- The pipe was not entirely or completely cleaned.

As will be noted in other portions of this memorandum, west side unit processes data was assumed for the east side unit processes. Unless the residence time in the interceptor can be reduced, it would appear that these lower values cannot be assumed.

2. Pump The Wastewater

The same analysis as performed above for oxygen depletion and sulfide increase can be performed for a force main. If the velocity can be increased from 0.5 – 2.0 fps, the problem decreases considerably. This option could be considered.

3. Add An Oxidant

If a strong oxidant would be added to the aerated grit chamber or another similar location, the sulfide increase could be minimized. A strong oxidant would be required, such as hydrogen peroxide. The annual operating cost for the addition would approximate $200,000. It would seem that this addition would not be cost effective.

4. Add More Iron

If additional iron was added at some location, down the pipeline or even at the splitter box, continued precipitation would occur. There is concern related to the splitter box feed point, since adequate mixing time may not be achieved prior to the primary clarifiers. Based on the data, it is estimated that the amount of iron required would approach 1.5 times what now is being added. This would increase the cost of addition to a total of $180,000 per year.

6.0 BASIS OF DESIGN FOR OPTIONS

Included in Tables 6, 7 and 8 are the recommended basis of design for the options previously discussed.

Table 6
Recommended Basis of Design for Packed Bed Scrubbing Options

Option	Air Flow (cfm)	Design H_2S (ppm(v))	Required % Removal	Tower Dia. (ft)	Stages	Packing Depth (ft)	Recirc. Rate (gpm)
E-1	28,456	50	96	9	2	10	415 each
E-1 (a)	28,456	25	92	9	1	10	415
E-1 (b)	37,686	40	96	10	2	10	510 each
E-2	22,427	10	96	8	1	10	326
E-3	47,393	10	99	11	1	10	620
E-4	50,883	10	99	12	1	10	735
E-4 (a)	75,849	10	99	10	2 parallel	10	510 each
E-4 (b)	60,113	10	99	12	2 parallel	12	415 each
SD-1	26,200	5	53	8	1	8	326
W-1	8,796	20	71	5	1	8	126
W-2	22,644	10	71	8	1	8	326
W-3	34,996	7.5	71	10	1	10	510
W-4	48,884	5	71	11	1	10	620
C-1	108,957	15	93	12	2 parallel	10	735 each

Table 7
Recommended Basis of Design for Bio-filter Options

Option	Air Flow (cfm)	Design H_2S (ppm(v))	Required % Removal	Residence Time (sec)	Depth (ft)	Area (ft^2)
E-2 (a)	22,427	10	97	40	5	3,005
E-3 (a)	47,393	10	97	40	5	6,350
SD-1 (a)	26,200	5	65	30	5	2,620
W-1 (a)	8,796	20	75	30	5	880
W-2 (a)	22,644	10	75	30	5	2,264
W-3 (a)	34,996	7.5	75	30	5	3,500
W-4 (a)	48,884	5	75	30	5	4,888
C-1 (a)	108,957	15	95	30	5	10,896

Table 8
Recommended Basis of Design for Carbon Options

Option	Air Flow (cfm)	Design H_2S (ppm(v))	Required % Removal	Required Pounds	Decay Rate (days)
SD-1 (b)	26,200	5	53	30,000	550
W-1 (b)	8,796	20	71	10,000	364
W-2 (b)	22,644	10	71	20,000	380
W-3 (b)	34,996	7.5	71	30,000	423
W-4 (b)	48,884	5	71	40,000	423
C-1 (b)	108,957	15	93	60,000	423

7.0 COST ESTIMATES

7.1 Control Strategies

The following control strategies will be considered:

1. Separate systems for the east and west sides:

    - Option – S: One option for the east side would be to only construct odor control for the primary clarifiers and splitter box. When control is required for East Aeration Basins, a separate control unit would be installed.

    - Option – S (1): A sub option of the above would be to include the exhaust from the DAF Building at this time.

    - Option – S (2): This option would allow for the inclusion of the aeration basins in the odor control unit serving the primary clarifiers. Covers for the aeration basin could be added at a later date.

    - Option - S (3): This sub option would provide for inclusion of the exhaust from the DAF Building.

- Option – S (4): This option control only the exhaust from the Solids Dewatering Building.

- Option – S (5): This option for the west side would only control the exhaust from the West Primary Clarifiers.

- Option – S (6): This option for the west side would be similar to option S (5), but would include the exhaust from the Solids Dewatering Building.

- Option – S (7): This option is similar to option S (5) but would include the West Aeration Basins.

- Option – S (8): This option would add the exhaust from the Solids Dewatering Building to option S (7).

- One centralized system located in the area of the existing trickling filters. This would require that foul air from the both the east and west side unit processes be ducted to the central system – option C.

7.2 Cover Costs

It is assumed that flat covers will be used in lieu of occupied enclosures. The cost of covers will be the same for all alternatives. Table 9 presents the estimated cost of covers.

Table 9
Estimated Cost for Covers[1]

Source	Area (ft^2)	Unit Cost ($)	Total Cost ($)
East Splitter Box	224	60	14,000
East Primary Clarifiers	28,456	35	1,000,000
East Aeration Basins	16,028	35	560,980
West Primary Clarifier	17,592	35	616,000
West Aeration Basins	7,696	35	269,000

[1] Costs do not include contingencies.

7.3 Control Options Costs

Table 10 provides the estimate of costs for the various control options. The operating costs are based on the following:

Wet Scrubbing

1. Labor - $1.00 per cfm, annual.
2. Electrical - $0.05 per kw/hr.
3. NaOH - $0.45 per gal.
4. NaOCl - $0.73 per gal.

Two operating costs will be provided in Table 10. The first cost reflects total oxidation of the sulfur compounds. The second reflects only partial oxidation. If this option was selected, the

blow down from the wet scrubber(s) would have to be piped to an aerobic zone of an aeration tank.

Bio-filtration

In order to calculate required areas for bio-filtration, an inorganic media was assumed. If organic media is used, the areas required will be two to three times that shown in Table 7. The advantages of inorganic media are: (1) higher removal rates, and; (2) longer media life. This assumption will also be reflected in the costs that follow.

1. Labor - $20,000 per system annually, regardless of the size.
2. Electrical - $0.05 per kw/hr.
3. Media replacement - $24/ft^3 based on a ten-year life.

Carbon

1. Labor - $20,000 per system, annually, regardless of size.
2. Electrical - $0.05 per kw/hr.
3. Carbon replacement - $15.00 per pound.

Table 10 provides the capital and operating costs for the main strategic options in addition to the specific control options.

Table 10
Estimates of Capital and Operating Costs for Control Options[1]

Strategic Option	Control Option	Description	Capital Cost ($)[2]	Annual Operating Cost ($)				
				Labor	Electrical	Chemicals	Media Replacement	Total
S	E-1	Control Only East Primary Clarifiers	550,000	28,000	33,000	322,000 161,000	-	383,000 222,000
S-1	E-1 (b)	Control East Primary Clarifiers and DAF Exhaust	625,000	38,000	42,000	341,000 254,000	-	421,000 334,000
S	E-2	Control of East Aeration Basins Alone (12 MGD) – Wet Scrubbing	400,000	22,000	23,000	78,000 40,000	-	123,000 85,000
S	E-2 (a)	Control of Aeration Basins Alone (12 MGD) – Bio-filtration	673,000	20,000	23,000	-	36,000	79,000
S	E-3	Control of East Aeration Basins Alone (18 MGD) – Wet Scrubbing	600,000	47,000	48,000	165,000 85,000	-	260,000 180,000
S	E-3 (a)	Control of East Aeration Basins Alone (18 MGD) – Bio-filtration	1,422,000	20,000	48,000	-	76,000	144,000
S (1)	E-4	Control of East Primary Clarifiers and Aeration Basins (12 MGD) – Wet Scrubbing	910,000	51,000	51,000	177,000 91,000	-	279,000 193,000
S-(2)	E-4 (a)	Control of East Primary Clarifiers and Aeration Basins (18 MGD) – Wet Scrubbing	1,200,000	76,000	76,000	254,000 136,000	-	406,000 288,000
S-(3)	E-4 (b)	Control of East Primary Clarifier, Aeration Basins (12 MGD) and DAF – Wet Scrubbing	1,000,000	60,000	62,000	210,000 108,000	-	332,000 230,000
S-(4)	SD-1	Control of the Solids Dewatering Building – Wet Scrubbing	350,000	26,000	26,000	46,000 23,000	-	98,000 75,000
S-(4)	SD-1 (a)	Control of the Solids Dewatering Building – Bio-filtration	786,000	20,000	26,000	-	31,000	77,000

[1] Costs do not include contingencies or covers.

[2] Costs are installed costs.

Table 10 (Continued)

Strategic Option	Control Option	Description	Capital Cost ($)[1]	Annual Operating Cost ($)				
				Labor	Electrical	Chemicals	Media Replacement	Total
S-(4)	SD-1 (b)	Control of Solids Dewatering Building – Carbon	500,000	20,000	26,000	-	299,000	345,000
S-(5)	W-1	Control of West Primary Clarifiers – Wet Scrubbing	250,000	9,000	9,000	61,000 31,000	-	79,000 49,000
S-(5)	W–1 (a)	Control of West Primary Clarifiers – Bio-filtration	264,000	20,000	9,000	-	11,000	40,000
S-(5)	W-1 (b)	Control of West Primary Clarifiers – Carbon	250,000	20,000	9,000	-	150,000	179,000
S-(6)	W-2	Control of West Primary Clarifiers and West Aeration Basins – Wet Scrubbing	450,000	23,000	23,000	-	79,000 40,000	125,000 86,000
S-(6)	W- 2 (a)	Control of West Primary Clarifiers and West Aeration Basins – Bio-filtration	679,000	20,000	23,000	-	27,000	70,000
S-(6)	W-2 (b)	Control of West Primary Clarifiers and West Aeration Basins – Carbon	400,000	20,000	23,000	-	288,000	331,000
S-(7)	W-3	Control of West Primary Clarifiers and Dewatering Building – Wet Scrubbing	450,000	35,000	35,000	88,000 43,000	-	158,000 113,000
S-(7)	W-3 (a)	Control of West Primary Clarifiers and Dewatering Building – Bio-filtration	1,050,000	20,000	35,000	-	59,000	114,000
S-(7)	W-3 (b)	Control of West Primary Clarifiers and Dewatering Building – Carbon	750,000	20,000	35,000	-	388,000	443,000

[1] Costs are installed costs.

Table 10 (Continued)

Strategic Option	Control Option	Description	Capital Cost ($)[1]	Annual Operating Cost ($)				
				Labor	Electrical	Chemicals	Media Replacement	Total
S-(8)	W-4	Control of West Primary Clarifiers, Aeration Basins and Solids Dewatering – Wet Scrubbing	750,000	49,000	49,000	85,000 44,000	-	183,000 142,000
S-(8)	W-4 (a)	Control of West Primary Clarifiers, Aeration Basins and Solids Dewatering – Bio-filtration	1,467,000	20,000	49,000	-	59,000	128,000
S-(8)	W-4 (b)	Control of West Primary Clarifiers, Aeration Basins and Solids Dewatering – Carbon	750,000	20,000	49,000	-	518,000	587,000
C	C-1	Centralized System – Wet Scrubbing	1,800,000	108,000	109,000	558,000 280,000	-	775,000 497,000
C	C-1 (a)	Centralized System – Bio-filtration	3,270,000	20,000	109,000	-	131,000	260,000
C	C-1 (b)	Centralized System – Carbon	1,200,000	20,000	109,000	-	777,000	906,000

[1] Costs are installed costs.

7.4 Project Costs

Table 11 provides an estimate of cost for various project options. Assumptions are as follows:

1. Electrical – 20% of control cost.
2. Site – 20% of control + ducting costs.
3. Contingencies – 35%.

Table 11
Project Cost Estimates

Strategic Option	Control Option	Description	Covers	Control	Ducting	Electrical	Site	Subtotal	Cont.	Total Cost
S	E-1	Control of East Primaries and Splitter Box	1,014,000	550,000	100,000	110,000	130,000	1,904,000	666,000	2,570,000
S	E-1 (a)	Control of East Primaries and Splitter Box – Reduced D/T	1,014,000	400,000	100,000	80,000	100,000	1,694,000	593,000	2,287,000
S (1)	E-1 (b)	Control of East Primaries + DAF	1,014,000	625,000	100,000	125,000	145,000	2,009,000	703,000	2,712,000
S	E-2	Control of East Aeration Basins (12 MGD) – Wet Scrubbing	561,000	400,000	150,000	80,000	110,000	1,301,000	455,000	1,756,000
S	E-2 (a)	Control of East Aeration Basins (12 MGD) – Bio-filtration	561,000	673,000	150,000	135,000	165,000	1,684,000	589,000	2,273,000
S	E-3	Control of East Aeration Basins (18 MGD)	This Option Not Estimated							
S (1)	E-4	Control of East Primary Clarifiers and Aeration Basins – Wet Scrubbing	1,575,000	910,000	200,000	182,000	222,000	3,089,000	1,081,000	4,170,000
S (3)	E-4 (b)	Control of East Primary Clarifiers, Aeration Basins and DAF – Wet Scrubbing	1,575,000	1,000,000	250,000	200,000	240,000	3,265,000	1,143,000	4,408,000
S (4)	SD-1	Control of Solids Dewatering Building – Wet Scrubbing	-	350,000	100,000	70,000	90,000	610,000	214,000	824,000
S (4)	SD-1 (a)	Control of Solids Dewatering Building – Bio-filtration	-	786,000	100,000	157,000	177,000	1,220,000	427,000	1,647,000
S (4)	SD-1 (b)	Control of Solids Dewatering Building – Carbon	-	500,000	100,000	100,000	120,000	820,000	287,000	1,107,000
S (5)	W-1	Control of West Primaries – Wet Scrubbing	616,000	250,000	100,000	50,000	70,000	1,086,000	380,000	1,466,000
S (5)	W-1 (a)	Control of West Primaries – Bio-filtration	616,000	264,000	100,000	53,000	73,000	1,106,000	387,000	1,493,000
S (5)	W-1 (b)	Control of West Primaries – Carbon	616,000	250,000	100,000	50,000	70,000	1,086,000	380,000	1,466,000

Table 11 (Continued)

Strategic Option	Control Option	Description	Covers	Control	Ducting	Electrical	Site	Subtotal	Cont.	Total Cost
S (6)	W-2	Control of West Primaries and West Aeration – Wet Scrubbing	885,000	450,000	250,000	90,000	140,000	1,815,000	635,000	2,450,000
S (6)	W-2 (a)	Control of West Primaries and West Aeration – Bio-filtration	885,000	679,000	250,000	136,000	186,000	2,136,000	748,000	2,884,000
S (6)	W-2 (b)	Control of West Primaries and West Aeration – Carbon	885,000	400,000	250,000	80,000	130,000	1,745,000	611,000	2,356,000
S (7)	W-3	Control of West Primaries and Solids Dewatering Building – Wet Scrubbing	616,000	450,000	200,000	90,000	130,000	1,486,000	520,000	2,006,000
S (7)	W-3 (a)	Control of West Primaries and Solids Dewatering Building – Bio-filtration	616,000	1,050,000	200,000	210,000	250,000	2,326,000	814,000	3,140,000
S (7)	W-3 (b)	Control of West Primaries and Solids Dewatering Building – Carbon	616,000	750,000	200,000	150,000	190,000	1,906,000	667,000	2,573,000
S (8)	W-4	Control of West Primaries, West Aeration and Solids Dewatering Building – Wet Scrubbing	885,000	750,000	300,000	150,000	210,000	2,295,000	803,000	3,098,000
S (8)	W-4 (a)	Control of West Primaries, West Aeration and Solids Dewatering Building – Bio-filtration	885,000	1,467,000	300,000	293,000	353,000	3,298,000	1,154,000	4,452,000
S (8)	W-4 (b)	Control of West Primaries, West Aeration and Solids Dewatering Building – Carbon	885,000	750,000	300,000	150,000	210,000	2,295,000	803,000	3,098,000
C	C-1	Centralized Facility – Wet Scrubbing	2,460,000	1,800,000	500,000	360,000	460,000	5,580,000	1,953,000	7,533,000
C	C-1 (a)	Centralized Facility – Bio-filtration	2,460,000	3,270,000	500,000	654,000	754,000	7,638,000	2,673,000	10,311,000
C	C-1 (b)	Centralized Facility – Carbon	2,460,000	1,200,000	500,000	240,000	340,000	4,740,000	1,659,000	6,399,000

7.5 Discussion

Unless a centralized bio-filter is installed, bio-filtration is not recommended for the east side. In addition, a bio-filter requires a fairly constant odor load in order to maintain a healthy biomass on the filter. Therefore, if the dewatering operation is intermittent, bio-filtration for the west side alone may be difficult.

Table 12 compares some of the alternatives based on a present worth cost. An interest rate of 5% and a term of 20 years were used. The alternatives that will be evaluated are:

1. Wet scrubbing for the East Primary Clarifiers (and splitter box), including control for the DAF building, with future construction of separate odor control for the East Aeration Basins.

2. Combined wet scrubbing for the East Primary Clarifiers (and splitter box), including control for the DAF Building and the East Aeration Basins.

3. Wet scrubbing for the combined west side facilities – it is understood that this option may not occur. The evaluation is performed to evaluate the various control technologies.

4. Bio-filtration for the west side unit processes.

5. Total for east and west sides assuming separate construction and wet scrubbing.

6. Total for east and west sides assuming separate construction and wet scrubbing for the east side and bio-filtration for the west.

7. Total for east and west sides assuming separate construction and wet scrubbing for the east side and carbon for the west.

8. Carbon for the west side facilities.

9. Centralized system assuming wet scrubbing.

10. Centralized system assuming bio-filtration.

11. Centralized system assuming carbon.

Table 12
Present Worth Analysis for Key Options

Strategic Option	Control Option	Option	Capital Cost ($)	Operating Cost ($)	Present Worth Cost ($)
S (1), S	E-1 (b) E-2	Control for East Primary Clarifiers and DAF – Future Separate Control for East Aeration Basins	4,468,000	419,000	9,689,000
S (3)	E-4 (b)	Control for East Primary Clarifiers, East Aeration Basins and DAF Building	4,408,000	230,000	7,274,000
S (8)	W-4	Control of West Side Unit Processes – Wet Scrubbing	3,098,000	142,000	4,867,000
S (8)	W-4 (a)	Control of West Side Unit Processes – Bio-filtration	4,452,000	128,000	6,047,000
S (8)	W-4 (b)	Control of West Side Unit Processes – Carbon	3,098,000	587,000	10,412,000
S (3), S (8)	E-4 (b) W-4	Total Separate construction – Wet Scrubbing for West	7,506,000	372,000	12,141,000
S (3), S (8)	E-4 (b) W-4 (a)	Total Separate construction – Bio-filtration for West	8,860,000	358,000	13,321,000
S (3), S (8)	E-4 (b) W-4 (b)	Total Separate construction – Carbon for West	7,506,000	817,000	17,689,000
C	C-1	Centralized System – Wet Scrubbing	7,533,000	497,000	13,726,000
C	C-1 (a)	Centralized System – Bio-filtration	10,311,000	260,000	13,551,000
C	C-1 (b)	Centralized System – Carbon	6,399,000	906,000	17,688,000

Separate systems are recommended for Lincoln because the centralized systems are more expensive and reduced ability to phase the project. Due to the size of the potential project, phasing can be considered for abatement using the following order of priority:

1. East Primary Clarifiers
2. East Aeration Basins
3. Solids Dewatering Building
4. West Primary Clarifiers
5. West Aeration Basins

Since single stage wet scrubbing is assumed (in all cases but the East Primary Clarifiers alone), it is recommended that the sizing allow for the potential future expansion. Some options for a phased approach are as follows:

1. Cover the East Primary Clarifiers (and splitter box) and install 2-stage wet scrubbing with a total parallel capacity of 60,113 cfm (option E-4b). Prior to connecting the exhaust from the East Aeration Basins, the system can operate in series. After the aeration basins are connected, the system can be converted to a parallel system. This includes control for the DAF Building because it is an odor source under calm conditions and its proximity to the proposed ductwork and scrubbers for the east side makes it economically advantageous to control in conjunction with other east side controls.

2. Provide Solids Dewatering Building control. However, if the ventilation within the structure could be modified to allow for a vertical stack above the roof, odors from this source could be minimized. Total control will not be achieved. However, the results could be evaluated once the modification has been made. This would defer control of this source.

CITY OF LINCOLN

THERESA STREET WWTP

ODOR ABATEMENT STUDY

FINAL CALCULATIONS

1.0 FINAL CALCULATIONS

The calculations and tables, dated December 5, 2002, presented in the following pages are updates to the information included in Technical Memorandum No. 1. The tables have been updated based upon the additional sampling and modeling discussed in Technical Memorandum No. 2

LIST OF TABLES

Table 1
Base Data

Lincoln - Theresa Street WWTP

Name of Facility	Lincoln - Theresa Street WWTP	
Date of Run	12/05/02	
Number of Sources	57	
Dilution Series 1	27	7
Dilution Series 2	567	189
Turbulence Factors	None	0.05
Endpoints	Avg	1
Slope Correction	Avg	-0.3
Peaking Factors	Area	10

Light	0.1	Moderate	0.2	High	0.3
Peak	1	5			
Peak	-0.5	Limiting D/T (1)	100	Limiting D/T (2)	500
Point	3	Limiting OER (1)	0.2	Limiting OER (2)	0.5

Sample Type Factors
A,P or V 1 = None 2 = Light 3 = Mod 4 = High

Source Information

Sample #	Sample Location	Date	Time	Sample Type	Factor	Process ID	D/T	Base Sensory Data Dil 3	Dil 2	Dil 1	Dil Series	H2S	Mer	NH3	Source Information Area	cfm	Height
1	Anoxic Zone A-12 - West AB	01/07/02		A	1	AB2	86	43	86	123	1	0.13	0	0	2364		2
2	Zone 2 A-12 - West AB	01/07/02		V		AB3-1	30	30	61	112	1	0.003	0	0	5332	2500	2
3	Zone 4 A-12 - West AB	01/07/02		V		AB5	46	19	30	33	1	0	0	0	2366	2500	2
4	Solids Bldg Exhaust	01/07/02		P		DWBP	213	40	95	147	1	0.25	0	0		22000	8
5	DAF Bldg Exhaust	01/07/02		P		DAFQ	66	16	25	42	1	0.005	0	0		9230	15
6	East Splitter Box w/ Fe	01/08/02		A	4	PRICSP	127	55	134	175	1	0.3	0	0	224		5
7	Primary Clarifier - A-8A Quiescent w/ Fe	01/08/02		A	1	PRIQ	1263	173	355	273	1	3.4	0	0	24531		2
8	Primary Clarifier - A-8A Weir w/ Fe	01/08/02		A	3	PRIW	839	226	505	710	1	12	0	0	3925		2
9	East Aeration Basin A-13 w/Fe	01/08/02		A	4	AB4	58	15	28	42	1	0	0	0	16028	17800	5
10	Main Splitter Box w/Fe	01/08/02		A	4	ISP	88	66	134	745	2	13	0.1	0	342		5
11	Primary Clarifier - A-7C Quiescent	01/08/02		A	1	PRIQ	134	43	65	295	1	1.7	0	0	15708		2
12	Primary Clarifier - A-7C Weir	01/08/02		A	3	PRIW	216	66	145	502	2	17	0	0	1884		2
13	Wet Well - A-3A w/Fe	01/08/02		A	1	WW	325	85	226	419	1	0.14	0	0	740		0
14	Wet Well - A-3A wo/Fe	01/09/02		A	1	WW	112	51	93	122	1	0.49	0	0	740		0
15	West Splitter Box w/o Fe	01/09/02		A	4	PRICSP	97	66	134	654	2	33	0.5	0	224		5
16	Grit #3 - A-6C w/o Fe	01/09/02		V		GR2	31	15	36	191	2	3.2	0	0	4896	1600	5
17	Trickling Filter #8	01/09/02		A	1	TFILT	15	9	13	21	1	0.002	0	0	90432		2
18	Screening Vent w/o Fe	01/09/02		P		SCR	28	21	30	66	1	0.29	0	0		1000	15
19	East Aeration Basin A-13 w/o Fe	01/09/02		A	4	AB4	29	14	21	39	1	0.016	0	0	16028	17800	5
20	Primary Clarifier - A-8A Quiescent w/o Fe	01/10/02		A	1	PRIQ	460	79	135	712	1	2.5	0	0	24531		2
21	Final Clarifier - A-10B - Quiescent w/o Fe	01/10/02		A	1	FINQ	45	16	25	32	1	2.5	0	0	26533		2
22	Final Clarifier - A-10B - Floc Zone w/o Fe	01/10/02		A	1		219	71	162	275	1	0.56	0	0	314		2
23	Digester #1 Vent	01/10/02		P		PRIDV	12	11	36	86	1	0.046	0	10		100	50
24	Total East Primary Clarifiers w/Fe			A			1051	200	430	492	1				28456		2
25	Total West Side Aeration			V			54	31	59	89	1				10062	5000	5
26	Total West Side Primary Clarifiers			A			175	55	105	399	1				17592		2
27	Future Zones 1 and 2 East Side Aeration			A	1	AB3-1	1800	173	355	273	1				5,200		
28	Future Zone 3 East Side Aeration			V		AB4-1	80	43	86	123	1				10,814	12,009	2
29	Future Zone 4 East Side Aeration			V		AB5	30	30	61	112	1				5,214	5,791	2
30	Total Future East Side Aeration			V			637	82	167	169	1				21,228	17,800	
31	18 MGD E. Side Aeration - Zones 1 and 2			A	1	AB3-1	1800	173	355	273	1				7,734		2
32	18 MGD E. Side Aeration - Zone 3			V		AB4-1	80	43	86	123	1				16,222	18,014	2
33	18 MGD E. Side Aeration - Zone 4			V		AB5	30	30	61	112	1				7,822	8,687	2
34	Total 18 MGD Aeration			A			637	82	167	169	1				31,778	26,700	5
35	E. Side Aeration/Modified D/T/12 MGD - Zones 1 and 2			A	1	AB2	86	43	86	123	1				5,200		
36	E. Side Aeration Modified D/T/12 MGD - Zone 3					AB3-1	30	30	61	112	1				10,814	8,489	2
37	E. Side Aeration Modified D/T/12 MGD - Zone 4					AB5	46	19	30	33	1				5,214	4,093	2
38	Total East Side Aeration Modified D/T/12 MGD						54	31	59	89	1				21,228	12,582	
39	E. Side Aeration/Modified D/T/18 MGD - Zones 1 and 2			A	1	AB2	86	43	86	123	1				7,734		2
40	E. Side Aeration/Modified D/T/18 MGD - Zone 3					AB3-1	30	30	61	112	1				16,222	12,734	2
41	E. Side Aeration/Modified D/T/18 MGD - Zone 4					AB5	46	19	30	33	1				7,822	6,140	2
42	Total East Side Aeration/Modified D/T/18 MGD						54	31	59	89	1				31,778	18,874	5
43	Center Aeration System			V			54	31	59	89.3	1				10,062	5000	5
44	Combined Aeration Systems/Existing D/T/12 MGD			A			248	48	95	116	1				41,352	27,800	5
45	Combined Aeration Systems/Existing D/T/18 MGD			A			248	48	95	116	1				51,902	36,700	5
46	Combined Aeration Systems/Modified D/T/12 MGD						54	31	59	89.3	1				41,352	22,582	5
47	Combined Aeration Systems/Modified D/T/18 MGD						54	31	59	89.3	1				36,013	28,874	5
48	East Side Primary Clarifiers Quiescent - Modified D/T			A			134	43	65	295	1				24,531		
49	East Side Primary Clarifiers Weir - Modified D/T						216	66	145	502	1				3,925		
50	Total East Side Primary Clarifiers - Modified D/T			A			175	55	105	399	1				28,456		
51	East Splitter (1) (RE)	10/16/02		A	4	PRICSP	2900			150		2			224		5
52	East Splitter (2) (RE)	10/17/02		A	4	PRICSP	3400			170		4.2			224		5
53	Primary Clarifier A-8A (Q) (1) (RE)	10/16/02		A	1	PRIQ	490			170		2.4			24531		2
54	Primary Clarifier A-8A (Q) (2) (RE)	10/17/02		A	1	PRIQ	670			140		1.4			24531		2
55	East Aeration - Zone 1 (RE)	10/16/02		V		AB4	50			75		0.004			16028	17800	5
56	Primary Clarifier A-8A (W) (RE)			A	3	PRIW	1072			442					3925		2
57	Total East Side Primary + Splitter (RE)			A			871			291					28456		2

Table 2
Sensory Data

Lincoln - Theresa Street WWTP

Sample #	Sample Type	Sample Location	D/T	Dilutions				Dose -Response Data							
								Logs							
												m	b	r	Test
1	A	Anoxic Zone A-12 - West AB	86	43	86	123	1.6335	1.9345	2.0899	1.9345	-0.2359	2.0650	-0.959	Okay
2	V	Zone 2 A-12 - West AB	30	30	61	112	1.4771	1.7853	2.0492	1.4771	-0.3873	2.0645	-0.989	Okay
3	V	Zone 4 A-12 - West AB	46	19	30	33	1.2788	1.4771	1.5185	1.6628	-0.1442	1.5342	-0.894	Check
4	P	Solids Bldg Exhaust	213	40	95	147	1.6021	1.9777	2.1673	2.3284	-0.2428	2.0999	-0.958	Okay
5	P	DAF Bldg Exhaust	66	16	25	42	1.2041	1.3979	1.6232	1.8195	-0.2303	1.5832	-0.998	Okay
6	A	East Splitter Box w/ Fe	127	55	134	175	1.7404	2.1271	2.2430	2.1038	-0.2389	2.2181	-0.919	Okay
7	A	Primary Clarifier - A-8A Quiescent w/ Fe	1263	173	355	273	2.2380	2.5502	2.4362	3.1014	-0.0639	2.4566	-0.543	Check
8	A	Primary Clarifier - A-8A Weir w/ Fe	839	226	505	710	2.3541	2.7033	2.8513	2.9238	-0.1700	2.7652	-0.945	Okay
9	A	East Aeration Basin A-13 w/Fe	58	15	28	42	1.1761	1.4472	1.6232	1.7634	-0.2536	1.6079	-0.975	Okay
10	A	Main Splitter Box w/Fe	88	66	134	745	1.8195	2.1271	2.8722	1.9445	-0.5413	3.1806	-0.992	Okay
11	A	Primary Clarifier - A-7C Quiescent	134	43	65	295	1.6335	1.8129	2.4698	2.1271	-0.3932	2.2704	-0.977	Okay
12	A	Primary Clarifier - A-7C Weir	216	66	145	502	1.8195	2.1614	2.7007	2.3345	-0.3775	2.8601	-0.973	Okay
13	A	Wet Well - A-3A w/Fe	325	85	226	419	1.9294	2.3541	2.6222	2.5119	-0.2758	2.5112	-0.973	Okay
14	A	Wet Well - A-3A wo/Fe	112	51	93	122	1.7076	1.9685	2.0864	2.0492	-0.1848	2.0611	-0.95	Okay
15	A	West Splitter Box w/o Fe	97	66	134	654	1.8195	2.1271	2.8156	1.9868	-0.5013	3.0947	-0.99	Okay
16	V	Grit #3 - A-6C w/o Fe	31	15	36	191	1.1761	1.5563	2.2810	1.4914	-0.7409	2.9134	-0.983	Okay
17	A	Trickling Filter #8	15	9	13	21	0.9542	1.1139	1.3222	1.1761	-0.3129	1.3676	-1	Okay
18	P	Screening Vent w/o Fe	28	21	30	66	1.3222	1.4771	1.8195	1.4472	-0.3437	1.8004	-0.994	Okay
19	A	East Aeration Basin A-13 w/o Fe	29	14	21	39	1.1461	1.3222	1.5911	1.4624	-0.3043	1.5840	-1	Okay
20	A	Primary Clarifier - A-8A Quiescent w/o Fe	460	79	135	712	1.8976	2.1303	2.8525	2.6628	-0.3586	2.5656	-0.983	Okay
21	A	Final Clarifier - A-10B - Quiescent w/o Fe	45	16	25	32	1.2041	1.3979	1.5051	1.6532	-0.1821	1.5072	-0.964	Okay
22	A	Final Clarifier - A-10B - Floc Zone w/o Fe	219	71	162	275	1.8513	2.2095	2.4393	2.3404	-0.2513	2.3574	-0.974	Okay
23	P	Digester #1 Vent	12	11	36	86	1.0414	1.5563	1.9345	1.0792	-0.8276	2.1387	-0.982	Okay
24	A	Total East Primary Clarifiers w/Fe	1051	200	430	492	2.2999	2.6335	2.6915	3.0216	-0.1296	2.6400	-0.882	Check
25	V	Total West Side Aeration	54	31	59	89	1.4867	1.7709	1.9510	1.7324	-0.2680	1.9396	-0.973	Okay
26	A	Total West Side Primary Clarifiers	175	54.5	105	398.5	1.7364	2.0212	2.6004	2.2430	-0.3852	2.4116	-0.996	Okay
27	A	Future Zones 1 and 2 East Side Aeration	1800	173	355	273	2.2380	2.5502	2.4362	3.2553	-0.0609	2.4543	-0.543	Check
28	V	Future Zone 3 East Side Aeration	80	43	86	123	1.6335	1.9345	2.0899	1.9031	-0.2398	2.0680	-0.959	Okay
29	V	Future Zone 4 East Side Aeration	30	30	61	112	1.4771	1.7853	2.0492	1.4771	-0.3873	2.0645	-0.989	Okay
30	V	Total Future East Side Aeration	636.7	82	167	169	1.9138	2.2236	2.2287	2.8039	-0.1123	2.2073	-0.818	Check
31	A	18 MGD E. Side Aeration - Zones 1 and 2	1800	173	355	273	2.2380	2.5502	2.4362	3.2553	-0.0609	2.4543	-0.543	Check
32	V	18 MGD E. Side Aeration - Zone 3	80	43	86	123	1.6335	1.9345	2.0899	1.9031	-0.2398	2.0680	-0.959	Okay
33	V	18 MGD E. Side Aeration - Zone 4	30	30	61	112	1.4771	1.7853	2.0492	1.4771	-0.3873	2.0645	-0.989	Okay
34	A	Total 18 MGD Aeration	636.7	82	167	169	1.9138	2.2236	2.2287	2.8039	-0.1123	2.2073	-0.818	Check
35	A	Side Aeration/Modified D/T/12 MGD - Zones 1 and	86	43	86	123	1.6335	1.9345	2.0899	1.9345	-0.2359	2.0650	-0.959	Okay
36		E. Side Aeration Modified D/T/12 MGD - Zone 3	30	30	61	112	1.4771	1.7853	2.0492	1.4771	-0.3873	2.0645	-0.989	Okay
37		E. Side Aeration Modified D/T/12 MGD - Zone 4	46	19	30	33	1.2788	1.4771	1.5185	1.6628	-0.1442	1.5342	-0.894	Check
38		Total East Side Aeration Modified D/T/12 MGD	54	31	59	89	1.4867	1.7709	1.9510	1.7324	-0.2680	1.9396	-0.973	Okay
39	A	Side Aeration/Modified D/T/18 MGD - Zones 1 and	86	43	86	123	1.6335	1.9345	2.0899	1.9345	-0.2359	2.0650	-0.959	Okay
40		E. Side Aeration/Modified D/T/18 MGD - Zone 3	30	30	61	112	1.4771	1.7853	2.0492	1.4771	-0.3873	2.0645	-0.989	Okay
41		E. Side Aeration/Modified D/T/18 MGD - Zone 4	46	19	30	33	1.2788	1.4771	1.5185	1.6628	-0.1442	1.5342	-0.894	Check
42		Total East Side Aeration/Modified D/T/18 MGD	54	31	59	89	1.4867	1.7709	1.9510	1.7324	-0.2680	1.9396	-0.973	Okay
43	V	Center Aeration System	54	31	59	89	1.4867	1.7709	1.9510	1.7324	-0.2680	1.9396	-0.973	Okay
44	A	Combined Aeration Systems/Existing D/T/12 MGD	248.2	48	95	116	1.6792	1.9782	2.0645	2.3948	-0.1609	2.0294	-0.916	Okay
45	A	Combined Aeration Systems/Existing D/T/18 MGD	248.2	48	95	116	1.6792	1.9782	2.0645	2.3948	-0.1609	2.0294	-0.916	Okay
46		Combined Aeration Systems/Modified D/T/12 MGD	54	31	59	89	1.4867	1.7709	1.9510	1.7324	-0.2680	1.9396	-0.973	Okay
47		Combined Aeration Systems/Modified D/T/18 MGD	54	31	59	89	1.4867	1.7709	1.9510	1.7324	-0.2680	1.9396	-0.973	Okay
48	A	East Side Primary Clarifiers Quiescent - Modified D/T	134	43	65	295	1.6335	1.8129	2.4698	2.1271	-0.3932	2.2704	-0.977	Okay
49		East Side Primary Clarifiers Weir - Modified D/T	216	66	145	502	1.8195	2.1614	2.7007	2.3345	-0.3775	2.5136	-1	Okay
50	A	Total East Side Primary Clarifiers - Modified D/T	175	54.5	105	398.5	1.7364	2.0212	2.6004	2.2430	-0.3852	2.4116	-0.996	Okay
51	A	East Splitter (1) (RE)	2900			150			2.1761	3.4624	-0.5200			
52	A	East Splitter (2) (RE)	3400			170			2.2304	3.5315	-0.5200			
53	A	Primary Clarifier A-8A (Q) (1) (RE)	490			170			2.2304	2.6902	-0.4200			
54	A	Primary Clarifier A-8A (Q) (2) (RE)	670			140			2.1461	2.8261	-0.5200			
55	V	East Aeration - Zone 1 (RE)	50			75			1.8751	1.6990	-0.6200			
56	A	Primary Clarifier A-8A (W) (RE)	1072			442			2.6454	3.0302	-0.5200			
57	A	Total East Side Primary + Splitter (RE)	871			291					-0.5200			

Table 3
Exhaust Rates

Lincoln - Theresa Street WWTP

Sample #	Sample Location	Sample Type	Area (ft^2)	Area (m^2)	Total Exhaust Rate (ft^3/min)	Total Exhaust Rate (m3/sec)	Unit Exhaust Rate (ft3/min/ft2)	Unit Exhaust Rate (m3/sec/m2)
1	Anoxic Zone A-12 - West AB	A	2364	219.62	118.20	0.06	0.050	0.0003
2	Zone 2 A-12 - West AB	V	5332	495.34	2500.00	1.18	0.469	0.0024
3	Zone 4 A-12 - West AB	V	2366	219.80	2500.00	1.18	1.057	0.0054
4	Solids Bldg Exhaust	P			22000.00	10.38	Point	Point
5	DAF Bldg Exhaust	P			9230.00	4.36	Point	Point
6	East Splitter Box w/ Fe	A	224	20.81	67.20	0.03	0.300	0.0015
7	Primary Clarifier - A-8A Quiescent w/ Fe	A	24531	2278.93	1226.55	0.58	0.050	0.0003
8	Primary Clarifier - A-8A Weir w/ Fe	A	3925	364.63	785.00	0.37	0.200	0.0010
9	East Aeration Basin A-13 w/Fe	A	16028	1489.00	4808.40	2.27	0.300	0.0015
10	Main Splitter Box w/Fe	A	342	31.77	102.60	0.05	0.300	0.0015
11	Primary Clarifier - A-7C Quiescent	A	15708	1459.27	785.40	0.37	0.050	0.0003
12	Primary Clarifier - A-7C Weir	A	1884	175.02	376.80	0.18	0.200	0.0010
13	Wet Well - A-3A w/Fe	A	740	68.75	37.00	0.02	0.050	0.0003
14	Wet Well - A-3A wo/Fe	A	740	68.75	37.00	0.02	0.050	0.0003
15	West Splitter Box w/o Fe	A	224	20.81	67.20	0.03	0.300	0.0015
16	Grit #3 - A-6C w/o Fe	V	4896	454.84	1600.00	0.76	0.327	0.0017
17	Trickling Filter #8	A	90432	8401.13	4521.60	2.13	0.050	0.0003
18	Screening Vent w/o Fe	P			1000.00	0.47	Point	Point
19	East Aeration Basin A-13 w/o Fe	A	16028	1489.00	4808.40	2.27	0.300	0.0015
20	Primary Clarifier - A-8A Quiescent w/o Fe	A	24531	2278.93	1226.55	0.58	0.050	0.0003
21	Final Clarifier - A-10B - Quiescent w/o Fe	A	26533	2464.92	1326.65	0.63	0.050	0.0003
22	Final Clarifier - A-10B - Floc Zone w/o Fe	A	314	29.17	15.70	0.01	0.050	0.0003
23	Digester #1 Vent	P			100.00	0.05	Point	Point
24	Total East Primary Clarifiers w/Fe	A	28456	2643.56	8536.80	4.03	0.300	0.0015
25	Total West Side Aeration	V	10062	934.76	5000.00	2.36	0.497	0.0025
26	Total West Side Primary Clarifiers	A	17592	1634.30	5277.60	2.49	0.300	0.0015
27	Future Zones 1 and 2 East Side Aeration	A	5200	483.08	260.00	0.12	0.050	0.0003
28	Future Zone 3 East Side Aeration	V	10814	1004.62	12009.00	5.67	1.111	0.0056
29	Future Zone 4 East Side Aeration	V	5214	484.38	5791.00	2.73	1.111	0.0056
30	Total Future East Side Aeration	V	21228	1972.08	18060.00	8.52	0.851	0.0043
31	18 MGD E. Side Aeration - Zones 1 and 2	A	7734	718.49	386.70	0.18	0.050	0.0003
32	18 MGD E. Side Aeration - Zone 3	V	16222	1507.02	18013.50	8.50	1.110	0.0056
33	18 MGD E. Side Aeration - Zone 4	V	7822	726.66	8686.50	4.10	1.111	0.0056
34	Total 18 MGD Aeration	A	31778	2952.18	9533.40	4.50	0.300	0.0015
35	E. Side Aeration/Modified D/T/12 MGD - Zones 1 and 2	A	5200	483.08	260.00	0.12	0.050	0.0003
36	E. Side Aeration Modified D/T/12 MGD - Zone 3		10814	1004.62	3244.20	1.53	0.300	0.0015
37	E. Side Aeration Modified D/T/12 MGD - Zone 4		5214	484.38	1564.20	0.74	0.300	0.0015
38	Total East Side Aeration Modified D/T/12 MGD		21228	1972.08	6368.40	3.01	0.300	0.0015
39	E. Side Aeration/Modified D/T/18 MGD - Zones 1 and 2	A	7734	718.49	386.70	0.18	0.050	0.0003
40	E. Side Aeration/Modified D/T/18 MGD - Zone 3		16222	1507.02	4866.60	2.30	0.300	0.0015
41	E. Side Aeration/Modified D/T/18 MGD - Zone 4		7822	726.66	2346.60	1.11	0.300	0.0015
42	Total East Side Aeration/Modified D/T/18 MGD		31778	2952.18	9533.40	4.50	0.300	0.0015
43	Center Aeration System	V	10062	934.76	5000.00	2.36	0.497	0.0025
44	Combined Aeration Systems/Existing D/T/12 MGD	A	41352	3841.60	12405.60	5.86	0.300	0.0015
45	Combined Aeration Systems/Existing D/T/18 MGD	A	51902	4821.70	15570.60	7.35	0.300	0.0015
46	Combined Aeration Systems/Modified D/T/12 MGD		41352	3841.60	12405.60	5.86	0.300	0.0015
47	Combined Aeration Systems/Modified D/T/18 MGD		36013	3345.61	10803.90	5.10	0.300	0.0015
48	East Side Primary Clarifiers Quiescent - Modified D/T	A	24531	2278.93	7359.30	3.47	0.300	0.0015
49	East Side Primary Clarifiers Weir - Modified D/T		3925	364.63	1177.50	0.56	0.300	0.0015
50	Total East Side Primary Clarifiers - Modified D/T	A	28456	2643.56	8536.80	4.03	0.300	0.0015
51	East Splitter (1) (RE)	A	224	20.81	67.20	0.03	0.300	0.0015
52	East Splitter (2) (RE)	A	224	20.81	67.20	0.03	0.300	0.0015
53	Primary Clarifier A-8A (Q) (1) (RE)	A	24531	2278.93	1226.55	0.58	0.050	0.0003
54	Primary Clarifier A-8A (Q) (2) (RE)	A	24531	2278.93	1226.55	0.58	0.050	0.0003
55	East Aeration - Zone 1 (RE)	V	16028	1489.00	17800.00	8.40	1.111	0.0056
56	Primary Clarifier A-8A (W) (RE)	A	3925	364.63	785.00	0.37	0.200	0.0010
57	Total East Side Primary + Splitter (RE)	A	28456	2643.56	8536.80	4.03	0.300	0.0015

Table 4
Odor Emission Rates

Lincoln - Theresa Street WWTP

Sample #	Sample Location	Odor Emission Rate ($O.U.-ft^3/min \times 10^6$)	Odor Emission Rate ($O.U.-m^3/sec$)	Butanol Odor Emission Rate (gr/sec)
1	Anoxic Zone A-12 - West AB	0 01017	4.8	0 0
2	Zone 2 A-12 - West AB	0 07500	35 4	0 4
3	Zone 4 A-12 - West AB	0 11500	54.3	0 1
4	Solids Bldg Exhaust	4 68600	2211.8	4 6
5	DAF Bldg Exhaust	0 60918	287.5	0 6
6	East Splitter Box w/ Fe	0 00853	4.0	0 0
7	Primary Clarifier - A-8A Quiescent w/ Fe	1 54913	731 2	0 5
8	Primary Clarifier - A-8A Weir w/ Fe	0 65862	310 9	0 8
9	East Aeration Basin A-13 w/Fe	0 27889	131.6	0 3
10	Main Splitter Box w/Fe	0 00903	4.3	0 1
11	Primary Clarifier - A-7C Quiescent	0 10524	49 7	0 3
12	Primary Clarifier - A-7C Weir	0 08139	38.4	0 3
13	Wet Well - A-3A w/Fe	0 01203	5 7	0 0
14	Wet Well - A-3A wo/Fe	0.00414	2 0	0 0
15	West Splitter Box w/o Fe	0 00652	3.1	0 1
16	Grit #3 - A-6C w/o Fe	0 04960	23.4	0 4
17	Trickling Filter #8	0 06782	32 0	0 1
18	Screening Vent w/o Fe	0 02800	13 2	0 1
19	East Aeration Basin A-13 w/o Fe	0 13944	65 8	0 3
20	Primary Clarifier - A-8A Quiescent w/o Fe	0 56421	266.3	1 2
21	Final Clarifier - A-10B - Quiescent w/o Fe	0 05970	28.2	0 1
22	Final Clarifier - A-10B - Floc Zone w/o Fe	0 00344	1 6	0 0
23	Digester #1 Vent	0 00120	0.6	0 0
24	Total East Primary Clarifiers w/Fe	2 20775	1042.1	6.0
25	Total West Side Aeration	0 20017	94 5	0 6
26	Total West Side Primary Clarifiers	0 18663	88.1	3 0
27	Future Zones 1 and 2 East Side Aeration	0.46800	220 9	0 1
28	Future Zone 3 East Side Aeration	0 96072	453.5	2 1
29	Future Zone 4 East Side Aeration	0 17373	82.0	0 9
30	Total Future East Side Aeration	1 60245	756 4	3 1
31	18 MGD E. Side Aeration - Zones 1 and 2	0.69606	328 5	0 2
32	18 MGD E Side Aeration - Zone 3	1 44108	680 2	3 2
33	18 MGD E Side Aeration - Zone 4	0 26060	123 0	1 4
34	Total 18 MGD Aeration	2 39774	1131.7	2 3
35	Side Aeration/Modified D/T/12 MGD - Zones 1 an	0 02236	10 6	0 0
36	E Side Aeration Modified D/T/12 MGD - Zone 3	0.09733	45 9	0 5
37	E. Side Aeration Modified D/T/12 MGD - Zone 4	0 07195	34 0	0 1
38	Total East Side Aeration Modified D/T/12 MGD	0 19164	90.5	0 8
39	Side Aeration/Modified D/T/18 MGD - Zones 1 an	0 03326	15 7	0 1
40	E Side Aeration/Modified D/T/18 MGD - Zone 3	0 14600	68 9	0 8
41	E. Side Aeration/Modified D/T/18 MGD - Zone 4	0 10794	50.9	0 1
42	Total East Side Aeration/Modified D/T/18 MGD	0 28720	135 6	1 2
43	Center Aeration System	0 20017	127.4	0 6
44	Combined Aeration Systems/Existing D/T/12 MGD	2 00278	978.3	4 4
45	Combined Aeration Systems/Existing D/T/18 MGD	2 79807	1353 6	3 6
46	Combined Aeration Systems/Modified D/T/12 MGI	0 59197	312 4	2 1
47	Combined Aeration Systems/Modified D/T/18 MGI	0.68753	357 5	2 5
48	East Side Primary Clarifiers Quiescent - Modified D/	0.98615	465 5	3 1
49	East Side Primary Clarifiers Weir - Modified D/T	0 25434	120 0	0 8
50	Total East Side Primary Clarifiers - Modified D/T	1 24049	585.5	3 9
51	East Splitter (1) (RE)	0 19488	92.0	0 0
52	East Splitter (2) (RE)	0 22848	107 8	0 0
53	Primary Clarifier A-8A (Q) (1) (RE)	0 60101	283 7	0 3
54	Primary Clarifier A-8A (Q) (2) (RE)	0 82179	387.9	0.2
55	East Aeration - Zone 1 (RE)	0 89000	420.1	1 9
56	Primary Clarifier A-8A (W) (RE)	0.84152	397 2	0 5
57	Total East Side Primary + Splitter (RE)	1 66331	785 1	0 7

Table 5
D/T Sort

Lincoln - Theresa Street WWTP

Sample #	Sample Location	D/T	Rank	Sample #	Sample Location	D/T	Rank
1	Anoxic Zone A-12 - West AB	86	30	52	East Splitter (2) (RE)	3400	1
2	Zone 2 A-12 - West AB	30	49	51	East Splitter (1) (RE)	2900	2
3	Zone 4 A-12 - West AB	46	44	27	Future Zones 1 and 2 East Side Aeration	1800	3
4	Solids Bldg Exhaust	213	21	31	18 MGD E. Side Aeration - Zones 1 and 2	1800	4
5	DAF Bldg Exhaust	66	35	7	Primary Clarifier - A-8A Quiescent w/ Fe	1263	5
6	East Splitter Box w/ Fe	127	26	56	Primary Clarifier A-8A (W) (RE)	1072	6
7	Primary Clarifier - A-8A Quiescent w/ Fe	1263	5	24	Total East Primary Clarifiers w/Fe	1051	7
8	Primary Clarifier - A-8A Weir w/ Fe	839	9	57	Total East Side Primary + Splitter (RE)	871	8
9	East Aeration Basin A-13 w/Fe	58	36	8	Primary Clarifier - A-8A Weir w/ Fe	839	9
10	Main Splitter Box w/Fe	88	29	54	Primary Clarifier A-8A (Q) (2) (RE)	670	10
11	Primary Clarifier - A-7C Quiescent	134	24	30	Total Future East Side Aeration	638	11
12	Primary Clarifier - A-7C Weir	216	19	34	Total 18 MGD Aeration	637	12
13	Wet Well - A-3A w/Fe	325	15	53	Primary Clarifier A-8A (Q) (1) (RE)	490	13
14	Wet Well - A-3A wo/Fe	112	27	20	Primary Clarifier - A-8A Quiescent w/o Fe	460	14
15	West Splitter Box w/o Fe	97	28	13	Wet Well - A-3A w/Fe	325	15
16	Grit #3 - A-6C w/o Fe	31	48	45	Combined Aeration Systems/Existing D/T/18 MGI	250	16
17	Trickling Filter #8	15	56	44	Combined Aeration Systems/Existing D/T/12 MGI	248	17
18	Screening Vent w/o Fe	28	55	22	Final Clarifier - A-10B - Floc Zone w/o Fe	219	18
19	East Aeration Basin A-13 w/o Fe	29	54	12	Primary Clarifier - A-7C Weir	216	19
20	Primary Clarifier - A-8A Quiescent w/o Fe	460	14	49	East Side Primary Clarifiers Weir - Modified D/T	216	20
21	Final Clarifier - A-10B - Quiescent w/o Fe	45	47	4	Solids Bldg Exhaust	213	21
22	Final Clarifier - A-10B - Floc Zone w/o Fe	219	18	26	Total West Side Primary Clarifiers	175	22
23	Digester #1 Vent	12	57	50	Total East Side Primary Clarifiers - Modified D/T	175	23
24	Total East Primary Clarifiers w/Fe	1051	7	11	Primary Clarifier - A-7C Quiescent	134	24
25	Total West Side Aeration	54	38	48	East Side Primary Clarifiers Quiescent - Modified D/	134	25
26	Total West Side Primary Clarifiers	175	22	6	East Splitter Box w/ Fe	127	26
27	Future Zones 1 and 2 East Side Aeration	1800	3	14	Wet Well - A-3A wo/Fe	112	27
28	Future Zone 3 East Side Aeration	80	33	15	West Splitter Box w/o Fe	97	28
29	Future Zone 4 East Side Aeration	30	50	10	Main Splitter Box w/Fe	88	29
30	Total Future East Side Aeration	638	11	1	Anoxic Zone A-12 - West AB	86	30
31	18 MGD E. Side Aeration - Zones 1 and 2	1800	4	35	Side Aeration/Modified D/T/12 MGD - Zones 1 an	86	31
32	18 MGD E. Side Aeration - Zone 3	80	34	39	Side Aeration/Modified D/T/18 MGD - Zones 1 an	86	32
33	18 MGD E. Side Aeration - Zone 4	30	51	28	Future Zone 3 East Side Aeration	80	33
34	Total 18 MGD Aeration	637	12	32	18 MGD E. Side Aeration - Zone 3	80	34
35	E. Side Aeration/Modified D/T/12 MGD - Zones 1 and	86	31	5	DAF Bldg Exhaust	66	35
36	E. Side Aeration Modified D/T/12 MGD - Zone 3	30	52	9	East Aeration Basin A-13 w/Fe	58	36
37	E. Side Aeration Modified D/T/12 MGD - Zone 4	46	45	47	Combined Aeration Systems/Modified D/T/18 MGI	55	37
38	Total East Side Aeration Modified D/T/12 MGD	54	39	25	Total West Side Aeration	54	38
39	E. Side Aeration/Modified D/T/18 MGD - Zones 1 and	86	32	38	Total East Side Aeration Modified D/T/12 MGD	54	39

Table 5
D/T Sort

40	E. Side Aeration/Modified D/T/18 MGD - Zone 3	30	53	42	Total East Side Aeration/Modified D/T/18 MGD	54	40
41	E. Side Aeration/Modified D/T/18 MGD - Zone 4	46	46	43	Center Aeration System	54	41
42	Total East Side Aeration/Modified D/T/18 MGD	54	40	46	Combined Aeration Systems/Modified D/T/12 MGI	54	42
43	Center Aeration System	54	41	55	East Aeration - Zone 1 (RE)	50	43
44	Combined Aeration Systems/Existing D/T/12 MGD	248	17	3	Zone 4 A-12 - West AB	46	44
45	Combined Aeration Systems/Existing D/T/18 MGD	250	16	37	E. Side Aeration Modified D/T/12 MGD - Zone 4	46	45
46	Combined Aeration Systems/Modified D/T/12 MGD	54	42	41	E. Side Aeration/Modified D/T/18 MGD - Zone 4	46	46
47	Combined Aeration Systems/Modified D/T/18 MGD	55	37	21	Final Clarifier - A-10B - Quiescent w/o Fe	45	47
48	East Side Primary Clarifiers Quiescent - Modified D/T	134	25	16	Grit #3 - A-6C w/o Fe	31	48
49	East Side Primary Clarifiers Weir - Modified D/T	216	20	2	Zone 2 A-12 - West AB	30	49
50	Total East Side Primary Clarifiers - Modified D/T	175	23	29	Future Zone 4 East Side Aeration	30	50
51	East Splitter (1) (RE)	2900	2	33	18 MGD E. Side Aeration - Zone 4	30	51
52	East Splitter (2) (RE)	3400	1	36	E. Side Aeration Modified D/T/12 MGD - Zone 3	30	52
53	Primary Clarifier A-8A (Q) (1) (RE)	490	13	40	E. Side Aeration/Modified D/T/18 MGD - Zone 3	30	53
54	Primary Clarifier A-8A (Q) (2) (RE)	670	10	19	East Aeration Basin A-13 w/o Fe	29	54
55	East Aeration - Zone 1 (RE)	50	43	18	Screening Vent w/o Fe	28	55
56	Primary Clarifier A-8A (W) (RE)	1072	6	17	Trickling Filter #8	15	56
57	Total East Side Primary + Splitter (RE)	871	8	23	Digester #1 Vent	12	57

Table 6
OER Sort

Lincoln - Theresa Street WWTP

Sample #	Sample Location	OER	Rank	Sample #	Sample Location	OER	Rank
1	Anoxic Zone A-12 - West AB	0.01017	51	4	Solids Bldg Exhaust	4.686	1
2	Zone 2 A-12 - West AB	0.07500	42	45	Combined Aeration Systems/Existing D/T/18 MGD	2.798	2
3	Zone 4 A-12 - West AB	0.11500	37	34	Total 18 MGD Aeration	2.398	3
4	Solids Bldg Exhaust	4.68600	1	24	Total East Primary Clarifiers w/Fe	2.208	4
5	DAF Bldg Exhaust	0.60918	19	44	Combined Aeration Systems/Existing D/T/12 MGD	2.003	5
6	East Splitter Box w/ Fe	0.00853	53	57	Total East Side Primary + Splitter (RE)	1.663	6
7	Primary Clarifier - A-8A Quiescent w/ Fe	1.54913	8	30	Total Future East Side Aeration	1.602	7
8	Primary Clarifier - A-8A Weir w/ Fe	0.65862	18	7	Primary Clarifier - A-8A Quiescent w/ Fe	1.549	8
9	East Aeration Basin A-13 w/Fe	0.27889	25	32	18 MGD E. Side Aeration - Zone 3	1.441	9
10	Main Splitter Box w/Fe	0.00903	52	50	Total East Side Primary Clarifiers - Modified D/T	1.240	10
11	Primary Clarifier - A-7C Quiescent	0.10524	39	48	East Side Primary Clarifiers Quiescent - Modified D/T	0.986	11
12	Primary Clarifier - A-7C Weir	0.08139	41	28	Future Zone 3 East Side Aeration	0.961	12
13	Wet Well - A-3A w/Fe	0.01203	50	55	East Aeration - Zone 1 (RE)	0.890	13
14	Wet Well - A-3A wo/Fe	0.00414	55	56	Primary Clarifier A-8A (W) (RE)	0.842	14
15	West Splitter Box w/o Fe	0.00652	54	54	Primary Clarifier A-8A (Q) (2) (RE)	0.822	15
16	Grit #3 - A-6C w/o Fe	0.04960	46	31	18 MGD E. Side Aeration - Zones 1 and 2	0.696	16
17	Trickling Filter #8	0.06782	44	47	Combined Aeration Systems/Modified D/T/18 MGD	0.688	17
18	Screening Vent w/o Fe	0.02800	48	8	Primary Clarifier - A-8A Weir w/ Fe	0.659	18
19	East Aeration Basin A-13 w/o Fe	0.13944	36	5	DAF Bldg Exhaust	0.609	19
20	Primary Clarifier - A-8A Quiescent w/o Fe	0.56421	22	53	Primary Clarifier A-8A (Q) (1) (RE)	0.601	20
21	Final Clarifier - A-10B - Quiescent w/o Fe	0.05970	45	46	Combined Aeration Systems/Modified D/T/12 MGD	0.592	21
22	Final Clarifier - A-10B - Floc Zone w/o Fe	0.00344	56	20	Primary Clarifier - A-8A Quiescent w/o Fe	0.564	22
23	Digester #1 Vent	0.00120	57	27	Future Zones 1 and 2 East Side Aeration	0.468	23
24	Total East Primary Clarifiers w/Fe	2.20775	4	42	Total East Side Aeration/Modified D/T/18 MGD	0.287	24
25	Total West Side Aeration	0.20017	29	9	East Aeration Basin A-13 w/Fe	0.279	25
26	Total West Side Primary Clarifiers	0.18663	33	33	18 MGD E. Side Aeration - Zone 4	0.261	26
27	Future Zones 1 and 2 East Side Aeration	0.46800	23	49	East Side Primary Clarifiers Weir - Modified D/T	0.254	27
28	Future Zone 3 East Side Aeration	0.96072	12	52	East Splitter (2) (RE)	0.228	28
29	Future Zone 4 East Side Aeration	0.17373	34	25	Total West Side Aeration	0.200	29
30	Total Future East Side Aeration	1.60245	7	43	Center Aeration System	0.200	30
31	18 MGD E. Side Aeration - Zones 1 and 2	0.69606	16	51	East Splitter (1) (RE)	0.195	31
32	18 MGD E. Side Aeration - Zone 3	1.44108	9	38	Total East Side Aeration Modified D/T/12 MGD	0.192	32
33	18 MGD E. Side Aeration - Zone 4	0.26060	26	26	Total West Side Primary Clarifiers	0.187	33
34	Total 18 MGD Aeration	2.39774	3	29	Future Zone 4 East Side Aeration	0.174	34
35	E. Side Aeration/Modified D/T/12 MGD - Zones 1 and	0.02236	49	40	E. Side Aeration/Modified D/T/18 MGD - Zone 3	0.146	35
36	E. Side Aeration Modified D/T/12 MGD - Zone 3	0.09733	40	19	East Aeration Basin A-13 w/o Fe	0.139	36
37	E. Side Aeration Modified D/T/12 MGD - Zone 4	0.07195	43	3	Zone 4 A-12 - West AB	0.115	37
38	Total East Side Aeration Modified D/T/12 MGD	0.19164	32	41	E. Side Aeration/Modified D/T/18 MGD - Zone 4	0.108	38

Table 6
OER Sort

39	E. Side Aeration/Modified D/T/18 MGD - Zones 1 and 2	0.03326	47	11
40	E. Side Aeration/Modified D/T/18 MGD - Zone 3	0.14600	35	36
41	E. Side Aeration/Modified D/T/18 MGD - Zone 4	0.10794	38	12
42	Total East Side Aeration/Modified D/T/18 MGD	0.28720	24	2
43	Center Aeration System	0.20017	30	37
44	Combined Aeration Systems/Existing D/T/12 MGD	2.00278	5	17
45	Combined Aeration Systems/Existing D/T/18 MGD	2.79807	2	21
46	Combined Aeration Systems/Modified D/T/12 MGD	0.59197	21	16
47	Combined Aeration Systems/Modified D/T/18 MGD	0.68753	17	39
48	East Side Primary Clarifiers Quiescent - Modified D/T	0.98615	11	18
49	East Side Primary Clarifiers Weir - Modified D/T	0.25434	27	35
50	Total East Side Primary Clarifiers - Modified D/T	1.24049	10	13
51	East Splitter (1) (RE)	0.19488	31	1
52	East Splitter (2) (RE)	0.22848	28	10
53	Primary Clarifier A-8A (Q) (1) (RE)	0.60101	20	6
54	Primary Clarifier A-8A (Q) (2) (RE)	0.82179	15	15
55	East Aeration - Zone 1 (RE)	0.89000	13	14
56	Primary Clarifier A-8A (W) (RE)	0.84152	14	22
57	Total East Side Primary + Splitter (RE)	1.66331	6	23

	Primary Clarifier - A-7C Quiescent	0.105	39	
	E. Side Aeration Modified D/T/12 MGD - Zone 3	0.097	40	
	Primary Clarifier - A-7C Weir	0.081	41	
	Zone 2 A-12 - West AB	0.075	42	
	E. Side Aeration Modified D/T/12 MGD - Zone 4	0.072	43	
	Trickling Filter #8	0.068	44	
	Final Clarifier - A-10B - Quiescent w/o Fe	0.060	45	
	Grit #3 - A-6C w/o Fe	0.050	46	
	E. Side Aeration/Modified D/T/18 MGD - Zones 1 and 2	0.033	47	
	Screening Vent w/o Fe	0.028	48	
	E. Side Aeration/Modified D/T/12 MGD - Zones 1 and 2	0.022	49	
	Wet Well - A-3A w/Fe	0.012	50	
	Anoxic Zone A-12 - West AB	0.010	51	
	Main Splitter Box w/Fe	0.009	52	
	East Splitter Box w/ Fe	0.009	53	
	West Splitter Box w/o Fe	0.007	54	
	Wet Well - A-3A wo/Fe	0.004	55	
	Final Clarifier - A-10B - Floc Zone w/o Fe	0.003	56	
	Digester #1 Vent	0.001	57	

Table 7
Intensity Sort

Lincoln - Theresa Street WWTP

Sample #	Sample Location	Intensity	Rank	Sample #	Sample Location	Intensity	Rank
1	Anoxic Zone A-12 - West AB	0.021	51	24	Total East Primary Clarifiers w/Fe	5.982	1
2	Zone 2 A-12 - West AB	0.399	31	4	Solids Bldg Exhaust	4.610	2
3	Zone 4 A-12 - West AB	0.118	40	44	Center Aeration System	4.405	3
4	Solids Bldg Exhaust	4.610	2	50	East Side Primary Clarifiers Weir - Modified D/T	3.938	4
5	DAF Bldg Exhaust	0.553	26	45	mbined Aeration Systems/Existing D/T/12 MG	3.575	5
6	East Splitter Box w/ Fe	0.017	52	32	18 MGD E. Side Aeration - Zones 1 and 2	3.159	6
7	Primary Clarifier - A-8A Quiescent w/ Fe	0.477	29	30	Total Future East Side Aeration	3.132	7
8	Primary Clarifier - A-8A Weir w/ Fe	0.795	21	48	mbined Aeration Systems/Modified D/T/18 MG	3.095	8
9	East Aeration Basin A-13 w/Fe	0.288	34	26	Total West Side Primary Clarifiers	2.998	9
10	Main Splitter Box w/Fe	0.109	42	47	mbined Aeration Systems/Modified D/T/12 MG	2.488	10
11	Primary Clarifier - A-7C Quiescent	0.330	32	34	18 MGD E. Side Aeration - Zone 4	2.301	11
12	Primary Clarifier - A-7C Weir	0.270	35	28	Future Zone 3 East Side Aeration	2.106	12
13	Wet Well - A-3A w/Fe	0.022	50	46	mbined Aeration Systems/Existing D/T/18 MG	2.085	13
14	Wet Well - A-3A wo/Fe	0.006	56	55	Primary Clarifier A-8A (Q) (2) (RE)	1.903	14
15	West Splitter Box w/o Fe	0.063	47	33	18 MGD E. Side Aeration - Zone 3	1.387	15
16	Grit #3 - A-6C w/o Fe	0.436	30	20	Primary Clarifier - A-8A Quiescent w/o Fe	1.245	16
17	Trickling Filter #8	0.135	39	42	. Side Aeration/Modified D/T/18 MGD - Zone	1.214	17
18	Screening Vent w/o Fe	0.094	44	29	Future Zone 4 East Side Aeration	0.925	18
19	East Aeration Basin A-13 w/o Fe	0.267	36	49	t Side Primary Clarifiers Quiescent - Modified D	0.843	19
20	Primary Clarifier - A-8A Quiescent w/o Fe	1.245	16	38	. Side Aeration Modified D/T/12 MGD - Zone	0.811	20
21	Final Clarifier - A-10B - Quiescent w/o Fe	0.061	48	8	Primary Clarifier - A-8A Weir w/ Fe	0.795	21
22	Final Clarifier - A-10B - Floc Zone w/o Fe	0.006	57	40	de Aeration/Modified D/T/18 MGD - Zones 1 a	0.777	22
23	Digester #1 Vent	0.012	55	57	Primary Clarifier A-8A (W) (RE)	0.739	23
24	Total East Primary Clarifiers w/Fe	5.982	1	25	Total West Side Aeration	0.637	24
25	Total West Side Aeration	0.637	24	43	Total East Side Aeration/Modified D/T/18 MGI	0.637	25
26	Total West Side Primary Clarifiers	2.998	9	5	DAF Bldg Exhaust	0.553	26
26	Future Zones 1 and 2 East Side Aeration	0.101	43	36	de Aeration/Modified D/T/12 MGD - Zones 1 a	0.518	27
27	Future Zone 3 East Side Aeration	2.106	12	56	East Aeration - Zone 1 (RE)	0.495	28
28	Future Zone 4 East Side Aeration	0.925	18	7	Primary Clarifier - A-8A Quiescent w/ Fe	0.477	29
29	Total Future East Side Aeration	3.132	7	16	Total Future East Side Aeration	0.436	30
30	18 MGD E. Side Aeration - Zones 1 and 2	0.151	38	2	18 MGD E. Side Aeration - Zones 1 and 2	0.399	31
31	18 MGD E. Side Aeration - Zones 1 and 2	3.159	6	11	18 MGD E. Side Aeration - Zones 1 and 2	0.330	32
32	18 MGD E. Side Aeration - Zone 3	1.387	15	53	18 MGD E. Side Aeration - Zone 3	0.297	33
33	18 MGD E. Side Aeration - Zone 4	2.301	11	9	18 MGD E. Side Aeration - Zone 4	0.288	34
34	Total 18 MGD Aeration	0.046	49	12	Total 18 MGD Aeration	0.270	35
35	de Aeration/Modified D/T/12 MGD - Zones 1 a	0.518	27	19	de Aeration/Modified D/T/12 MGD - Zones 1 a	0.267	36
36	. Side Aeration Modified D/T/12 MGD - Zone	0.074	45	54	. Side Aeration Modified D/T/12 MGD - Zone	0.245	37

Table 7
Intensity Sort

37	Ł. Side Aeration Modified D/T/12 MGD - Zone ‹	0.811	20	31	Ł. Side Aeration Modified D/T/12 MGD - Zone ‹	0.151	38
38	Total East Side Aeration Modified D/T/12 MGL	0.068	46	17	Total East Side Aeration Modified D/T/12 MGL	0.135	39
39	de Aeration/Modified D/T/18 MGD - Zones 1 a	0.777	22	3	de Aeration/Modified D/T/18 MGD - Zones 1 a	0.118	40
40	Ł. Side Aeration/Modified D/T/18 MGD - Zone	0.110	41	41	Ł. Side Aeration/Modified D/T/18 MGD - Zone	0.110	41
41	Ł. Side Aeration/Modified D/T/18 MGD - Zone	1.214	17	10	Ł. Side Aeration/Modified D/T/18 MGD - Zone	0.109	42
42	Total East Side Aeration/Modified D/T/18 MGL	0.637	25	27	Total East Side Aeration/Modified D/T/18 MGL	0.101	43
43	Center Aeration System	4.405	3	18	Center Aeration System	0.094	44
44	mbined Aeration Systems/Existing D/T/12 MC	3.575	5	37	mbined Aeration Systems/Existing D/T/12 MC	0.074	45
45	mbined Aeration Systems/Existing D/T/18 MC	2.085	13	39	mbined Aeration Systems/Existing D/T/18 MC	0.068	46
46	mbined Aeration Systems/Modified D/T/12 M	2.488	10	15	mbined Aeration Systems/Modified D/T/12 M	0.063	47
47	mbined Aeration Systems/Modified D/T/18 M	3.095	8	21	mbined Aeration Systems/Modified D/T/18 M	0.061	48
48	st Side Primary Clarifiers Quiescent - Modified D	0.843	19	35	st Side Primary Clarifiers Quiescent - Modified D	0.046	49
49	East Side Primary Clarifiers Weir - Modified D/T	3.938	4	13	East Side Primary Clarifiers Weir - Modified D/T	0.022	50
50	Total East Side Primary Clarifiers - Modified D/	0.014	54	1	Total East Side Primary Clarifiers - Modified D/	0.021	51
51	East Splitter (1) (RE)	0.016	53	6	East Splitter (1) (RE)	0.017	52
52	East Splitter (2) (RE)	0.297	33	52	East Splitter (2) (RE)	0.016	53
53	Primary Clarifier A-8A (Q) (1) (RE)	0.245	37	51	Primary Clarifier A-8A (Q) (1) (RE)	0.014	54
54	Primary Clarifier A-8A (Q) (2) (RE)	1.903	14	23	Primary Clarifier A-8A (Q) (2) (RE)	0.012	55
55	East Aeration - Zone 1 (RE)	0.495	28	14	East Aeration - Zone 1 (RE)	0.006	56
56	Primary Clarifier A-8A (W) (RE)	0.739	23	22	Primary Clarifier A-8A (W) (RE)	0.006	57

Table 8
Combined Sort

Lincoln - Theresa Street WWTP

D/T Sample Location	OER Sample Location	Intensity Sample Location
East Splitter (2) (RE)	Solids Bldg Exhaust	Total East Primary Clarifiers w/Fe
East Splitter (1) (RE)	Combined Aeration Systems/Existing D/T/18 MGD	Solids Bldg Exhaust
Future Zones 1 and 2 East Side Aeration	Total 18 MGD Aeration	Center Aeration System
18 MGD E. Side Aeration - Zones 1 and 2	Total East Primary Clarifiers w/Fe	East Side Primary Clarifiers Weir - Modified D/T
Primary Clarifier - A-8A Quiescent w/ Fe	Combined Aeration Systems/Existing D/T/12 MGD	Combined Aeration Systems/Existing D/T/12 MGD
Primary Clarifier A-8A (W) (RE)	Total East Side Primary + Splitter (RE)	18 MGD E. Side Aeration - Zones 1 and 2
Total East Primary Clarifiers w/Fe	Total Future East Side Aeration	Total Future East Side Aeration
Total East Side Primary + Splitter (RE)	Primary Clarifier - A-8A Quiescent w/ Fe	Combined Aeration Systems/Modified D/T/18 MGD
Primary Clarifier - A-8A Weir w/ Fe	18 MGD E. Side Aeration - Zone 3	Total West Side Primary Clarifiers
Primary Clarifier A-8A (Q) (2) (RE)	Total East Side Primary Clarifiers - Modified D/T	Combined Aeration Systems/Modified D/T/12 MGD
Total Future East Side Aeration	East Side Primary Clarifiers Quiescent - Modified D/T	18 MGD E. Side Aeration - Zone 4
Total 18 MGD Aeration	Future Zone 3 East Side Aeration	Future Zone 3 East Side Aeration
Primary Clarifier A-8A (Q) (1) (RE)	East Aeration - Zone 1 (RE)	Combined Aeration Systems/Existing D/T/18 MGD
Primary Clarifier - A-8A Quiescent w/o Fe	Primary Clarifier A-8A (W) (RE)	Primary Clarifier A-8A (Q) (2) (RE)
Wet Well - A-3A w/Fe	Primary Clarifier A-8A (Q) (2) (RE)	18 MGD E. Side Aeration - Zone 3
Combined Aeration Systems/Existing D/T/18 MGI	18 MGD E. Side Aeration - Zones 1 and 2	Primary Clarifier - A-8A Quiescent w/o Fe
Combined Aeration Systems/Existing D/T/12 MGI	Combined Aeration Systems/Modified D/T/18 MGD	E. Side Aeration/Modified D/T/18 MGD - Zone 4
Final Clarifier - A-10B - Floc Zone w/o Fe	Primary Clarifier - A-8A Weir w/ Fe	Future Zone 4 East Side Aeration
Primary Clarifier - A-7C Weir	DAF Bldg Exhaust	East Side Primary Clarifiers Quiescent - Modified D/T
East Side Primary Clarifiers Weir - Modified D/T	Primary Clarifier A-8A (Q) (1) (RE)	E. Side Aeration Modified D/T/12 MGD - Zone 4
Solids Bldg Exhaust	Combined Aeration Systems/Modified D/T/12 MGD	Primary Clarifier - A-8A Weir w/ Fe
Total West Side Primary Clarifiers	Primary Clarifier - A-8A Quiescent w/o Fe	E. Side Aeration/Modified D/T/18 MGD - Zones 1 and 2
Total East Side Primary Clarifiers - Modified D/T	Future Zones 1 and 2 East Side Aeration	Primary Clarifier A-8A (W) (RE)
Primary Clarifier - A-7C Quiescent	Total East Side Aeration/Modified D/T/18 MGD	Total West Side Aeration
East Side Primary Clarifiers Quiescent - Modified D/	East Aeration Basin A-13 w/Fe	Total East Side Aeration/Modified D/T/18 MGD
East Splitter Box w/ Fe	18 MGD E. Side Aeration - Zone 4	DAF Bldg Exhaust
Wet Well - A-3A wo/Fe	East Side Primary Clarifiers Weir - Modified D/T	E. Side Aeration/Modified D/T/12 MGD - Zones 1 and 2
West Splitter Box w/o Fe	East Splitter (2) (RE)	East Aeration - Zone 1 (RE)
Main Splitter Box w/Fe	Total West Side Aeration	Primary Clarifier - A-8A Quiescent w/ Fe
Anoxic Zone A-12 - West AB	Center Aeration System	Total Future East Side Aeration
Side Aeration/Modified D/T/12 MGD - Zones 1 an	East Splitter (1) (RE)	18 MGD E. Side Aeration - Zones 1 and 2
Side Aeration/Modified D/T/18 MGD - Zones 1 an	Total East Side Aeration Modified D/T/12 MGD	18 MGD E. Side Aeration - Zones 1 and 2
Future Zone 3 East Side Aeration	Total West Side Primary Clarifiers	18 MGD E. Side Aeration - Zone 3
18 MGD E. Side Aeration - Zone 3	Future Zone 4 East Side Aeration	18 MGD E. Side Aeration - Zone 4
DAF Bldg Exhaust	E. Side Aeration/Modified D/T/18 MGD - Zone 3	Total 18 MGD Aeration
East Aeration Basin A-13 w/Fe	East Aeration Basin A-13 w/o Fe	E. Side Aeration/Modified D/T/12 MGD - Zones 1 and 2
Combined Aeration Systems/Modified D/T/18 MGI	Zone 4 A-12 - West AB	E. Side Aeration Modified D/T/12 MGD - Zone 3
Total West Side Aeration	E. Side Aeration/Modified D/T/18 MGD - Zone 4	E. Side Aeration Modified D/T/12 MGD - Zone 4
Total East Side Aeration Modified D/T/12 MGD	Primary Clarifier - A-7C Quiescent	Total East Side Aeration Modified D/T/12 MGD
Total East Side Aeration/Modified D/T/18 MGD	E. Side Aeration Modified D/T/12 MGD - Zone 3	E. Side Aeration/Modified D/T/18 MGD - Zones 1 and 2
Center Aeration System	Primary Clarifier - A-7C Weir	E. Side Aeration/Modified D/T/18 MGD - Zone 3
Combined Aeration Systems/Modified D/T/12 MGI	Zone 2 A-12 - West AB	E. Side Aeration/Modified D/T/18 MGD - Zone 4
East Aeration - Zone 1 (RE)	E. Side Aeration Modified D/T/12 MGD - Zone 4	Total East Side Aeration/Modified D/T/18 MGD
Zone 4 A-12 - West AB	Trickling Filter #8	Center Aeration System
E. Side Aeration Modified D/T/12 MGD - Zone 4	Final Clarifier - A-10B - Quiescent w/o Fe	Combined Aeration Systems/Existing D/T/12 MGD

Table 8
Combined Sort

E. Side Aeration/Modified D/T/18 MGD - Zone 4
Final Clarifier - A-10B - Quiescent w/o Fe
Grit #3 - A-6C w/o Fe
Zone 2 A-12 - West AB
Future Zone 4 East Side Aeration
18 MGD E. Side Aeration - Zone 4
E. Side Aeration Modified D/T/12 MGD - Zone 3
E. Side Aeration/Modified D/T/18 MGD - Zone 3
East Aeration Basin A-13 w/o Fe
Screening Vent w/o Fe
Trickling Filter #8
Digester #1 Vent

Grit #3 - A-6C w/o Fe
E. Side Aeration/Modified D/T/18 MGD - Zones 1 and 2
Screening Vent w/o Fe
E. Side Aeration/Modified D/T/12 MGD - Zones 1 and 2
Wet Well - A-3A w/Fe
Anoxic Zone A-12 - West AB
Main Splitter Box w/Fe
Main Splitter Box w/Fe
East Splitter Box w/ Fe
West Splitter Box w/o Fe
Wet Well - A-3A wo/Fe
Final Clarifier - A-10B - Floc Zone w/o Fe
Digester #1 Vent

Combined Aeration Systems/Existing D/T/18 MGD
Combined Aeration Systems/Modified D/T/12 MGD
Combined Aeration Systems/Modified D/T/18 MGD
East Side Primary Clarifiers Quiescent - Modified D/T
East Side Primary Clarifiers Weir - Modified D/T
Total East Side Primary Clarifiers - Modified D/T
East Splitter (1) (RE)
East Splitter (2) (RE)
Primary Clarifier A-8A (Q) (1) (RE)
Primary Clarifier A-8A (Q) (2) (RE)
East Aeration - Zone 1 (RE)
Primary Clarifier A-8A (W) (RE)

Table 9
Average Model Input Data
Lincoln - Theresa Street WWTP

Sample #	Sample Location	Initial D/T x m3/sec	Final D/T x m3/sec	Slope Correction	Final Endpoint
4	Solids Bldg Exhaust	2211.79	1.00	-0.3	0.809
45	Combined Aeration Systems/Existing D/T/18 MGD	1353.65	1.00	-0.3	0.536
34	Total 18 MGD Aeration	1131.73	1.00	-0.3	0.374
24	Total East Primary Clarifiers w/Fe	1042.06	1.00	-0.3	0.432
44	Combined Aeration Systems/Existing D/T/12 MGD	978.27	1.00	-0.3	0.536
57	Total East Side Primary + Splitter (RE)	785.08	1.00	-0.3	1.733
30	Total Future East Side Aeration	756.36	1.00	-0.3	0.374
7	Primary Clarifier - A-8A Quiescent w/ Fe	731.19	1.00	-0.3	0.213
32	18 MGD E. Side Aeration - Zone 3	680.19	1.00	-0.3	0.799
50	Total East Side Primary Clarifiers - Modified D/T	585.51	1.00	-0.3	1.284
48	East Side Primary Clarifiers Quiescent - Modified D/	465.46	1.00	-0.3	1.311
28	Future Zone 3 East Side Aeration	453.46	1.00	-0.3	0.799
55	East Aeration - Zone 1 (RE)	420.08	1.00	-0.3	2.067
56	Primary Clarifier A-8A (W) (RE)	397.20	1.00	-0.3	1.733
54	Primary Clarifier A-8A (Q) (2) (RE)	387.88	1.00	-0.3	1.733
31	18 MGD E. Side Aeration - Zones 1 and 2	328.54	1.00	-0.3	0.203
47	Combined Aeration Systems/Modified D/T/18 MGD	357.48	1.00	-0.3	0.893
8	Primary Clarifier - A-8A Weir w/ Fe	310.87	1.00	-0.3	0.567
5	DAF Bldg Exhaust	287.53	1.00	-0.3	0.768
53	Primary Clarifier A-8A (Q) (1) (RE)	283.68	1.00	-0.3	1.400
46	Combined Aeration Systems/Modified D/T/12 MGD	312.37	1.00	-0.3	0.893
20	Primary Clarifier - A-8A Quiescent w/o Fe	266.31	1.00	-0.3	1.195
27	Future Zones 1 and 2 East Side Aeration	220.90	1.00	-0.3	0.203
42	Total East Side Aeration/Modified D/T/18 MGD	135.56	1.00	-0.3	0.893
9	East Aeration Basin A-13 w/Fe	131.63	1.00	-0.3	0.845
33	18 MGD E. Side Aeration - Zone 4	123.00	1.00	-0.3	1.291
49	East Side Primary Clarifiers Weir - Modified D/T	120.05	1.00	-0.3	1.258
52	East Splitter (2) (RE)	107.84	1.00	-0.3	1.733
25	Total West Side Aeration	94.48	1.00	-0.3	0.893
43	Center Aeration System	127.44	1.00	-0.3	0.893
51	East Splitter (1) (RE)	91.98	1.00	-0.3	1.733
38	Total East Side Aeration Modified D/T/12 MGD	90.45	1.00	-0.3	0.893
26	Total West Side Primary Clarifiers	88.09	1.00	-0.3	1.284
29	Future Zone 4 East Side Aeration	82.00	1.00	-0.3	1.291
40	E. Side Aeration/Modified D/T/18 MGD - Zone 3	68.91	1.00	-0.3	1.291
19	East Aeration Basin A-13 w/o Fe	65.82	1.00	-0.3	1.014
3	Zone 4 A-12 - West AB	54.28	1.00	-0.3	0.481
41	E. Side Aeration/Modified D/T/18 MGD - Zone 4	50.95	1.00	-0.3	0.481
11	Primary Clarifier - A-7C Quiescent	49.67	1.00	-0.3	1.311
36	E. Side Aeration Modified D/T/12 MGD - Zone 3	45.94	1.00	-0.3	1.291
12	Primary Clarifier - A-7C Weir	38.42	1.00	-0.3	1.258
2	Zone 2 A-12 - West AB	35.40	1.00	-0.3	1.291
37	E. Side Aeration Modified D/T/12 MGD - Zone 4	33.96	1.00	-0.3	0.481
17	Trickling Filter #8	32.01	1.00	-0.3	1.043

Table 9
Average Model Input Data

21	Final Clarifier - A-10B - Quiescent w/o Fe	28.18	1.00	-0.3	0.607
16	Grit #3 - A-6C w/o Fe	23.41	1.00	-0.3	2.470
39	Side Aeration/Modified D/T/18 MGD - Zones 1 an	15.70	1.00	-0.3	0.786
18	Screening Vent w/o Fe	13.22	1.00	-0.3	1.146
18	Side Aeration/Modified D/T/12 MGD - Zones 1 an	13.22	1.00	-0.3	1.146
35	Wet Well - A-3A w/Fe	10.55	1.00	-0.3	0.786
13	Anoxic Zone A-12 - West AB	5.68	1.00	-0.3	0.919
1	Main Splitter Box w/Fe	4.80	1.00	-0.3	0.786
10	East Splitter Box w/ Fe	4.26	1.00	-0.3	1.804
6	West Splitter Box w/o Fe	4.03	1.00	-0.3	0.796
15	Wet Well - A-3A wo/Fe	3.08	1.00	-0.3	1.671
14	Final Clarifier - A-10B - Floc Zone w/o Fe	1.96	1.00	-0.3	0.616
22	Digester #1 Vent	1.62	1.00	-0.3	0.838

Table 10
Peak Model Input Data
Lincoln - Theresa Street WWTP

Sample #	Sample Location	Initial D/T x m3/sec	Final Endpoint
4	Solids Bldg Exhaust	6635.38	1.00
45	Combined Aeration Systems/Existing D/T/18 MGI	13536.49	1.00
34	Total 18 MGD Aeration	11317.31	1.00
24	Total East Primary Clarifiers w/Fe	10420.57	1.00
44	Combined Aeration Systems/Existing D/T/12 MGI	9782.74	1.00
57	Total East Side Primary + Splitter (RE)	7850.82	1.00
30	Total Future East Side Aeration	2269.07	1.00
7	Primary Clarifier - A-8A Quiescent w/ Fe	7311.91	1.00
32	18 MGD E Side Aeration - Zone 3	2040.57	1.00
50	Total East Side Primary Clarifiers - Modified D/T	5855.09	1.00
48	East Side Primary Clarifiers Quiescent - Modified D/	4654.61	1.00
28	Future Zone 3 East Side Aeration	1360.38	1.00
55	East Aeration - Zone 1 (RE)	1260.24	1.00
56	Primary Clarifier A-8A (W) (RE)	3971.97	1.00
54	Primary Clarifier A-8A (Q) (2) (RE)	3878.84	1.00
31	18 MGD E Side Aeration - Zones 1 and 2	3285.40	1.00
47	Combined Aeration Systems/Modified D/T/18 MGI	1072.43	1.00
8	Primary Clarifier - A-8A Weir w/ Fe	3108.66	1.00
5	DAF Bldg Exhaust	862.60	1.00
53	Primary Clarifier A-8A (Q) (1) (RE)	2836.76	1.00
46	Combined Aeration Systems/Modified D/T/12 MGI	937.12	1.00
20	Primary Clarifier - A-8A Quiescent w/o Fe	2663.09	1.00
27	Future Zones 1 and 2 East Side Aeration	2208.96	1.00
42	Total East Side Aeration/Modified D/T/18 MGD	406.67	1.00
9	East Aeration Basin A-13 w/Fe	1316.35	1.00
33	18 MGD E. Side Aeration - Zone 4	369.00	1.00
49	East Side Primary Clarifiers Weir - Modified D/T	360.15	1.00
52	East Splitter (2) (RE)	1078.43	1.00
25	Total West Side Aeration	283.43	1.00
43	Center Aeration System	382.32	1.00
51	East Splitter (1) (RE)	919.83	1.00
38	Total East Side Aeration Modified D/T/12 MGD	271.36	1.00
26	Total West Side Primary Clarifiers	880.90	1.00
29	Future Zone 4 East Side Aeration	246.00	1.00
40	E. Side Aeration/Modified D/T/18 MGD - Zone 3	206.73	1.00
19	East Aeration Basin A-13 w/o Fe	658.17	1.00
3	Zone 4 A-12 - West AB	162.84	1.00
41	E. Side Aeration/Modified D/T/18 MGD - Zone 4	152.85	1.00
11	Primary Clarifier - A-7C Quiescent	496.75	1.00
36	E. Side Aeration Modified D/T/12 MGD - Zone 3	137.81	1.00
12	Primary Clarifier - A-7C Weir	384.16	1.00
2	Zone 2 A-12 - West AB	106.20	1.00
37	E. Side Aeration Modified D/T/12 MGD - Zone 4	101.89	1.00
17	Trickling Filter #8	320.13	1.00

Table 10
Peak Model Input Data

21	Final Clarifier - A-10B - Quiescent w/o Fe	281.78	1.00
16	Grit #3 - A-6C w/o Fe	70.23	1.00
39	Side Aeration/Modified D/T/18 MGD - Zones 1 an	156.97	1.00
18	Screening Vent w/o Fe	39.65	1.00
18	Side Aeration/Modified D/T/12 MGD - Zones 1 an	39.65	1.00
35	Wet Well - A-3A w/Fe	105.54	1.00
13	Anoxic Zone A-12 - West AB	56.76	1.00
1	Main Splitter Box w/Fe	47.98	1.00
10	East Splitter Box w/ Fe	42.62	1.00
6	West Splitter Box w/o Fe	40.28	1.00
15	Wet Well - A-3A wo/Fe	30.77	1.00
14	Final Clarifier - A-10B - Floc Zone w/o Fe	19.56	1.00
22	Digester #1 Vent	16.23	1.00

Table 11
Average Transport Distances

Lincoln - Theresa Street WWTP

Location	Allowable	Stability Class 6						Stability Class 4					
		1 m/s		2 m/s		4 m/s		1 m/s		2 m/s		4 m/s	
		Max/Dist	1	Max/Dist	1	Max/Dist	1	Max/Dist	1	Max/Dist	1	Max/Dist	1
Solids Bldg Exhaust	0.809	1.31/464	1050	1.10/372	650	1.19/197	420	.264/527	-	-	-	-	-
Combined Aeration Systems/Existing D/T/18 MGI	0.536	4.0/131	1310	2.0/131	780	1.0/131	480	3.8/69	520	1.9/69	330	.94/69	180
Total 18 MGD Aeration	0.374	3.5/85	1050	1.8/85	610	.89/85	310	3.3/56	450	1.7/56	280	.824/56	130
Total East Primary Clarifiers w/Fe	0.432	3.0/131	350	1.5/131	300	.75/131	-	2.8/69	230	1.4/69	120	-	-
Combined Aeration Systems/Existing D/T/12 MGI	0.536	4.0/73	1150	2.0/73	710	1.0/73	420	3.8/44	460	1.9/44	290	.96/44	180
Total East Side Primary + Splitter (RE)	1.733	3.0/129	1310	1.5/129	780	.74/129	480	2.8/67	520	1.4/67	330	.71/67	180
Total Future East Side Aeration	0.374	2.8/83	850	1.4/83	480	.71/83	250	2.7/54	360	1.3/54	230	.67/54	90
Primary Clarifier - A-8A Quiescent w/ Fe	0.213	2.2/131	410	1.1/131	190	.56/131	-	2.1/69	190	1.1/69	80	-	-
18 MGD E. Side Aeration - Zone 3	0.799	3.2/69	890	1.6/69	550	.8/69	320	3.1/40	350	1.6/40	230	.78/40	150
Total East Side Primary Clarifiers - Modified D/T	1.284	3.6/66	550	1.8/66	310	.89/66	150	3.5/37	240	1.7/37	150	.87/37	50
ast Side Primary Clarifiers Quiescent - Modified D/	1.311	1.9/129	350	.95/129	-	-	-	1.8/67	150	.9/67	-	-	-
Future Zone 3 East Side Aeration	0.799	2.3/73	390	1.1/73	120	-	-	2.2/45	150	1.1/45	80	-	-
East Aeration - Zone 1 (RE)	2.067	1.6/129	310	.8/129	-	-	-	1.5/67	120	.75/67	-	-	-
Primary Clarifier A-8A (W) (RE)	1.733	2.8/62	410	1.4/62	250	.7/62	-	2.8/34	180	1.4/34	120	.7/34	-
Primary Clarifier A-8A (Q) (2) (RE)	1.733	2.6/109	520	1.3/109	320	.66/109	120	2.6/51	220	1.3/51	150	.65/51	80
18 MGD E. Side Aeration - Zones 1 and 2	0.203	1.8/70	230	.9/70	-	-	-	1.7/42	120	.87/42	-	-	-
ombined Aeration Systems/Modified D/T/18 MG	0.893	.2/364	-	-	-	-	-	-	-	-	-	-	-
Primary Clarifier - A-8A Weir w/ Fe	0.567	1.2/129	210	.58/129	-	-	-	1.1/67	80	-	-	-	-
DAF Bldg Exhaust	0.768	1.1/129	110	-	-	-	-	1.0/67	67	-	-	-	-
Primary Clarifier A-8A (Q) (1) (RE)	1.400	1.1/85	110	-	-	-	-	1.0/56	90	-	-	-	-
ombined Aeration Systems/Modified D/T/12 MG	0.893	.98/85	85	-	-	-	-	.93/56	70	-	-	-	-
Primary Clarifier - A-8A Quiescent w/o Fe	1.195	1.7/60	650	.84/60	420	.42/60	220	1.6/32	380	.82/32	180	.41/32	80
Future Zones 1 and 2 East Side Aeration	0.203	.6/129	-	-	-	-	-	-	-	-	-	-	-
Total East Side Aeration/Modified D/T/18 MGD	0.893	1.3/57	450	.66/57	350	.33/57	150	1.3/29	220	.65/29	150	.32/29	40
East Aeration Basin A-13 w/Fe	0.845	2.7/43	150	1.4/43	80	.7/43	-	2.7/21	80	-	-	-	-
18 MGD E. Side Aeration - Zone 4	1.291	.56/126	-	-	-	-	-	-	-	-	-	-	-
East Side Primary Clarifiers Weir - Modified D/T	1.258	1.2/61	120	.62/61	-	-	-	-	-	-	-	-	-
East Splitter (2) (RE)	1.733	1.2/61	120	.62/61	-	-	-	-	-	-	-	-	-
Total West Side Aeration	0.893	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Center Aeration System	0.893	.86/66	-	-	-	-	-	-	-	-	-	-	-
East Splitter (1) (RE)	1.733	.88/60	-	-	-	-	-	-	-	-	-	-	-
Total East Side Aeration Modified D/T/12 MGD	0.893	.37/73	-	-	-	-	-	-	-	-	-	-	-
Total West Side Primary Clarifiers	1.284	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Future Zone 4 East Side Aeration	1.291	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E. Side Aeration/Modified D/T/18 MGD - Zone 3	1.291	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
East Aeration Basin A-13 w/o Fe	1.014	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zone 4 A-12 - West AB	0.481	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E. Side Aeration/Modified D/T/18 MGD - Zone 4	0.481	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Primary Clarifier - A-7C Quiescent	1.311	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E. Side Aeration Modified D/T/12 MGD - Zone 3	1.291	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Primary Clarifier - A-7C Weir	1.258	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zone 2 A-12 - West AB	1.291	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 11
Average Transport Distances

E. Side Aeration Modified D/T/12 MGD - Zone 4	0.481	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Trickling Filter #8	1.043	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Final Clarifier - A-10B - Quiescent w/o Fe	0.607	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Grit #3 - A-6C w/o Fe	2.470	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
ide Aeration/Modified D/T/18 MGD - Zones 1 an	0.786	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Screening Vent w/o Fe	1.146	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
ide Aeration/Modified D/T/12 MGD - Zones 1 an	1.146	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Wet Well - A-3A w/Fe	0.786	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Anoxic Zone A-12 - West AB	0.919	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Main Splitter Box w/Fe	0.786	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
East Splitter Box w/ Fe	1.804	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
West Splitter Box w/o Fe	0.796	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Wet Well - A-3A wo/Fe	1.671	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Final Clarifier - A-10B - Floc Zone w/o Fe	0.616	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Digester #1 Vent	0.838	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 12
Peak Transport Distances

Lincoln - Theresa Street WWTP

Location	Allowabl	Allowabl	Stability Class 6									Stability Class 4								
			1 m/s			2 m/s			4 m/s			1 m/s			2 m/s			4 m/s		
			Max/Dist	1	5	Max/Dist	1	5	Max/Dist	1	5	Max/Dist	1	5	Max/Dist	1	5	Max/Dist	1	5
Solids Bldg Exhaust	1	5	3.93/464	>2000		3.31/332	1400		3.68/197	900		.79/527			1.72/230	500		3.8/90	400	
Combined Aeration Systems/Existing D/T/18 MGI	1	5	39.7/131	>2000	1150	19.8/131	>2000	700	10.0/131	1300	400	37.6/69	1210	480	18.8/69	800	290	9.4/69	590	180
Total 18 MGD Aeration	1	5	35.2/85	>2000	1090	17.6/85	2,000	650	8.8/85	1200	360	33/56	1200	450	16.5/56	790	260	8.2/56	500	130
Total East Primary Clarifiers w/Fe	1	5	29.9/131	>2000	950	14.9/131	1800	560	7.5/131	1100	300	28.3/69	1090	390	14.2/69	700	240	7.1/69	450	120
Combined Aeration Systems/Existing D/T/12 MGI	1	5	40.0/73	>2000	910	20.0/73	1700	580	10.0/73	1100	340	38.5/44	1000	380	19.2/44	650	250	9.6/44	410	150
Total East Side Primary + Splitter (RE)	1	5	29.7/129	>2000	910	14.9/129	1700	550	7.4/129	1090	290	28.4/67	1000	380	14.2/67	650	240	7.1/67	430	120
Total Future East Side Aeration	1	5	28.4/83	>2000	890	14.2/83	1700	510	7.1/83	1000	250	26.8/54	1000	360	13.4/54	650	230	6.7/54	400	120
Primary Clarifier - A-8A Quiescent w/ Fe	1	5	22.3/131	>2000	750	11.2/131	1410	450	5.6/131	900	120	21.1/69	850	330	10.6/69	550	180	5.3/69	390	80
18 MGD E. Side Aeration - Zone 3	1	5	32.1/69	>2000	720	16.0/69	1300	450	8.0/69	810	250	31.2/40	810	310	15.6/40	510	180	7.8/40	310	60
Total East Side Primary Clarifiers - Modified D/T	1	5	35.6/66	>2000	720	17.8/66	1320	450	8.9/66	810	250	34.7/37	800	300	17.4/37	520	180	8.7/37	350	140
ast Side Primary Clarifiers Quiescent - Modified D/	1	5	18.9/129	>2000	650	9.5/129	1250	440	4.7/129	760	-	18.0/67	750	280	9.0/67	510	150	4.5/67	320	
Future Zone 3 East Side Aeration	1	5	22.7/73	1900	630	11.4/73	1200	380	5.7/73	710	150	21.9/45	710	280	11.0/45	480	150	5.5/45	310	80
East Aeration - Zone 1 (RE)	1	5	15.8/129	1810	580	7.9/129	1110	320	7.9/129	1110	310	15.1/67	690	250	7.5/67	450	150	3.8/67	290	80
Primary Clarifier A-8A (W) (RE)	1	5	28.2/62	1610	550	14.1/62	1020	360	7.1/62	620	260	27.7/34	620	250	13.8/34	410	150	6.9/34	280	80
Primary Clarifier A-8A (Q) (2) (RE)	1	5	26.0/109	1510	550	13.0/109	1000	350	6.5/109	620	180	25.1/51	620	240	13.1/51	420	150	6.5/51	280	80
18 MGD E. Side Aeration - Zones 1 and 2	1	5	18.0/70	1510	510	9.0/70	920	270	4.5/70	580	-	17.5/42	610	240	8.7/42	380	130	4.4/42	250	
ombined Aeration Systems/Modified D/T/18 MGI	1	5	.64/364					-	-											
Primary Clarifier - A-8A Weir w/ Fe	1	5	1.6/129	1410	450	5.8/129	900	200	2.9/129	520		11.0/67	550	180	5.6/67	350	80	2.8/67	220	
DAF Bldg Exhaust	1	5	10.8/129	1400	440	5.4/129	820	180	2.7/129	510	-	10.3/67	520	180	5.2/67	350	80	2.6/67	220	
Primary Clarifier A-8A (Q) (1) (RE)	1	5	10.7/85	1410	410	5.4/85	820	150	2.7/85	510		10.0/56	550	180	5.0/56	350	56			
ombined Aeration Systems/Modified D/T/12 MGI	1	5	9.9/85	1310	380	4.9/85	820		-			9.2/56	550	150	4.6/56	320				
Primary Clarifier - A-8A Quiescent w/o Fe	1	5	16.8/60	1010	350	8.4/60	650	190	4.2/60	410		16.5/32	440	150	8.2/32	290	50			
Future Zones 1 and 2 East Side Aeration	1	5	6.4/129	850	250	3.2/129	520		-			6.2/64	350	120	3.1/64	220				
Total East Side Aeration/Modified D/T/18 MGD	1	5	13.3/57	800	250	6.7/57	500	130	3.3/57	300		13.1/29	350	120	6.6/29	250	60			
East Aeration Basin A-13 w/Fe	1	5	27.3/43	790	280	13.7/43	510	150	6.8/43	350	80	27.0/21	320	120	13.5/21	220	80	6.7/21	150	50
18 MGD E. Side Aeration - Zone 4	1	5	5.6/126	710	120						-		-		-					
East Side Primary Clarifiers Weir - Modified D/T	1	5	12.3/61	700	250	6.2/61	450	110	3.1/61	250		11.3/36	310	100	5.6/36	180	50	2.8/36	120	
East Splitter (2) (RE)	1	5	12.3/61	700	250	6.2/61	450	110	3.1/61	250		11.3/36	310	100	5.6/36	180	50	2.8/36	120	
Total West Side Aeration	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Center Aeration System	1	5	8.7/66	610	120	4.3/66	400						-							
East Splitter (1) (RE)	1	5	8.8/60	610	220	4.4/60	410					8.6/32	280	60	4.3/32	190				
Total East Side Aeration Modified D/T/12 MGD	1	5	3.7/73	NR							-									
Total West Side Primary Clarifiers	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Future Zone 4 East Side Aeration	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E. Side Aeration/Modified D/T/18 MGD - Zone 3	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
East Aeration Basin A-13 w/o Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zone 4 A-12 - West AB	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E. Side Aeration/Modified D/T/18 MGD - Zone 4	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Primary Clarifier - A-7C Quiescent	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E. Side Aeration Modified D/T/12 MGD - Zone 3	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Primary Clarifier - A-7C Weir	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zone 2 A-12 - West AB	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E. Side Aeration Modified D/T/12 MGD - Zone 4	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Trickling Filter #8	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Final Clarifier - A-10B - Quiescent w/o Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Grit #3 - A-6C w/o Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Side Aeration/Modified D/T/18 MGD - Zones 1 an	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Screening Vent w/o Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Side Aeration/Modified D/T/12 MGD - Zones 1 an	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Wet Well - A-3A w/Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Anoxic Zone A-12 - West AB	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Main Splitter Box w/Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
East Splitter Box w/ Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
West Splitter Box w/o Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Wet Well - A-3A wo/Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Final Clarifier - A-10B - Floc Zone w/o Fe	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Digester #1 Vent	1	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 13
Priority Odor Sources
Class 1
Lincoln - Theresa Street WWTP

Rank	Class 1 Sources Average
1	ombined Aeration Systems/Existing D/T/18 MC
2	Total East Side Primary + Splitter (RE)
3	ombined Aeration Systems/Existing D/T/12 MC
4	Solids Bldg Exhaust
5	Total 18 MGD Aeration
6	18 MGD E. Side Aeration - Zone 3
7	Total Future East Side Aeration
8	Primary Clarifier - A-8A Quiescent w/o Fe
9	Total East Side Primary Clarifiers - Modified D/T
10	Primary Clarifier A-8A (Q) (2) (RE)
11	Total East Side Aeration/Modified D/T/18 MGD
12	Primary Clarifier - A-8A Quiescent w/ Fe
13	Primary Clarifier A-8A (W) (RE)
14	Future Zone 3 East Side Aeration
15	Total East Primary Clarifiers w/Fe
16	st Side Primary Clarifiers Quiescent - Modified D
17	East Aeration - Zone 1 (RE)
18	18 MGD E. Side Aeration - Zones 1 and 2
19	Primary Clarifier - A-8A Weir w/ Fe
20	East Aeration Basin A-13 w/Fe
21	East Side Primary Clarifiers Weir - Modified D/T
22	East Splitter (2) (RE)
23	DAF Bldg Exhaust
24	Primary Clarifier A-8A (Q) (1) (RE)
25	mbined Aeration Systems/Modified D/T/12 MG

Rank	Class 1 Sources Peak
1	ombined Aeration Systems/Existing D/T/18 MG
2	Total 18 MGD Aeration
3	Total East Primary Clarifiers w/Fe
4	ombined Aeration Systems/Existing D/T/12 MG
5	Total East Side Primary + Splitter (RE)
6	Total Future East Side Aeration
7	Primary Clarifier - A-8A Quiescent w/ Fe
8	18 MGD E. Side Aeration - Zone 3
9	Total East Side Primary Clarifiers - Modified D/T
10	st Side Primary Clarifiers Quiescent - Modified D
11	Future Zone 3 East Side Aeration
12	East Aeration - Zone 1 (RE)
13	Primary Clarifier A-8A (W) (RE)
15	18 MGD E. Side Aeration - Zones 1 and 2
16	Primary Clarifier - A-8A Weir w/ Fe
17	DAF Bldg Exhaust
18	Primary Clarifier A-8A (Q) (1) (RE)
19	mbined Aeration Systems/Modified D/T/12 MC
20	Primary Clarifier - A-8A Quiescent w/o Fe
21	East Aeration Basin A-13 w/Fe
22	Future Zones 1 and 2 East Side Aeration
23	Total East Side Aeration/Modified D/T/18 MGD
24	East Side Primary Clarifiers Weir - Modified D/T
25	East Splitter (2) (RE)
26	East Splitter (1) (RE)
27	18 MGD E. Side Aeration - Zone 4
28	Center Aeration System

Priority of Odor Sources
Class 2
Lincoln - Theresa Street WWTP

1	Solids Bldg Exhaust
2	ombined Aeration Systems/Existing D/T/18 MGD
3	ombined Aeration Systems/Existing D/T/12 MGD
4	Primary Clarifier A-8A (Q) (1) (RE)
5	Primary Clarifier - A-8A Quiescent w/o Fe
6	Total East Side Primary Clarifiers - Modified D/T
7	ıst Side Primary Clarifiers Quiescent - Modified D/T
8	18 MGD E. Side Aeration - Zone 3
9	Future Zone 3 East Side Aeration
10	East Side Primary Clarifiers Weir - Modified D/T
11	East Aeration - Zone 1 (RE)
12	DAF Bldg Exhaust
13	ɔmbined Aeration Systems/Modified D/T/18 MGD
14	ɔmbined Aeration Systems/Modified D/T/12 MGD
15	Total 18 MGD Aeration
16	Total East Primary Clarifiers w/Fe
17	Total East Side Primary + Splitter (RE)
18	Total Future East Side Aeration
19	Primary Clarifier - A-8A Quiescent w/ Fe
20	Primary Clarifier A-8A (W) (RE)
21	Primary Clarifier A-8A (Q) (2) (RE)
22	18 MGD E. Side Aeration - Zones 1 and 2
23	Primary Clarifier - A-8A Weir w/ Fe
24	Future Zones 1 and 2 East Side Aeration
25	East Splitter (2) (RE)
26	East Splitter (1) (RE)