Odor Threshold Emission Factors for Common WWTP Processes

Authored by:

Michael A. McGinley, P.E.
St. Croix Sensory, Inc.

And

Charles M. McGinley, P.E.
St. Croix Sensory, Inc.

Presented at
Water Environment Federation / Air & Waste Management Association
Specialty Conference: Odors and Air Emissions 2008
Phoenix, AZ: 6-9 April 2008

St. Croix Sensory Inc.
P.O. Box 313, 3549 Lake Elmo Ave. N.
Lake Elmo, MN 55042 U.S.A.
800-879-9231
stcroix@fivesenses.com

ODOR THRESHOLD EMISSION FACTORS FOR COMMON WWTP PROCESSES

Michael A. McGinley, P.E. and Charles M. McGinley, P.E.
St. Croix Sensory, Inc.
3549 Lake Elmo Ave. N., P.O. Box 313, Lake Elmo, MN 55042

ABSTRACT

Odor threshold values of waste water treatment plant (WWTP) processes (i.e. screenings, primaries, aeration, dewatering, etc.) have frequently been reported in individual case study presentations, however, no one source has provided an overview of many odor samples collected at various locations.

A review of over seven years of WWTP odor sample results (over 1,000 samples) tested by a commercial laboratory yielded a statistical overview of odor threshold values of common WWTP processes. Emissions from each stage of WWTP as well as odor control processes were reviewed. These results can be used as emission factors for comparison to actual odor study testing results and for estimating odor emissions from plants under development. The geometric mean value would be used as a value for a typical process running under normal conditions. The 3^{rd} quartile value (75^{th} percentile) can be used as a more conservative value or as a likely maximum value for a typical process.

All test results were performed following the protocols of dynamic olfactometry testing standards: ASTM International E679-04, EN13725:2003, and AS/NZ 4323.3-2001. The review of odor threshold values also provides correlations of 1) odor threshold values with hydrogen sulfide concentration and 2) samples processed at two olfactometer presentation flow rates (i.e. 0.5-LPM vs. 20-LPM).

KEYWORDS

odor, odor threshold, detection threshold, olfactometry, olfactometer, emission factors

INTRODUCTION

St. Croix Sensory conducts odor evaluations for various consulting firms, sanitation districts, industries, universities, and government agencies throughout the U.S. and Canada. Odor threshold determination with dynamic dilution olfactometry is conducted following EN13725:2003 and ASTM International E679-04. Thousands of environmental air samples per year are evaluated from industries such as wastewater treatment, composting, municipal solid waste, agricultural, and various manufacturing.

This paper will present a statistical overview of over 1,000 odor threshold values from common WWTP processes. The results were compiled by reviewing over 10,000 data points collected at St. Croix Sensory and sorting these data by specific industry and process.

Client confidentiality was maintained throughout the process of this review by assigning threshold values to specific categories "in the blind" without knowledge or bias of the clients, project names, sampling protocols, or wastewater treatment plant locations. This paper only presents statistical summaries with no references to identifiable information about specific samples.

METHODOLOGY

Over 10,000 data points collected from 1999-2007 were reviewed in DataSense™ Olfactometry Software at St. Croix Sensory. The source of each odor sample was determined based on the sample description listed in the database as provided by the client on Chain of Custody documentation.

Of the 10,000 data points, approximately one quarter were identified as collected from a wastewater treatment plant. Of these WWTP samples, 1,774 had identifiable process sources.

To summarize the results, WWTP processes were grouped into ten main categories and coded with three digits to aid in data entry:

- 000 Control Samples (e.g. blanks, ambient)
- 100 Collection Systems
- 200 Preliminary Treatment
- 300 Primary Treatment
- 400 Biological Treatment
- 500 Sludge Thickening
- 600 Digesters
- 700 Dewatering
- 800 Biosolids
- 900 Odor Control Systems

Each of these main categories was broken down into several sub-categories. For example, category 900 included 910 – Carbon Outlets, 930 – Chemical Scrubber Outlets, 940 – Bio-Scrubber Outlets, and 950 – Biofilter Outlets.

Odor thresholds values were determined on an AC'SCENT® International Olfactometer with a presentation flow rate of 20-lpm, following dynamic dilution olfactometry standards CEN EN13725:2003, *Air Quality – Determination of Odour Concentration by Dynamic Olfactometry*, and ASTM International E679-04, *Standard Practice for Determination of Odor and Taste Threshold by a Forced-Choice Ascending Concentration Series Method of Limits* (Appendix X.3).

For each sub category with more than 10 samples identified (n>10), the detection threshold values were evaluated to summarize basic statistical information including the samples size, n, and the geometric mean, as well as the 1st quartile (25th percentile), median, and 3rd quartile (75th percentile).

In addition to the review of each process, the correlation between hydrogen sulfide and odor detection threshold was examined for all odor samples, regardless of industry source. There were 3,584 samples with a hydrogen sulfide concentration reported by the client on Chain of Custody documentation.

RESULTS

Control Samples

Category 000, control samples, includes two subcategories, samples labeled as blanks and samples labeled as ambient, background, upwind, etc. Table 1 shows the statistical summary of the results for these control sample categories. Of 130 samples categorized as blanks, 80% had a detection threshold (DT) less than 20, 93.1% had a DT less than 30, and 96.9% had a DT less than 40. The maximum detection threshold of the blank samples was 60 and the geometric mean of the detection threshold is 13.0.

Table 1 - Statistical summary of detection threshold results for category 000, control samples.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
010	Blanks	130	13	5	58	8	11	21
020	Ambient/Background	26	40	7	4,529	21	36	62

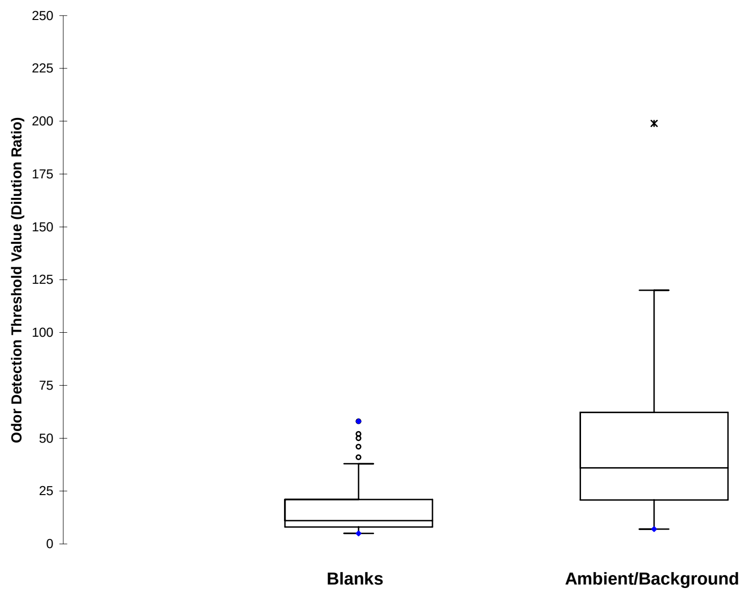
For the 26 samples categorized as ambient or background, 69.2% had a DT value less than 50 and 92.3% had a DT less than 100. The geometric mean for the ambient/background samples is 39.6. Figure 1 is a box plot that graphically presents the statistical summary information. The plot shows that all detection threshold results of the blanks samples are within the 75th percentile (under the 3rd quartile) of the ambient/background samples.

Box plots graphically represent numerical data through a summary of five numbers including the lowest observation, the 1st quartile, the median, the 3rd quartile, and the highest observation. Spacing between the different values in one box plot can indicate the variability of the data.

The 1st quartile, represented by the bottom of the box, is the cut-off point where 25% of all values are less than the value (the 25th percentile). The median, represented by a line bisecting the box, is where 50% of data points are less than and 50% of data points are greater than the value (the 50th percentile). The 3rd quartile, represented by the top of the box, is the cut-off where 25% of data points are greater than the value and 75% are less than the value (the 75th percentile). The interquartile range is the range between the 1st and 3rd quartile, the distance from the bottom to top of the box.

Outliers are values that are greater than or less than 1.5 times the interquartile range. The largest and lowest values that are not considered outliers are marked with a whisker (i.e. tick mark) and a line is drawn to connect the top or bottom of the box to the whisker. The ultimate minimum and maximum are labeled with closed circles. These are not shown on all graphs since in some cases the y-axis scale was adjusted for clarity. Outlier data points that are less than 3 times the interquartile range below the 1st quartile or above the 3rd quartile are considered mild outliers and identified with an open circle. Outlier data points that are 1.5 to 3 times the interquartile range below the 1st quartile or above the 3rd quartile are considered extreme outliers and displayed with a star data point.

Figure 1 - Box plot of detection threshold results for category 000, control samples. Note that an ambient background data point at 4,529 is not shown on the graph since the y-axis was scaled for clarity.



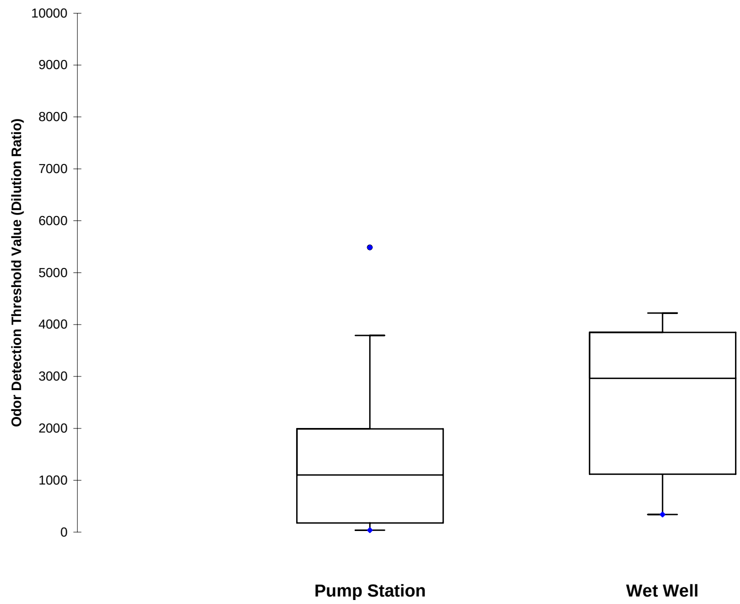
Collection Systems

Table 2 contains the statistical summaries of results of the two collection system categories identified with greater than ten records. The 15 Pump Station samples (i.e. ventilation) had a detection thresholds geometric mean of 639 with a range of 35 to 5,488. The 17 Wet Well samples had a geometric mean of 2,245 with a range of 333 to 33,000. Figure 2 is a box plot that graphically represents a summary of the results.

Table 2 - Statistical summary of detection threshold results for Category 100, collection systems.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
120	Pump Stations	15	639	35	5,488	175	1,100	1,988
130	Wet Wells	17	2,245	338	33,000	1,116	2,963	3,650

Figure 2 - Box plot of detection threshold results for category 100, collection systems. Note that two wet well data points (17,336 and 33,000) are not shown on the graph since the y-axis was scaled for clarity.



Preliminary Treatment

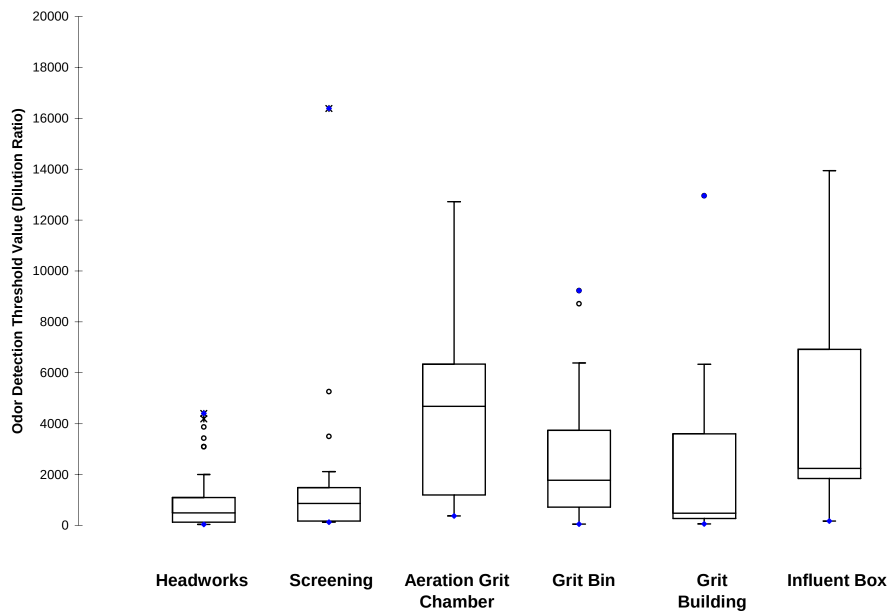
Six subcategories of preliminary treatment have more than 10 records. These subcategories include headworks, screen room/screen area, aeration grit chamber, grit bin/basin, grit building, and influent box. Table 3 summarizes the detection threshold results of these six sources. Aeration grit chamber and influent box had the highest maximum values and geometric means. All geometric means ranged from 476 to 3,200.

Figure 3 graphically presents the statistical summary of the preliminary treatment results. The aeration grit chamber and influent box samples also had the widest spread of results. The median values ranged from 498 to 4,683.

Table 3 - Statistical summary of detection threshold results for Category 200, preliminary treatment.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
210	Headworks	22	476	40	4,402	126	498	1,098
222	Screen Room – Screen Areas	24	719	130	16,399	167	861	1,480
230	Aeration Grit Chamber	17	3,200	376	62,508	1,196	4,683	6,341
232	Grit Bin – Basin	29	1,387	56	9,228	720	1,778	3,743
235	Grit Building	12	682	59	12,953	272	480	3,598
250	Influent Box	17	3,158	166	24,468	1,841	2,245	6,920

Figure 3 - Box plot of detection threshold results for Category 200, preliminary treatment. Note that an aeration grit chamber data point at 62,508 and two influent box data points (21,852 and 24,468) are not shown on the graph since the y-axis was scaled for clarity.



Primary Treatment

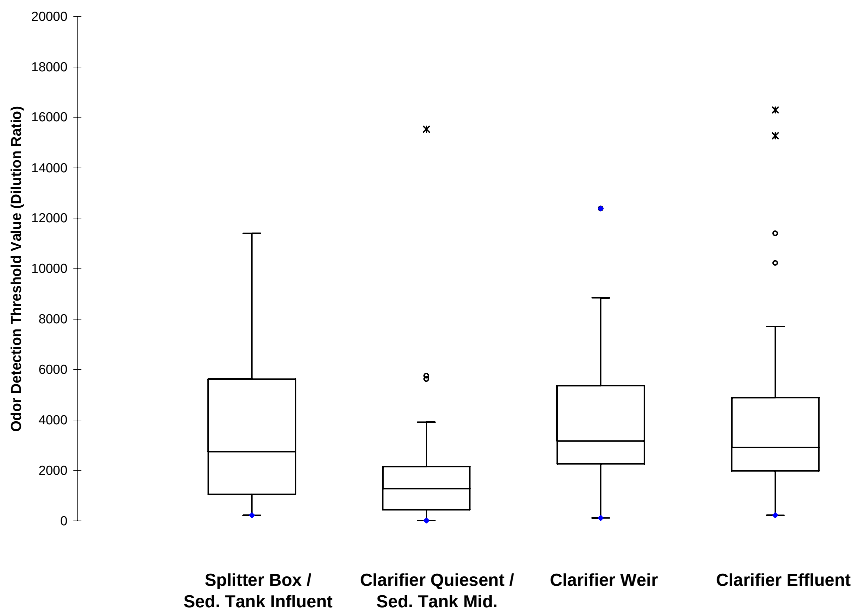
Table 4 provides the summary results of the primary treatment categories of primary splitter box/sedimentation tank influent, primary clarifier quiescent/sedimentation tank mid., primary clarifier weir, and primary clarifier influent. Detection threshold geometric means for these sources ranged from 947 to 2,322.

Table 4 - Statistical summary of detection threshold results for Category 300, primary treatment.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
320	Primary Splitter Box / Sed. Tank Influent	25	2,552	227	69,365	1,052	2,741	5,628
322	Primary Clarifier Quies. / Sed. Tank Mid.	69	947	12	20,088	436	1,277	2,153
324	Primary Clarifier Weir	32	2,322	115	12,387	2,262	3,166	5,363
326	Primary Clarifier Effluent	50	2,959	224	31,162	1,982	2,911	4,884

Figure 4 presents the box plots for the primary treatment sources. The primary clarifier quiescent/sedimentation tank mid. has the lowest median detection threshold, while the other three sources had similar medians, which had a small range from 2,741 to 3,166.

Figure 4 - Box plot of detection threshold results for Category 300, primary treatment. Note that a splitter box data point at 69,365, a clarifier quiescent data point at 20,088, and two clarifier effluent data points (21,272 and 31,162) are not shown on the graph since the y-axis was scaled for clarity.



Biological Treatment

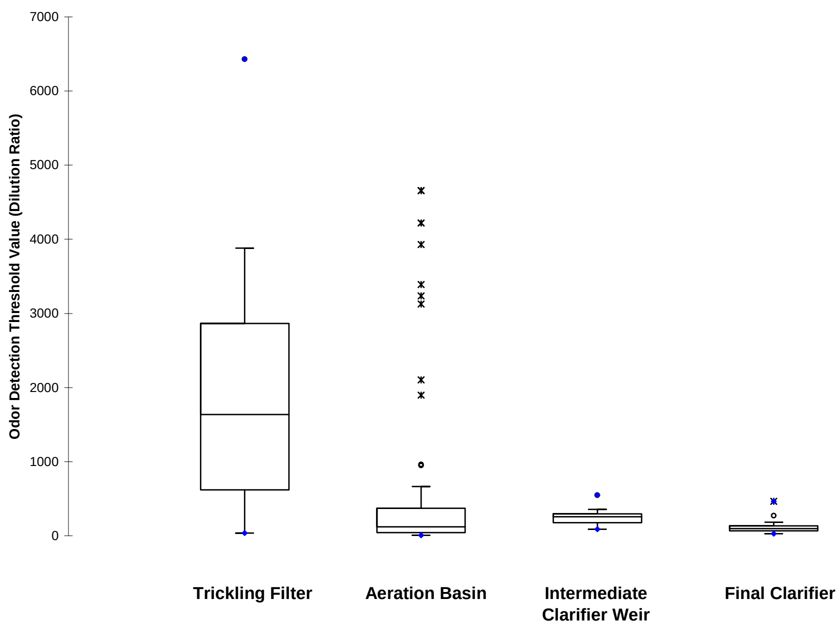
Biological treatment samples evaluated include the trickling filter, aeration basin, intermediate clarifier weir, and final clarifier. Over 100 aeration basin samples were identified. The detection threshold geometric means ranged from a low of 96 for the final clarifier to 1,006 for the trickling filter.

Table 5 - Statistical summary of detection threshold results for Category 400, biological treatment.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
410	Trickling Filter	18	1,006	37	6,430	617	1,637	2,864
424	Aeration Basin	113	134	8	14,000	45	122	371
444	Intermediate Clarifier Weir	11	234	89	550	178	255	295
448	Final Clarifier	25	96	28	465	68	97	135

The box plot summaries for biological treatment are shown in Figure 5. The median detection threshold for the trickling filter, 1,637, is significantly higher than all other categories, which range from 97 to 255. The aeration basin samples had a wide range of values with many outliers, but the majority of results lie in a small range of 45 to 371.

Figure 5 - Box plot of detection threshold results for Category 400, biological treatment. Note that an aeration basin data point at 14,000 is not shown on the graph since the y-axis was scaled for clarity.



Sludge Thickening

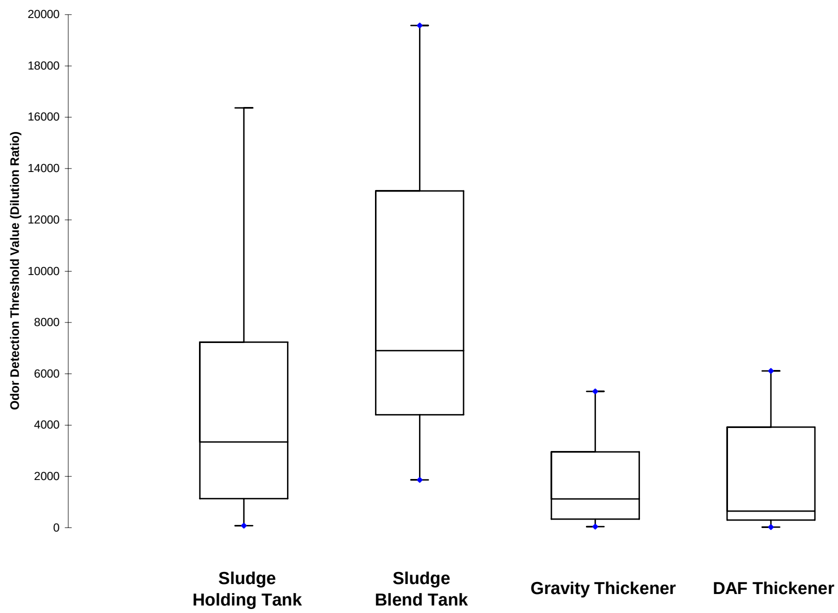
Sludge thickening processes include sludge holding tank, sludge blend tank, gravity thickener, and DAF thickener. Table 6 provides the statistical summary of these processes. The detection threshold geometric means for these four processes ranged from 755 for the DAF thickener to 6,998 for the sludge blend tank.

Table 6 - Statistical summary of detection threshold results for Category 500, sludge thickening.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
530	Sludge Holding Tank	39	2,571	79	38,360	1,135	3,344	7,237
535	Sludge Blend Tank	17	6,998	1,866	19,578	4,399	6,907	13,129
540	Gravity Thickener	33	868	49	5,311	333	1,119	2,953
550	DAF Thickener	22	755	29	6,113	303	653	3,922

Figure 6 displays the box plots for these sludge thickening processes. The sludge blend tank had the highest median detection threshold, 6,907, and the widest spread of results with the 1st quartile at 4,399 and 3rd quartile at 13,128. The sludge holding tank and sludge blend tank had the highest maximum detection threshold values of 19,578 and 38,360, respectively.

Figure 6 - Box plot of detection threshold results for Category 500, sludge thickening. Note that three sludge holding tank data points (28,943, 29,160, and 38,360) are not shown on the graph since the y-axis was scaled for clarity.



Digesters

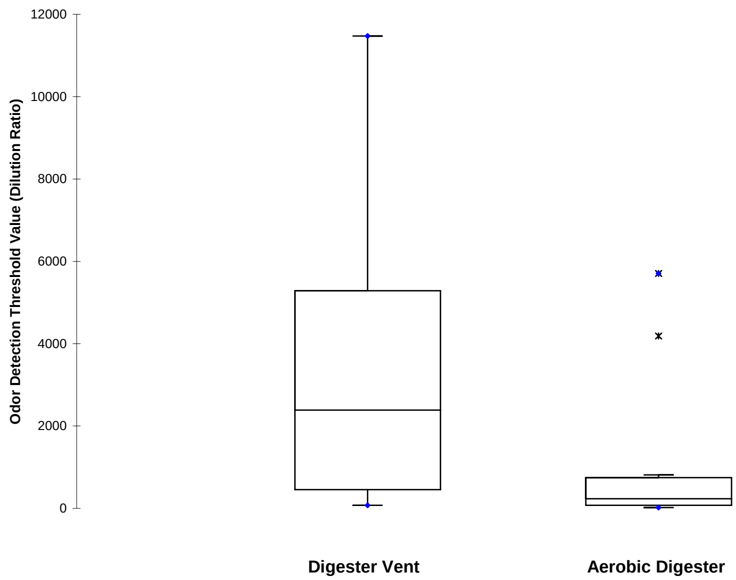
Digester sources were placed into two categories, digester (anaerobic) vent with 14 samples and aerobic digester with 10 samples. Table 7 contains the summary statistics for these sources. The detection threshold geometric mean is 1,471 for the digester vent and 279 for the aerobic digester.

Table 7- Statistical summary of detection threshold results for Category 600, digesters.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
620	Digester Vent	14	1,471	77	11,473	456	2,385	5,288
630	Aerobic Digester	10	279	22	5,704	73	236	747

Figure 7 displays the box plots for these two categories. The digester vent samples had a wider range of results with the value for the 25th percentile (1st quartile) at 456 and the value for the 75th percentile (3rd quartile) at 5,288. The maximum value for the aerobic digester, excluding outliers, is lower than the median value for the digester vent.

Figure 7 - Box plot of detection threshold results for Category 600, digesters.



Dewatering

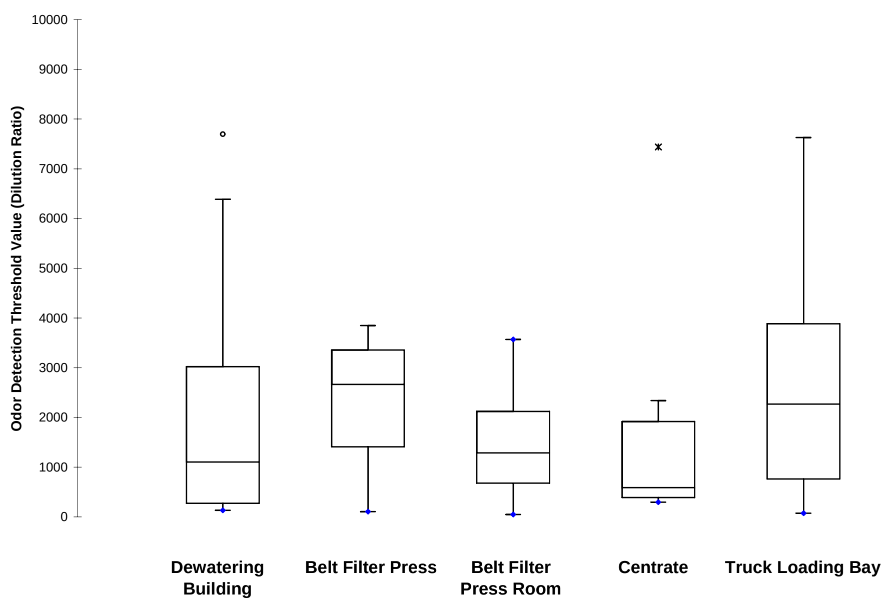
Five dewatering processes were identified with more than 10 records in our database. These processes included dewatering building, belt filter press, belt filter press room, centrate, and truck loading bay. Table 8 provides a summary of the detection threshold values for the dewatering processes. The geometric means of the detection threshold for the five processes only ranged from 994 to 1,703.

Table 8 - Statistical summary of detection threshold results for Category 700, dewatering.

Code	Category	N	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
725	Dewatering Building	22	1,105	133	73,586	273	1,105	3,020
730	Belt Filter Press	10	1,703	108	10,508	1,409	2,665	3,357
735	Belt Filter Press Room	15	994	48	3,568	678	1,288	2,122
750	Centrate	15	1,150	298	47,255	390	588	1,920
760	Truck Loading Bay	23	1,638	76	65,613	762	2,268	3,883

The box plots of dewatering processes are displayed in Figure 8. While the belt filter press room has the lowest geometric mean of detection threshold, 994, the centrate process has the lowest median detection threshold value of 588. While the maximum reported values were highest for dewatering building and tuck loading bay, the interquartile range of 25th to 75th percentile were vary similar with the 1st quartile values ranging from 273 to 1,409 and the 3rd quartile range from 2,122 to 3,883.

Figure 8 - Box plot of detection threshold results for Category 700, dewatering. Note that a dewatering data point (73,586), a belt filter press data point (10,508), two centrate data points (12,853 and 47,255), and a truck loading bay data point (65,613) are not shown on the graph since the y-axis was scaled for clarity.



Biosolids

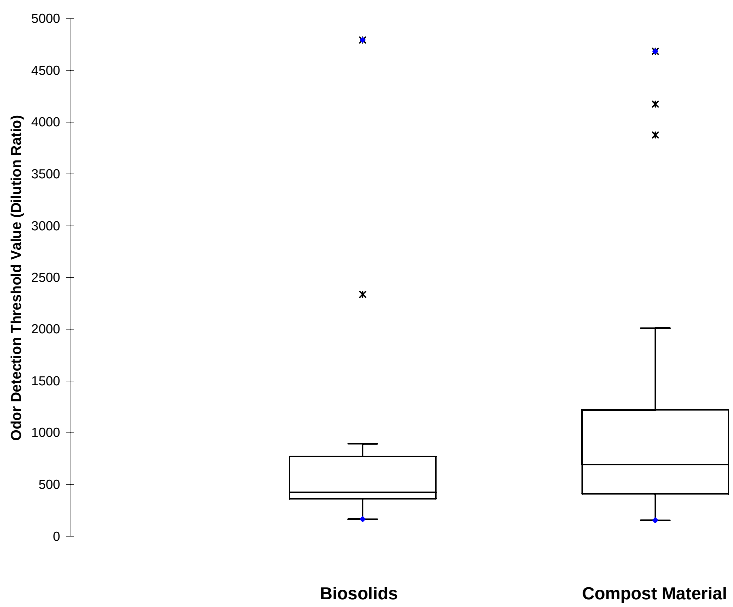
Biosolids processes identified include Biosolids and compost material. Table 9 provides the summary statistics for the Biosolids processes. Note that details of the types of compost materials and biosolids were not identified in the specific sample descriptions. The geometric mean detection threshold values are 584 for Biosolids and 707 for compost material.

Table 9 - Statistical summary of detection threshold results for Category 800, biosolids.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
810	Biosolids	12	584	167	4,794	362	427	772
820	Compost Material	45	707	155	4,686	409	693	1,221

Figure 9 presents the box plots for the biosolids processes. The two processes have similar statistical values with a median threshold value of 427 for biosolids and 693 for compost material. The 45 samples identified as compost materials had a wider range of threshold values compared to the 12 biosolids samples.

Figure 9 - Box plot detection threshold results for Category 800, biosolids.



Odor Control Systems

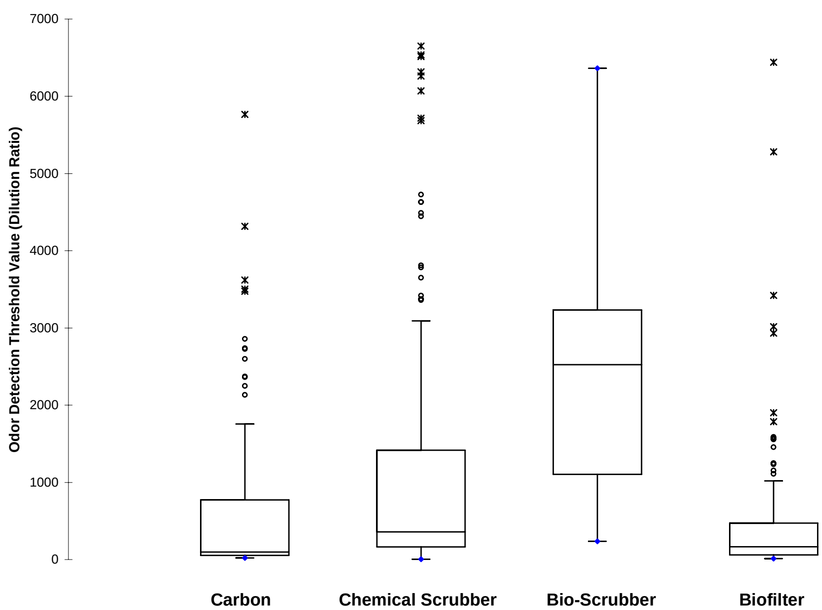
Four odor control systems were identified among the WWTP process samples including carbon, chemical scrubbers, bio-scrubbers, and biofilters. Since the sources for control system inlets vary greatly, the statistical summary would not be representative of anything; therefore, only control system outlet samples were reviewed. Of all sample sets evaluated, the scrubber and biofilter outlets were the two largest samples with 185 and 140 data points, respectively. Odor control systems was the main category with the highest overall number of samples. Table 10 provides a summary of the statistics from this sample set. Bio-scrubber outlets had the highest detection threshold geometric mean with a value of 1,843. The biofilter outlets had the lowest detection threshold geometric mean of 198; however, carbon system outlets were very similar with a geometric mean of 202.

Table 10 - Statistical summary of detection thrreshold results for Category 900, odor control systems.

Code	Category	n	Geo. Mean	Min.	Max.	1st Quart.	Median	3rd Quart.
910	Carbon Outlets	92	202	19	10,773	55	99	774
930	Scrubber Outlets	185	444	5	14,855	163	357	1,416
940	Bio-Scrubber Outlets	23	1,843	236	6,363	1,104	2,524	3,232
950	Biofilter Outlets	140	198	14	30,412	61	165	470

Figure 10 displays the box plots for the four types of odor control system outlets. The median detection threshold value of 99 for carbon systems was the lowest of all types. The 75th percentile of carbon and biofilter system outlets are lower than the 75th percentile of the chemical scrubber outlets and below the median of the bio-scrubber outlets.

Figure 10 - Box plot detection threshold results for Category 900, odor control systems. Note that three carbon system data points (9,865, 10,047, and 10,773), a chemical scrubber data point (14,855), and four biofilter data points (9,188, 10,338, 16,680, and 30,412) are not shown on the graph since the y-axis was scaled for clarity.



Hydrogen Sulfide Odor Threshold Correlation

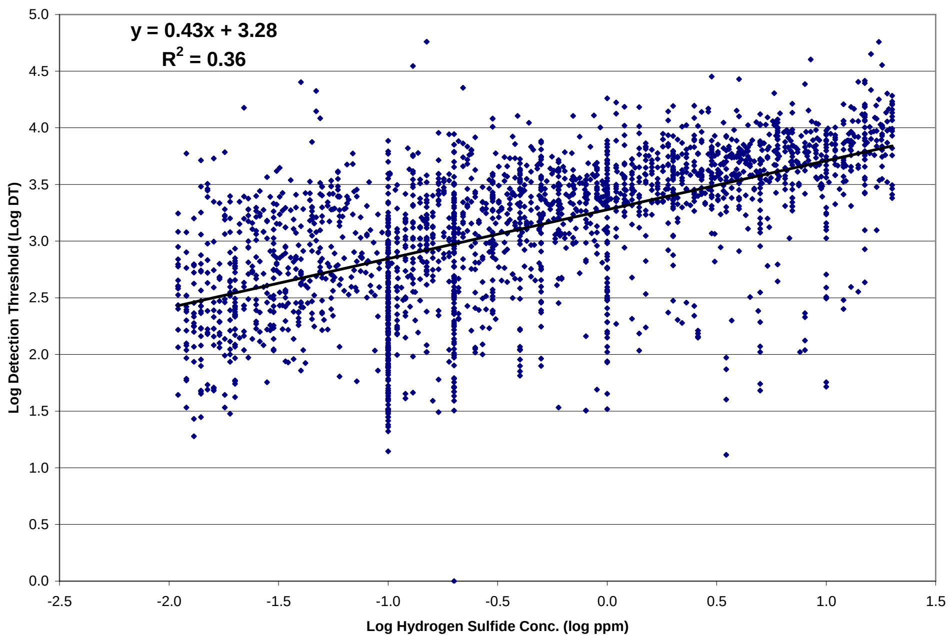
From 1999-2007, there were 3,584 WWTP odor samples submitted to St. Croix Sensory with hydrogen sulfide concentration information provided on Chain of Custody documentation. The hydrogen sulfide concentrations were not measured or otherwise confirmed by St. Croix Sensory. There were 2,373 samples with hydrogen sulfide concentration of 0.01-20ppm. These results were plotted to examine a correlation between hydrogen sulfide and odor detection threshold.

Figure 11 is the plot of log detection threshold vs. log hydrogen sulfide concentration. The best fit line has an equation of

Log (detection threshold) = 0.43 * Log(H_2S Conc.) + 3.28 [R=0.60]

Note that the x-axis intercept, x=0 or 10^0=1ppm, is a log detection threshold of 3.28, which is DT=$10^{3.28}$=1,905. This is a hydrogen sulfide detection threshold value of 0.52ppb (1,000ppb/1,905), a value generally in agreement with published odor threshold data.

Figure 11 - Relationship of detection threshold and hydrogen sulfide concentration displayed as a log-log plot of threshold values determined for samples with reported hydrogen sulfide concentrations in the range of 10 ppb to 20ppm.



Comparison of Olfactometer Presentation Flow Rates

Over 100 samples in the database were analyzed on both the AC'SCENT International Olfactometer with a presentation flow rate of 20-LPM and an Illinois Institute of Technology Research Institute (IITRI) Olfactometer with a presentation flow rate of 0.5-LPM. Tests run on the AC'SCENT Olfactometer were conducted according the EN13725:2003 and ASTM E679-04 (Appendix X.3). Tests run on the IITRI Olfactometer were conducted according to ASTM E679-04 (Appendix X.2).

A review of the samples evaluated at both presentation flow rates provided the following correlation equation for Detection Threshold (DT) values of 50-6,000 determined at 20LPM (DT's of 5-3,000 determined at 0.5LPM):

$$\mathrm{Log}(DT_{0.5LPM}) = 0.24 * [\mathrm{Log}(DT_{20LPM})]^{2.0}$$

The following equation can be utilized when converting from a DT at 0.5LPM to DT at 20LPM:

$$\mathrm{Log}(DT_{20LPM}) = 2.04 * [\mathrm{Log}(DT_{0.5LPM})]^{0.5}$$

DISCUSSION AND CONCLUSIONS

A review of odor detection threshold results from over 1,000 samples of various WWTP process sources provides a statistical summary for determining emission factors for comparison to measurements made during actual testing or for estimating emissions from plants under development.

When interpreting the results presented in this paper it is important to note that all data points are based on samples received by a commercial laboratory without any qualification of the samples. For example, in the review of carbon system outlets, some high values could be the result of samples collected from systems that were tested with the expectation that they were not performing well. Additionally, variations in values are likely the outcome of the wide range of variables related to the wastewater and related air emissions.

It is also important to note that the geometric mean can be biased high due to many outlier values on the high end. It is important to not only look at the geometric mean provided in the data tables, but also the information provided by the box plots. For example, a median value that is significantly lower than the geometric mean would suggest there were several high outlier points.

The following are a list of notable results from this data review of WWTP samples:

Table 11 - Summary of Detection Threshold (DT) geometric mean results for selected process categories.

Code	Category	DT Geo. Mean
010	Blanks	13
020	Ambient/Background	40
210	Headworks	480
222	Screen Room – Screen Areas	720
230	Aeration Grit Chamber	3,200
232	Grit Bin - Basin	1,400
235	Grit Building	680
250	Influent Box	3,200
320	Primary Splitter Box / Sed. Tank Influent	2,600
322	Primary Clarifier Quies. / Sed. Tank Mid.	950
324	Primary Clarifier Weir	2,300
326	Primary Clarifier Effluent	3,000
410	Trickling Filter	1,000
424	Aeration Basin	130
444	Intermediate Clarifier Weir	230
448	Final Clarifier	100
530	Sludge Holding Tank	2,600
535	Sludge Blend Tank	7,000
540	Gravity Thickener	870
550	DAF Thickener	760
910	Carbon Outlets	200
930	Scrubber Outlets	440
940	Bio-Scrubber Outlets	1,800
950	Biofilter Outlets	200

The review of odor detection threshold values with corresponding hydrogen sulfide concentration provides a poor overall correlation. However, the graph and resulting trendline can be used in some instances to provide a fair estimate of the expected value of one variable if the other is known. It is most important to note that for higher concentrations of hydrogen sulfide, knowing the concentration will allow you to make an estimate of order of magnitude of the detection threshold. The same is not true for low hydrogen sulfide concentration. Many samples reviewed with hydrogen sulfide concentrations less than 10ppb had detection threshold values across a wide range since other chemical odorants were also present in some samples.

A review of threshold values determined at both 0.5LPM and 20LPM provides a correlation equation that can be used to take the detection threshold (DT) value from one presentation flow rate to estimate the DT value expected with another flow rate. The following equation can be used to convert threshold values in the range of 50-6,000, determined at 20LPM, to the value that would be expected at 0.5LPM:

$$\text{Log}(DT_{0.5LPM}) = 0.24 * [\text{Log}(DT_{20LPM})]^{2.0}$$

While this equation will provide a reasonable estimate when needing to compare a value determined with one presentation flow rate to the expected value determined by the other flow rate. One must keep in mind the actual value could vary depending on the source and chemistry of the odorous air sample.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the clients, staff and assessors at St. Croix Sensory, Inc. for their involvement in determination of the threshold results used for the data in this report.

REFERENCES

ASTM International (2004). E679-04: *Standard Practice for Determination of Odor and Taste Threshold by a Forced-Choice Ascending Concentration Series Method of Limits*. Philadelphia, PA, USA.

Committee for European Normalization (CEN) (2003). EN13725: *Air Quality – Determination of Odour Concentration by Dynamic Olfactometry*, Brussels, Belgium.

Water Environment Federation (2004) *Control of Odors and Emissions from Waste Water Treatment Plants*, 1st ed.; Manual of Practice No. 25; Alexandria, Virginia.