COMMUNITY ODOR MONITORING PROJECT
PUGET SOUND CLEAN AIR AGENCY - UNDERSTANDINGS & RESULTS
January 23, 2014

INTRODUCTION/PURPOSE

The Puget Sound Clean Air Agency (the Agency) initiated a community odor monitoring project in the Everett/Marysville area to gain more information about odors in those communities with the intention that it may support possible solutions to those challenges. The integrated community odor monitoring program was established with the assistance of Odotech, Inc. (Odotech) as the contracted consultant for the project. This program was intended to provide real time information about the various odors in the community, assist the community with learning more about the odors they experience, and provide information to facilities about their odor emissions so they can respond appropriately to reduce emissions.

The project has been completed and Odotech has provided its final Annual Report to document the data collected along with its interpretation of what that data means. In addition to the Odotech report, the Agency is providing this summary of understandings that the Agency has reached through the continuous involvement in managing the project, reviewing the data, and considering Odotech's final report.

EXECUTIVE SUMMARY

Key understandings (to date) reached by the Agency:

- This project was innovative and pushed both the Agency staff and Odotech to stretch to maximize the benefits that could be realized from the technology.
- The preliminary audit of odor sources in the study area was complete and identified the relative importance of each source to the odor experience in the community.
- The monitoring/modeling system for the project, and as reported by Odotech, indicated that there are three significant odor sources that can contribute impacts in the community – the wastewater treatment plants in Everett and Marysville, and Cedar Grove Composting,
- The monitoring showed significant periods of calm wind conditions during the study and those calm conditions are difficult to reliably model for predicting offsite impacts.
- The odor observations provided by the community members participating in the study were primarily (although not exclusively) identified as "composting" and "fresh waste".
- The continuous odor monitoring and modeling system used for the project can provide a source an indication that they may be creating odor impacts offsite. However, it cannot establish the actual odor concentration at any offsite location at any specific time.
- The initial data review suggests that the meteorological conditions in the area may have more influence on the variable impacts in the community rather than variable emissions from any particular source.

I. WHAT WE LEARNED FROM THE PROJECT

A. Monitoring Technology

1. Source e-nose performance is most clearly representative for concentration data

   The e-nose operations installed to monitor odorous emissions from assigned source operations were direct measurements collected continuously. These e-noses were conditioned and calibrated specifically for the source they were assigned to monitor. Once the calibration was complete, there were no additional adjustments or assumptions applied to these measurements. If the calibration for each device is accurate and e-nose operational conditions are stable and consistent with performance expectations identified by Odotech, then the source odor measurements are the most directly representative and reliable.

2. Accuracy of emission and modeled concentration data is less reliable than concentration data

   E-nose concentration data collected, along with the meteorological data, were used to estimate the emission rate for the assigned process area(s). These process areas included in the study were primarily area sources, representing ground level sources that cover large surface areas. The estimated emission rate values were combined with meteorological data to predict odor concentrations outside the source property. Both of these estimates (emission rate and offsite concentrations) rely on computational models that are based on a range of assumptions. Layered assumptions in these modeling approaches provide information of less certainty than direct measurements.

3. Meteorological data fills information gaps alone that dispersion modeling does not address well

   The meteorological data collected at the two different sites to support the project provided new insights into the complexity and interrelation of the local conditions. Even during periods where the dispersion models were not predicting offsite impacts, the meteorology showed recurring patterns that could suggest what was happening without modeled impacts or observations. Subtle differences between simultaneous data collected at the two project meteorological stations indicate that it would be difficult for observations of odors in the community to be confirmed or invalidated by the meteorological data of one station alone.

4. Ambient e-noses can sense ambient odor levels

   Prior to installing of e-noses in the community as ambient monitors, there were concerns that these e-noses would not sense ambient odor concentrations. The past use of e-noses by Odotech has primarily been to monitor source strength level concentrations. Much of the concentrations predicted by the Odowatch system were less than the expected detection/quantification levels of an e-nose in ambient service. The ambient e-noses installed in a non-calibrated OdoCheck mode of operation did see recordable values. These recorded values varied, sometimes significantly when compared to the average or baseline values (see II.A.2 below for further understandings about ambient e-noses).

B. Sources

1. The relative magnitude and potential for odor emissions and impacts were thoroughly evaluated during the audit portion of the project

   The audit portion of the project completed a comprehensive evaluation of a full range of potential odor sources in the study area. This audit placed the various sources and their relative potential to contribute to odor impacts in the area. The sources that were recommended to have e-nose technology installed for the study represented the most significant sources from this mix. Sources identified in the audit were included in the study modeling, even if they were not considered significant contributors to the community's experience.

2. Air samples analyzed for odor strength were collected from a number of the sources surveyed

   Air samples were collected (and analyzed for odors) from some of the sources included in the preliminary audit. The results of these sampling efforts were included in the deliverable documents for the study. Moreover, these sampling results were also used to refine the emission factors assigned to the sampled sources in the system dispersion modeling.

3. Odowatch systems were installed or operational on most of the significant odor sources in the study area (Marysville WWTP and Granite Construction being the exceptions)

   E-nose technology was installed at the Everett WWTP, Lake Stevens WWTP, and CEMEX asphalt plant. This was in addition to the e-noses previously installed by Cedar Grove at their site. E-noses were also recommended for the Marysville WWTP and Granite Construction asphalt plant, but the Agency was unable to reach agreements with these two sources to participate in the study. The installed e-noses and recommended e-nose installations represented the most significant and possibly variable sources of odor emissions in the study area.

4. Every source identified in the survey as a potential source of odors was characterized and included in the Odowatch modeling, even if assigned emission rates were used

   The odor study did not leave a significant odor source out of the study consideration. For sources that chose not to cooperate with the study effort, emission rates were assigned for the dispersion modeling efforts based on previous experience. Other sources for which odor sampling was completed were included in the dispersion modeling profile, too. No identified odor source was left out of the study analysis.

5. Other than the asphalt plant, the monitored source odor concentrations do not exhibit a great deal of variability. When the recorded odor concentrations did change significantly from the average level, these changes tended to be of very short duration

   Source emissions monitored by e-noses showed a general lack of variability over time. When notable changes in odor concentrations were recorded for specific sources or process areas within a source, these changes were usually of short duration (hours rather than a whole day). These shorter term concentration increases (and related estimated emission rates) were also not found on a consistently recurring basis. The one exception to this would be CEMEX, as the source was not operational on every day during the study period.

C. Observations

1. Observations are generally supported by the monitored/modeled data
   - Everett area observations match the modeled data more closely
   - Marysville area observations have a looser match to the modeled data

   This is a conclusion reached by Odotech in their final report. The Agency is in general agreement with this conclusion.

2. Observations that do not relate well to modeling results cannot always be explained through the data collected

   The reasons for this are not fully understood, but the OdoWatch® technology was not designed or set up to achieve this as a goal. The technology completes complex calculations and estimations on a real time basis (every 4 minutes). The meteorology is also complex.

3. Observations overwhelmingly identified composting and fresh waste descriptions

   The participating observers were volunteers for the project. They were evaluated to assure their sense of smell was normal (within appropriate bounds for sensitivity and ability to distinguish odor types) and they were trained to provide the information requested for the study. The portion of the observations that identified composting or fresh waste was significant relative to other types of odors reported. The qualifying and training process at the start of the study provides support to the validity of the observations made.

4. Observations included various other descriptions

   In addition to the comments in I.C.3 above, the observation records also identified other odors in the study area (e.g. sewage, biogas, asphalt). These observations, beyond composting and fresh waste were limited. What this indicates is that the trained observers were able to distinguish between odors and would report those odors observed when they filed reports.

D. Overall

1. Dispersion modeling appears to under predict actual impacts offsite from sources

   Odotech indicated that published studies by others indicate that an odor level that represents the "annoyance threshold" is 5 OU/m^3 (i.e. for unpleasant odors, the annoyance threshold is 5 times the perception threshold of 1 OU/ m^3). Comparing that information with the large number of observations characterizing the observed odors as "unpleasant" or "very unpleasant", most of them do not correspond directly to OdoWatch® modeled concentrations that indicate impacts of 5 OU/m^3, or greater. The same phenomenon was observed by Agency project staff – clear composting odors were experienced in the study area and a review of the OdoWatch® results following the field visit did not show corresponding levels of impact to match those observations.

2. Meteorological conditions appear to have the greatest influence on impacts experienced rather than source odor emission variability

   Based on a general lack of source odor concentration variability, which affects the predicted odor emission rates (see I.B.5 above), the odor impacts (both observed and modeled) follow meteorological trends more closely. The peak odor impacts identified in the study have not been linked to any specific fluctuations of odor emission rates at the source.

3. A significant amount of time during the study was characterized as "calm" winds. These calm periods do not work well with standard dispersion modeling

   The study revealed a significant amount of time where the meteorological data would be characterized as "calm" and that this type of condition makes it difficult to characterize impacts with a dispersion model during these calm periods. Odotech reported greater than 63% of the Cedar Grove meteorological data and greater than 54% of the Marysville meteorological data would be classified as "calm". Odotech further identified that 94% of the observations recorded during the study period occurred during "calm" meteorological periods.

4. OdoWatch® system can provide sources an indication that they may be creating odor impacts offsite. However, it cannot establish the actual odor concentration at any offsite location at any specific time.

   The OdoWatch® system provides information about odor emissions and possible migration of those odors offsite. Odotech concluded that many of the odor observations were supported, in some manner, by actual model results or model indications of impacts in that direction. The combined factors identified in I.D.1 and I.D.3 support the conclusion that the dispersion modeling included in the OdoWatch® system cannot establish a reliable odor concentration at a specific offsite location at any specific time. Stated differently, if an odor sample were collected (and sent to an odor panel for analysis) at the location and time an odor observation were made, it would be difficult to have that result match the dispersion modeling predicted value.

5. OdoWatch® system is unable to provide reliable evidence that an odor event identified by an observer is not being created by the source being monitored

   This conclusion is related to the Agency understandings identified in I.D.4 above. Stated differently, the OdoWatch® system is unable to prove the "negative" and does not reliably negate reported observer experiences through the dispersion modeling results for any given period of time. The approach can indicate possible odor impacts but is unable to reliably demonstrate that there was no impact.

6. OdoWatch® system data provided information and insight on what may be happening in the region relative to odors at times when no observations were made

   The study did provide a significant amount of information during periods when no observations were reported. No data collected during the study was compared to complaints received by the Agency and only the qualified observer data was reviewed relative to the monitoring systems. Prior to the study, the absence of or a reduced level of complaints received by the Agency was the only indicator of potential impacts and persistence. The OdoWatch® system provided insights to potential impacts within the community even though odor observations were not available. Patterns of meteorological data and source emissions suggest periods of possible impacts.

7. During the study period, general meteorological data suggested calm winds on a north-south axis during late evenings through early morning periods, and that more active winds are on an approximate east-west axis during daylight hours.

   These general trends regarding the meteorological data are supportive of the overall conclusions regarding the relationship between odor observations and the source emissions. It helps one understand the timing of odor observations and the conditions that can lead to an odor impact. These comments are generalized as the wind rose data shown in the Odotech report for the two stations included in the study show related, but different wind profiles.

8. The odor impacts observed or predicted in the study area have been attributed to three sources

   The Odotech report identified that the largest predicted odor impacts were from the Everett Wastewater Treatment Plant (WWTP), the Marysville WWTP, and Cedar Grove Composting. The dispersion modeling results are consistent with the preliminary audit report, which identified these three sites as potentially important odor sources in the community. However, the observation data collected indicated that composting and fresh waste were the predominately experienced odors. Since the observations did identify other odor types (albeit in limited numbers), it is clear that other odors are present. The primary reasons for the difference between the observed odors and the predicted odor impacts are not clearly understood at this time.

9. The observation data included a significant number of observations for composting that were characterized as “unpleasant” or “very unpleasant”

   With the largest number of observed odor descriptions reported as composting (122 observations) or fresh waste (43 observations), the fact that these observations were overwhelming characterized as “unpleasant” or “very unpleasant” is important to note. These composting odor observations were characterized in this manner even when the intensity of the odor was listed as “medium”. Observations for “sewage” or “biogas” were characterized as equally unpleasant, yet the number of observations that reported those types of odor were limited to a total of three.

10. Cedar Grove is a significant source of odors in the study area and the modeled impacts from the OdoWatch® system indicated that the initial composting process activity (Phase I of the Gore technology) is the most significant portion of its emissions total and projected impact

    Cedar Grove is a significant source of odors in the study area, as shown in the Odotech report (see Table 4-6 of their final report). Specifically, the average emission rates illustrate this understanding. When the OdoWatch® system predicts odor concentrations offsite from the Cedar Grove operations, the majority of that impact is generally attributable to the primary composting process are (Phase I of the Gore System). This understanding is also consistent with comparative emission rates shown for each of the three process areas at Cedar Grove.

11. Everett and Marysville WWTP were identified as significant sources of odor in the study area, based on the OdoWatch® dispersion modeling analysis. However, the lack of wastewater related odor observations does not provide as strong a support for that conclusion, in comparison to composting.

    Odotech identifies these two wastewater treatment plants, along with Cedar Grove, as the three most significant sources of odor in the study area. However, it is unclear why the dispersion modeling analysis for the treatment plants are not more readily supported by the observer reports. Odotech's final report summarizes the number of modeled values greater than 2 OU/m3 and 5 OU/m3 (see Tables 4-8 and 4-9, respectively). There may be a number of combined factors which might explain this significant difference between the modeled results and observations in the community, but it will require more detailed analysis of the data to identify those factors and assess their influence on the results.

II. WHAT WE DID NOT LEARN FROM THE PROJECT

A. Monitoring Technology

1. We do not have a full understanding of the meteorological effects on odor dispersion and impacts because:
    - Significant periods of calm wind conditions existed during the study period, which makes reliable dispersion modeling more difficult
    - Limited resources for the study provided for two sets of meteorological data to be available for the OdoWatch® system operations. Compromising assumptions were necessary to use those data sets for multiple sites

    The amount of calm wind conditions during the study period was significant and Odotech clearly identified the challenges to the dispersion modeling analysis under those conditions. When these calm conditions exist, the source's odor emissions do not stop and the potential to have accumulated odors which can move in different directions after leaving any source is not readily simulated with the dispersion modeling technology used for the project. Additionally, the limitations of two meteorological monitoring systems to support the dispersion modeling aspect of the study illustrated some of the complexities of the localized conditions. Those two data sets suggested that additional meteorological data may have been more helpful to clarify the meteorology throughout the study area. However, even if every e-nose monitored site had its own onsite meteorological data to support the dispersion modeling analysis, the dispersion models would still not have explained the full impacts of calm conditions or the behavior of plumes farther away from the site boundaries.

2. Ambient e-nose recorded concentration events do not necessary relate closely to other data collected.

    Odotech reached this conclusion and we agree with it. What we did not learn is what capability the ambient e-noses may have had if they were calibrated to any of the emissions from the significant odor sources included in the study. We understand that the ambient e-nose installation was not Odotech's original recommendation. However, installing them in an OdoCheck survey mode reduced the chances of improving this source/event relationship. The installation was experimental, but it is unclear if any further work in this area of inquiry could proceed without the concurrence and interest by Odotech.

B. Sources

1. We were unable to collect site specific samples or collect continuous e-nose data for the Marysville WWTP and Granite Construction. Thus, the actual emission levels and variability of the odor emission rates from those sites could not be evaluated

    This is unfortunate, especially for the Marysville WWTP. With the conclusion that it is one of the three significant odor sources in the study area, the lack of sampling data or e-nose data for the site prevents further

analysis to discern further understanding of the differences between the dispersion modeling results and the observer records. Of the three facilities identified to have the potential for regional odor impact, the lack of facility specific sampling at Marysville WWTP makes the data related to this facility the least certain of the three sites.

2. We were unable to collect a full year of e-nose data, since the OdoWatch® system was activated in March 2013 and operated through November 2013

   The Odotech report indicated that a full year of monitoring data was collected during a study that started in September 2012 and ended in November 2013. It is important to clarify that the odor committee started their efforts in the fall of 2012, but the e-noses and OdoWatch® systems were not completely installed and operational until March 2013. There were challenges during the initial phase of the study to obtain agreements with the various participants and to get the systems installed and operationally functional. The study was completed in November because the Agency decided that the e-nose monitoring and OdoWatch® analyses had covered the most important periods of time relative to odors in the study area (spring, summer, fall).

3. Periods of notably different or increased odor emission conditions at the sources did not lead to any assessments of the operational reasons for the change

   The study did not collect much in the way of operational information which would identify changes in operations associated with emission increases. This note is balanced with the general impression that emission changes/increases are not readily correlated with the changes in modeled impacts offsite (see I.B.5 above). We also do not have information regarding how (or if) the participating OdoWatch® monitored sources accessed or used the data for their site. They did have access to that information during the study period.

C. Observations

1. We did not have the number of observers or geographic distribution for them that we had originally hoped to include

   We greatly value the efforts and contributions by the volunteer odor observer committee members. There are a few areas which may have benefited with some additional observer presence, especially since a comparison of the modeling results to the observer data has proved useful to the study. It is understood that circumstances external to the study may have affected the interest or willingness to participate in the study.

2. No conclusions can be drawn from any specific time regarding the absence of an observation

   No speculation is possible regarding any period of time when observations were not available. The observer committee members were volunteers and the information they provided to the study was valuable. However, the absence of an observation at any point in time is cannot be assigned any significance.

III. WHAT COULD STILL BE LEARNED THROUGH FURTHER WORK

There is a large amount of data collected during the project and the Agency continues to review the details to identify further discerning facts from that volume of data. However, the one area of inquiry that would probably help us the most to understand odor impacts in the community beyond the study results presented would be an analysis of the calm wind conditions. Evaluating additional dispersion modeling techniques may provide a better characterization of the calm wind odor plume behavior and if technically appropriate, apply that selected alternative dispersion model to a selected period of the study data. Since the calm wind conditions were a significant portion of the study period (greater than 54% of the total monitored time) and the standard dispersion model has difficulty characterizing plume profiles in these calm conditions, a better understanding of what may be happening during such a significant period of time would be appropriate.