APPENDIX C

WET WEATHER SHUTDOWN STATISTICAL ANALYSIS

Metro Influent Flow Statistical Analysis

Metro Process Evaluation
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1.1. General

It has been estimated that a nominal capacity of 10-11 MGD is available at the Onondaga County Metropolitan Wastewater Treatment Plant (Metro), on an average basis, to accept the SCA effluent and comply with the current pre-draft SPDES discharge. Since average daily influent flow to Metro is well below the 126.3 MGD secondary and tertiary treatment capacity, discharging an additional 6.5 MGD on an average basis should be acceptable under average conditions. However, during wet weather events, storm related flow can cause Metro to exceed 126.3 MGD and preclude additional discharge from the SCA. To evaluate the frequency and duration of wet weather events that result in Metro flow exceeding 126.3 MGD, a statistical analysis of the most recent seven years of influent data was performed. This seven-year period was selected as the most reliable and representative dataset, based on conversations with the County. The current computer system, that records influent flow, was installed in 2001 and several industrial customers permanently terminated discharge to Metro either prior to or during this period.

1.2. Statistical Analysis

The statistical analysis focused primarily on the daily data, since decisions on whether to allow discharge to Metro are likely made on a timeframe longer than an hour. Furthermore, the analysis of daily data led to more conservative results with respect to frequency and duration of wet weather events.

Utilizing an estimated average SCA supernatant discharge of 6.5 MGD to Metro, the influent flow threshold considered in this analysis was 118 MGD (126.3 – 6.5 SCA – 1.0 DestiNY). An exceedance event ("event") was defined as a calendar day or series of consecutive calendar days with maximum hourly influent flow greater than or equal to 118 MGD. On such days, the SCA would be unable to discharge to Metro because the resulting combined influent flow would exceed the plant's 126.3 MGD secondary and tertiary treatment capacity. Note that if two events were separated by a single day with maximum hourly influent flow less than 118 MGD, the two events were grouped as a single event.

The objective of the statistical analysis was to answer the following questions, which will allow Honeywell to design in accommodations for the periods when discharge of the SCA effluent is not allowed:

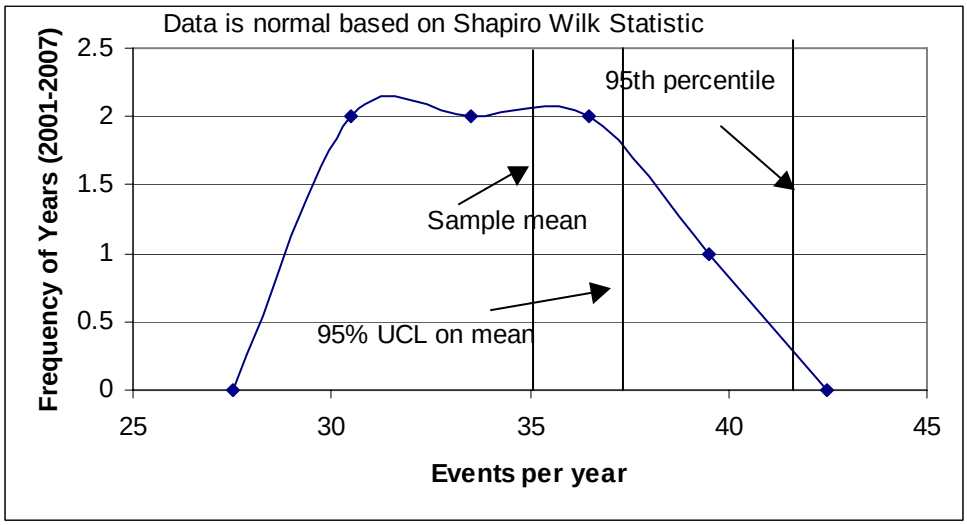
- How many events per year are expected?
- During what months are events expected?
- How long is an event expected to last?
- How often are events expected to occur?

To answer these questions, the flow data was evaluated statistically using USEPA ProUCL software (USEPA, 2007, ProUCL, Version 4.0, National Exposure Research Laboratory, Characterization and Monitoring Branch: Las Vegas, Nevada).

1.3. Expected Number of Events Per Year

Over the period 2001-2007, there were between 32 and 39 events per year, with each event ranging in duration from 1 day to 11 days long. A frequency distribution of events per year is shown in Figure 1-1. The data is normally distributed based on the Shapiro Wilk test statistic (USEPA ProUCL V. 4).

Figure 1-1. *Frequency of events per year over 2001-2007.*



On average, there were approximately 35 events per year. The 95% upper confidence limit (UCL) on that average is approximately 37 events per year, calculated using the Student's-t statistic, appropriate for a normal distribution (USEPA ProUCL V. 4). Furthermore, the 95th percentile of the distribution is approximately 42 events per year (i.e., 95% of all the data fall below 42 events per year). The 95th percentile was calculated using the Z score (standard normal variate) corresponding to the 95th percentile of a normal distribution:

$$95^{th}\ percentile = \mu + (\sigma \bullet Z_{0.95})$$

where:

μ is the 95% UCL on the mean of the data (37.3 events per year)

σ is the standard deviation of the data (2.8 events per year)

$Z_{0.95}$ is the standard normal variate corresponding to the 95th percentile of a normal distribution (1.64)

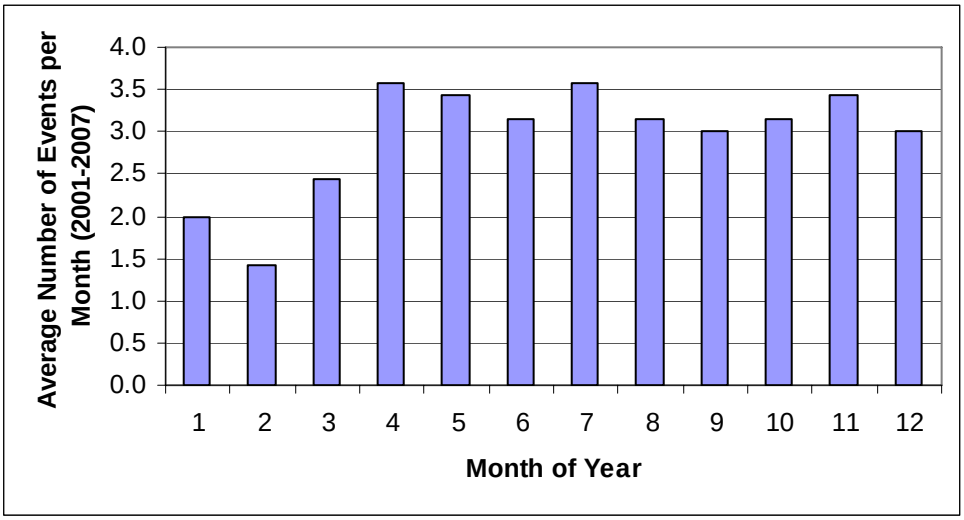
In summary, it can be stated with 95% confidence that:

- On average, approximately 37 events are expected per year
- No more than 42 events are expected per year.

1.4. Months of the Year that Events are Expected

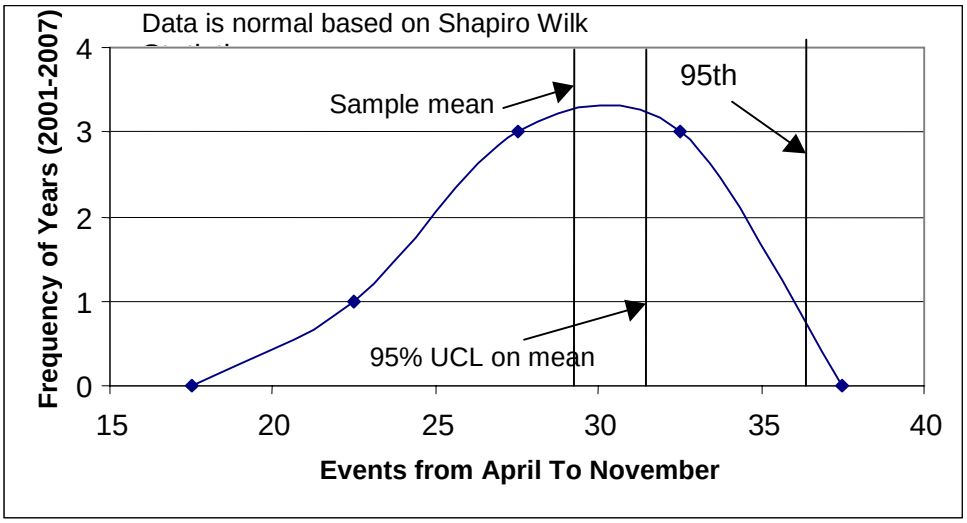
From April to November, there are on average 3 to 4 events per month. The months of November to March incur fewer events on average, ranging between 1 to 3 per month.

Figure 1-2. *Bar chart of average number of events per month over 2001-2007.*



Based on preliminary concepts, dredging at the SCA is expected to be active from April to November over a period of four years (2012-2015). Separate statistical analyses were conducted for the period April to November for comparison with analyses for the entire year. For example, the analysis of frequency of events per year yielded the frequency distribution shown in Figure 1-3 if only the period April to November is considered.

Figure 1-3. *Frequency of events over the period April to November for 2001-2007.*



Using the same approach as in Section 1.3, it can be concluded with 95% confidence that:

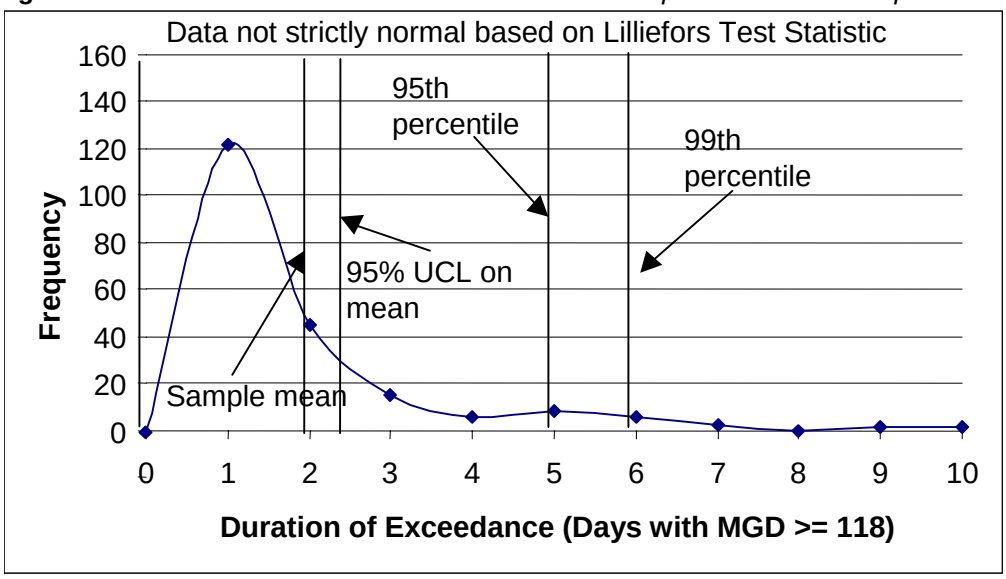
- On average, approximately 32 events are expected for the period April to November.
- No more than about 37 events are expected for the period April to November.

In general, the statistical analyses presented below are based on the April–November period since these months are considered to be representative of the period that the dredge at the SCA is expected to be active.

1.5. Duration of Events

Events for the period April–November over 2001-2007 lasted between 1 and 10 days long. Figure 1-4 presents a frequency distribution of event duration over 2001-2007 for the April-November time period. Note that the data is not strictly normally distributed based on the Lilliefors test statistic (USEPA ProUCL V. 4).

Figure 1-4. *Duration of events over 2001-2007 for the April-November time period.*



On average, an event lasts less than 2 days. When rounded to the nearest whole day, the upper bound (95% UCL) on that average is also about 2 days, calculated using the Chebyshev Theorem, which is recommended for non-parametric data (data with unknown distribution; USEPA ProUCL V. 4). Even though the data does not strictly follow a normal distribution, the 95th percentile of the distribution can be approximated as 5 days and the 99th percentile of the distribution can be approximated as 6 days, when rounding to the nearest whole day. The 95th and 99th percentiles are calculated using the Z scores (standard normal variate) corresponding to the 95th and 99th percentiles of a normal distribution, respectively:

$$\alpha^{th}\ percentile = \mu + (\sigma \bullet Z_{\alpha})$$

where:

μ is the 95% UCL on the mean of the data (2.4 days)

σ is the standard deviation of the data (1.5 days)

Z_{α} is the standard normal variate corresponding to the α^{th} percentile of a normal distribution ($Z_{0.95} = 1.64$; $Z_{0.99} = 2.3$).

In summary, it can be stated with 95% confidence that:

- On average, an event lasts approximately 2 days over the April to November period.
- An event will last no more than about 5 days over the April to November period.

Furthermore, we can state with 99% confidence that:

- An event will last no more than about 6 days over the April to November period.

Because the 95th and 99th percentiles of the distribution derived above assume that the data is normally distributed, which is not strictly true, an alternative analysis was performed to derive the upper percentiles of the data. Table 1-1 presents the frequency of event durations from 2001-2007 for the April-November time period.

Table 1-1. *Frequency of event duration over 2001-2007 for April-November time period.*

Event Duration (days)	Frequency	Cumulative Frequency
1	59%	59%
2	22%	81%
3	7%	88%
4	3%	91%
5	4%	95%
6	3%	98%
7	1%	99%
8	0%	99%
9	0%	100%
10	0%	100%

Events are predominantly between 1 and 2 days in duration, accounting for 81% of the 206 events that occurred during the April-November months of 2001-2007.

Furthermore, based on the 2001-2007 data for the April-November time period:

- 95% of events are less than 5 days in duration.
- 99% of events are less than 7 days in duration.

1.6. Frequency of Event Occurrence

In order to evaluate how often events are expected to occur, the inferences made thus far are summarized:

- In Section 1.4, it was found with 95% confidence that no more than approximately 37 events are expected over the period April to November.
- In Section 1.5, it was found with 95% confidence that an event will last less than 5 days over the period April to November; in other words, only 5% of events will last 5 or more days over the period April to November.

- In Section 1.5, it was found with 99% confidence that an event will last less than 7 days over the period April to November; in other words, only 1% of events will last 7 or more days over the period April to November.

If only 5% of events will last 5 or more days and there are no more than approximately 37 events expected over the period April to November, then only 2 events lasting 5 or more days are expected over the period April to November (2 = 5% of 37). In other words, an event lasting 5 or more days is expected 2 times per April-November period.

If only 1% of events will last 7 or more days and there are no more than approximately 37 events expected over the period April to November, then only 0.4 events lasting 7 or more days are expected over the period April to November (0.4 = 1% of 37). In other words, an event lasting 7 or more days is expected every two and a half April-November periods (1/0.4 events per April-November period).

1.7. Water Pretreatment Plant Effluent Holding Capacity

The design of the water pretreatment plant (WPTP) will include provisions for effluent flow retention so that the effluent discharge can be discontinued during periods when Metro is experiencing wet weather, high flow conditions. Effluent holding capacities of 1 day and 2 days were evaluated to estimate the number of events and duration that the SCA would need to shutdown.

Based on the frequency of event duration data presented in Table 1-1, assuming a 1 day effluent holding capacity (6.5 MG), the number of events and duration of shutdown of the SCA for the period April – November are estimated in Table 1-2.

Table 1-2. *SCA shutdown, WPTP effluent holding capacity of 1 day (6.5 MG)*

No. and % events when Metro Influent Flow >= 126 MGD						Assume WTP Effluent Holding Capacity = 1 day No. of events and duration shutdown SCA		
duration (days)	% of events	# of events	duration (days)	% of events	# of events	# of events	duration (days)	Total duration (days)
< 1	59	22	>= 1	41	15	8	0 to 1	0 to 8
< 2	81	30	>= 2	19	7	3	1 to 2	3 to 6
< 3	88	33	>= 3	12	4	1	2 to 3	2 to 3
< 4	91	34	>= 4	9	3	1	3 to 4	3 to 4
< 5	95	35	>= 5	5	2	1	4 to 5	4 to 5
< 6	98	36	>= 6	2	1	1	5 to 6	5 to 6
< 7	99	37	>= 7	1	0	0	6 to 7	0 to 0
Total						**15**	**Events**	**17 to 32 days**

Based on the frequency of event duration data presented in Table 1-1, assuming a 2 day effluent holding capacity (13 MG), the number of events and duration of shutdown of the SCA for the period April – November are estimated in Table 1-3.

Table 1-3. *SCA shutdown, WPTP effluent holding capacity of 2 days (13 MG)*

No. and % events when Metro Influent Flow >= 126 MGD						Assume WTP Effluent Holding Capacity = 2 days No. of events and duration shutdown SCA		
duration (days)	% of events	# of events	duration (days)	% of events	# of events	# of events	duration (days)	Total duration (days)
< 2	81	30	>= 2	19	7	3	0 to 1	0 to 3
< 3	88	33	>= 3	12	4	1	1 to 2	1 to 2
< 4	91	34	>= 4	9	3	1	2 to 3	2 to 3
< 5	95	35	>= 5	5	2	1	3 to 4	3 to 4
< 6	98	36	>= 6	2	1	1	4 to 5	4 to 5
< 7	99	37	>= 7	1	0	0	5 to 6	0 to 0
Total						**7**	**Events**	**10 to 17 days**

1.8. Summary and Conclusions

The statistical analysis focused on wet weather influent flow events, where an event is defined as a calendar day or series of consecutive calendar days with maximum hourly influent flow greater than or equal to 118 MGD (per previous discussion in Section 1.2). Note that if two events were separated by a single day with maximum hourly influent flow less than 118 MGD, the two events were grouped as a single event. The analysis considered daily influent flow data from 2001-2007 for the period April to November, over which the dredging operations at the SCA are anticipated to be active. Overall, the objective of the analysis was to provide Honeywell with design development information for the SCA. A summary of the statistical analyses performed is presented in Table 1-4.

Table 1-4. *Summary of Statistical Analyses.*

	April-November Analysis
Events per year (95% confidence level)	32 avg 37 max
Duration of events (95% confidence level)	2 days avg 5 days max
Duration of events (99% confidence level)	7 days max
Frequency of events	2 per year (>=5 days duration) every two and a half years (>=7 days duration)
SCA shutdown, 1 day WPTP holding capacity	15 events, total duration 17 to 32 days
SCA shutdown, 2 day WPTP holding capacity	7 events, total duration 10 to 17 days