Supplement #2 to Expert Witness Report

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On Civil Action Case:
San Antonio Bay Estuarine Waterkeeper et al vs Formosa Plastics Inc, et al, Civil Action 2:17-CV 47, in the United States District Court for the Southern District of Texas, Victoria Division

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December 2, 2018

I. Previous Expert Report and Additional Information Reviewed

In my Expert Report from July 9, 2018, I proposed a pond system as a preliminary conceptual design for Formosa's stormwater management. I noted several assumptions and limitations in the information available to me when I designed this system, including but not limited to:

1. The proposed system "does not address flood control requirements … to address the 100-year or even the 500-year storm events. Instead, the proposed system addresses the first flush caused by stormwater runoff[1]" (Expert Report at 43). In addition, my proposal was designed based on only rainfall, not additional washwater, being conveyed into the stormwater system.
2. The proposed system also addresses the pointed deficiency of Formosa's commingling of stormwaters potentially impacted by pellets/powder with non-impacted stormwater (Expert Report 19) by segregating, controlling and treating only those stormwater runoff flows that may become in contact with pellets or powders (assuming proper source controls and good housekeeping practices throughout the facility); therefore proposing a system that captures and treats only those areas where powders or pellets are manufactured or handled, which include manufacturing, storage, handling and transporting facilities for LLDPE, PPI, PPII, PEI, PEII, SPVC, PVC, warehouses (storage and packing), loading and shipping areas, etc.
3. I did not have at the time of the preparation of my report, a comprehensive hydraulic studies or information about the capacity of the stormwater conveyance system at Formosa. (Expert Report at 20-21)
4. The proposed system "assumes proper source controls … [and] it is assumed that those improvements … are not included as part of the stormwater management system or in the preliminary cost calculations." (Expert Report at 43).

Since submitting my report I have reviewed additional information provided to Plaintiffs by Formosa, including the Drainage Studies completed by Ganem and Kelly Surveying Inc. for Formosa during 2013. There was a different study conducted for each of the Outfalls 002, 003, 004, 005, 006, 007, 008 and 009. Additionally to these documents, since the preparation of the expert report, I have reviewed other documents related to the HDPE1 Pellet Project Bid Plans, South SW Pond Bid Plans and email documentation, TCEQ investigative report conducted between April and June of 2018, and additional Total Housekeeping Management (THM) Procedures. However, much of this addendum focuses on the information presented by the Drainage Studies, which was a piece of information that I was missing from my investigation.

[1] The proposed stormwater treatment system was based of the runoff caused by the 90-percentile precipitation event of Calhoun County (Precipitation =1.9 in; stormwater runoff = 0.7 in and typically associated with the first 30 minutes from the beginning of discharge or runoff), which was more conservative that the data recorded at Point Comfort's gage station.

II. Supplemental Opinions on Formosa's Stormwater Capacity

According to the 2013 drainage studies, the entire stormwater conveyance network for Outfalls 002- 009 was surveyed and modeled using HydroCAD 10.0 Software. The model was run for the 2-year storm event, which is a storm event that has a 50% probability of occurring within a given year, and corresponds to 4.6 inches of rain over a 24-hour period. According to the drainage studies prepared for Formosa, the hydraulic capacity of Formosa's system is undersized and this has important implications in the proper control of pellets and powder to ensure compliance with Formosa's permit. The details of my evaluation and assessment of the information presented in these reports, along with the implications of these findings is presented in the following paragraphs.

In general, key findings from these 2013 studies related to Formosa's drainage problems included the following:

- Poor maintenance of existing drainage facilities as indicated by silt in the culverts
- Evidence of gate valves not opened regularly due to the presence of algae and water plants
- Drainage facilities are undersized - a large percentage of the ditches and culverts within the plant are too small to handle a 1-year or 2-year storm event. A 1-year storm event has 100% probability of occurrence any given year, and corresponds to 3.5 inches of rain during a 24 hour period.
- Culverts with negative slopes - meaning that in order to flow in the appropriate direction (towards the outfall), water first flows backwards, and then needs to first accumulate and create enough water head (height of water) before moving towards the outfalls
- Ditches and long sections of pipe are undersized causing the entire network to back up into the individual plant units
- Gate valves are small relative to the culverts they serve requiring storage to detain water while being queued by the valves. The majority of the drainage network is barely adequate to handle the runoff without retaining water
- Except for conveyance systems feeding Outfalls 004 and 005, conveyance systems for all the other outfalls studied will present flooding under the modeled conditions.

More specifically relevant to drainage systems in those areas where pellets or powders are manufactured, handled, packed, stored, loaded or shipped which all drain towards Outfalls 002, 006, 008 or 009:

- Outfall 002 - numerous ditches within the PVC and VCM areas will experience flooding under the conditions modeled. Also, the main ditch discharging towards Outfall 002 is represented as a problematic area. For example, the report shows that an overflow between 1.05 and 3.12 feet is expected at least in two points of the Outfall 002

conveyance system. Based on my rough measures[2] and calculation made utilizing the site plans provided in the study, problem areas just around PVC and VCM areas include at least over 2 miles (10,600 feet) of ditches or trenches that currently flood under the 2-year storm event.

- Outfall 006 - LLDPE, PPI and PEI units main ditches and trenches would flood, and so would the main channel feeding into outfall 006 and housing internal gates PP1-001, PP1-002, PE1-001, LL-001, LL-002, and Internal Gate 005 (wheel screen), with all the ditches feeding into and out of these gates noted as problem areas. For example, the report shows that overflows of up to 4.83 feet are expected in at least in two points of the Outfall 006 conveyance system. Based on my rough measures and calculations made utilizing the site plans provided in the study, problem areas just around LLDPE, PPI and PEI include at least over 6 miles (35,400 feet) of ditches or trenches that currently flood under the 2-year storm event. Concrete channels modeled range from sizes 7'x 1.5' to 24'x5', so the sizing of these trenches varies considerably.
- Outfall 008 -The portion of PPII and PEII draining towards this outfall show that concrete channels surrounding the PEII process area would flood, and so would the concrete channel on the east side of the control room building area and the southwest block of the PPII area. For example, the report shows that overflow between 2.13 and 6.64 feet is expected in at least in six points of the Outfall 008 conveyance system. Based on my rough measures and calculation made utilizing the site plans provided in the study, problem areas just around PPII and PEII areas include at least on over 0.8 miles (3,560 feet) of ditches or trenches that currently flood under the 2-year storm event.
- Outfall 009 - The majority of the ditches on the north and south side of the SPVC unit (main conveyance ditches moving the water out of SPVC area towards Outfall 009) will flood. Also, internal concrete trenches will flood due to inadequate storage and system-wide backup. Additionally one of the grass ditches sections along the north side of PEII (discharging towards outfall 009) will flood. For example, one of the runs in the report shows that an overflow between 2.81 and 13.66 feet is expected in at least three points of the Outfall 009 conveyance system. Based on my rough measures and calculations made utilizing the site plans provided in the study, problem areas just around SPVC, PPII and PEII draining towards Outfall 009 include at least 1.6 miles (8,200 feet) of ditches or trenches that currently flood under the 2-year storm event.
- Therefore, expected flooding of the conveyance system draining towards Outfalls 002, 006, 008 and 009 is significant. There are roughly 10 miles of undersized ditches or trenches located exclusively at areas where pellets and powders are manufactured, handled, stored, packaged or shipped. These measurements do not include any other manufacturing or service areas where pellets and powders are not managed at the Formosa facility.

[2] The site plans were not print to scale and were provided in 8"x11" letter size paper. Therefore, the measures are the best estimate based on the documentation available.

Additionally, three of the critical assumptions made in the 2013 drainage studies to model the system, although industry-approved for general purposes, are not appropriate to represent Formosa's conveyance system, under-predicting the amount of flooding expected. The three assumptions were:

- Culverts and channels were modeled assuming clean conditions
- Each outfall gate is open one hour after rainfall begins
- Only rainfall is in the conveyance system, not other sources of water

First, from the drainage studies, the channels and culverts at Formosa have shown insufficient maintenance as evidence by accumulation of silt, algae and vegetation. Making the assumption of clean culverts and ditches invalid and also non-conservative. If the culverts and channels are not clean, that would diminish their storage capacity.

The second assumption assumes that the outfall gate opens one hour after rainfall begins. However, from Formosa's Procedure 51, Section 7.2 Gate Opening Procedures and per the Crabtree e-mail Re: South Pond, and information Plaintiffs have learned in depositions, it is unclear to me that this assumption is true in practice. The monitoring that needs to be conducted at the outfall gates prior to opening, includes pH (which takes 15 minutes at the lab *per outfall*), and at least previously also included Total Organic Carbon (TOC) and Oil and Grease (O&G) (which take 2 hours, and 40 minutes, respectively). These three constituents have an effluent limitation in Formosa's permit and measure of these parameters are required in compliance with permit requirements. If the opening of the outfall gates takes longer than one hour, that the conveyance system's capacity is further constrained as the stormwater runoff is detained for more time (potentially for more than twice the time) than what was modelled, meaning flooding will occur with more significance and potentially at other additional locations than what is currently shown in the study.

Finally, the drainage studies does not consider the influence of washwater flowing into the stormwater conveyance system. The model starts with the system being clear of water, and receiving as inflow the runoff originated from rainfall only, and not that coming from other sources that also gets discharged to the same conveyance system. Therefore, unless all ditches, trenches, culverts, sumps and any other element of the conveyance system are completely depleted of water before the storm begins, the study would also underestimate the flooding results. This means that, if in practice water is in the conveyance system when it begins raining, flooding will occur with more significance on those areas already identified as problem areas, and potentially other locations previously not identified would show flooding issues.

Looking in detail at those conditions modeled, it is my opinion that due to the three assumptions discussed above, it is likely that the conveyance system is in fact more compromised that what is shown in these studies.

The general significance of the undersizing of the stormwater conveyance system with respect to the control and management of pellets and powders at Formosa to avoid the release of those above trace amounts through the permitted outfalls can be found in my July 9, 2018 Expert Report (page 21): "*The hydraulic capacity of the conveyance system is critical for the proper control of pellets and powders released through stormwater. If capacity is compromised, and pellets and floating powder are in the stormwater, pellets and powders would be discharged beyond the banks of the ditch and/or would likely bypass any screening/boom targeting entrapment of floatables. Alternatively, to prevent overflow, the gates may be opened without proper visual inspection and manual removal, potentially allowing discharge of pellets and powder further downstream*". If the pellets and floating powders are discharged beyond the ditches' banks, that means that pellets would accumulate in other areas of the facility including roads, undeveloped/grassed areas, and any other surface where they could be further transported through wind, normal facility trafic, and additional rain to areas where may not be segregated from the stormwater runoff prior being discharge outside the facility boundaries. The conveyance system, when properly working, allows for runoff to flow through different pellet and powder controls (screens, booms, gabions, gates, ponds, etc.) that target the removal of these constituents prior to being discharged at designated outfalls. By contrast, if the system is overflowing, part of the flow and associated pellets/powders would then bypass these systems and would discharge without pellet/powder removal process resulting in an uncontrolled discharge.

Although the drainage studies were conducted for the 2-year storm event and results from the study conclude that the conveyance system would not be able to convey even the 1-year storm event, these events produce more rain than the ones utilized for the calculation of the first flush typically used for the design of stormwater quality treatment facilities. Meanwhile the 2-year and the 1-year event correspond to 4.6 and 3.5 inches respectively, the first flush I calculated corresponds to 1.9 inches. Looking at the overtopping depths in some areas of the system, it is my opinion that the conveyance system may not be able to convey the 1.9 inches without overtopping either, even under the current assumptions and not considering the hydraulic effects of washwaters.

However, ideally to determine whether the system can convey the first flush, the model could be run utilizing the 1.9 inches but also modifying the assumptions to reflect real conveyance maintenance conditions (the system is not clean), assume that the outfall gates are opened not within an hour, but the time period that better reflects the actual operation of the system, and the incorporation of the washwaters effect in the system. Realistically, representing in the model

obstructions created by the system not being clean of silt and debris, plus the incorporation of the washwater factors may be difficult. To overcome uncertainties, in engineering we typically account for what we call "safety factors". Safety factors vary depending on the uncertainties involved and the degree of risk that is acceptable but typically vary between 2 and 2.5. If I were to model the system exclusively for the conveyance of the first flush, I would adopt a safety factor of 2. That means that I would run the model utilizing a rain event of 3.8 inches (1.9 inches for the first flush event times 2), which would be a storm size comprised between the 1-year and the 2-year storm event at the Formosa facility.

Many times, in practice, engineers would utilize standard storm events for the design of hydraulic structures (conveyance systems including ditches, channels, culverts, flood protection ponds), therefore the use of at least a 2-year event or, more typically a bigger event (10- or 25-year event), is common even for the conveyance system of conveyance structures. The first flush is then utilized to determine the water quality volume, which is the stormwater that would need to be treated to achieve stormwater quality goals or requirements. In the stormwater pond system that I proposed in my expert report, for example, I utilized a 10-year storm event (which is bigger than the 2-year event) to design the new piping or trenches directing flow towards the water quality ponds; whereas I used the first flush to design the water quality ponds and screens (Expert Report page 46). Therefore, it is my opinion that utilizing at the very least a 2-year storm event to assess adequate conveyance capacity to transport stormwater runoff to the point of treatment is still adequate and, thus Formosa's conveyance system is undersized to accomplish this purpose.

Based on the drainage studies prepared for Formosa, the stormwater conveyance at the facility is significantly undersized to adequately convey the stormwater runoff from the point of generation to point of treatment and discharge. To ensure proper control of pellets and plastic, irrespective of the method of separation of pellets and powders from water that would be utilized (outfall screens, booms the series of ponds that I proposed, or the South Pond also proposed by Formosa), the conveyance system must first ensure that the stormwater containing pellets and powder can effectively be conveyed to any of these separation systems, and then to the designated outfalls. Therefore, the undersizing of the conveyance system is in my opinion a deficiency in Formosa's overall stormwater management system that would need to be corrected to ensure a reliable component of the overall Formosa's pellet and powder control strategy that complies with permit requirements.

III. Supplemental Opinions on Costs for Necessary Improvements

In my October 10, 2018 Supplemental Expert Report, I provided my opinion on the costs for necessary improvements for Formosa's stormwater system infrastructure and source control.

Based on new information from the 2013 drainage study and information I have learned from depositions, I make a few revisions to those opinions here.

I still believe the dollar amount for the source control bids [redacted] and the pretreatment system at the wastewater treatment plant ($216,000) are necessary.

Based on the 2013 drainage study, the stormwater ditches themselves must be redesigned and modified to manage at least a 2-year rainfall event, preferably larger. The 2013 stormwater study has limited maps of the stormwater system and reveals that building an adequate drainage system will likely be more complicated than simply expanding existing ditches, because of other infrastructure (such as culverts, streets, existing underground utilities, etc.), near the existing ditches. It is possible Formosa has already determined the costs of these necessary improvements, but we have not seen that information. I intend to review the maps available to estimate roughly the cost to build an adequate stormwater conveyance system, but have not been able to do that to date. I believe this will be a significant amount of costs, significantly more than the costs of the ponds I recommend for management of the stormwater.

I have not seen the latest plans for the South Pond and understand they are in Chinese, but I understand from information provided in depositions of Formosa employees that the South Pond is now not intended be a zero discharge system. A zero discharge system would have been more efficient at preventing the discharge of plastics from Formosa than the system I originally proposed in my first report. However, without the zero-discharge in the South Pond design, and based on the conceptual proposals I have reviewed for the South Pond, I cannot say at this time that the South Pond will be better for the purposes of reducing pellet discharges than my original designs for the water quality ponds. This means that the calculations I made for the South Pond Bid in my supplement project should be replaced with the amounts I projected for the holding ponds in my initial report: $1,678,821 (p. 48) or $2,648,723 (p. 47) would be the costs for necessary improvements to the stormwater system.