Comments on the Tradeport East Water Reclamation Facility

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Introduction

We have reviewed three documents pertaining to the *Tradeport East Water Reclamation Facility*: (1) Liberty County Development Authority Response to Public concern, (2) Liberty County Industrial Authority Wastewater Treatment Plant Fact Sheet, and (3) the CH2M-Hill Final Environmental Information Document: Water Reclamation Facility, Outfall, and Discharge to the Laurel View River. All three have described the Laurel View River receiving body as a "tidal basin."

The premise is that tidal action in the River will adequately flush away the effluent from the proposed reclamation facility. The "Response to Public Concern presents data to support this, based on a tidal prism of $1.7 \times 10^7 m^3$ $(600,000,000 ft^3)$. This estimate is larger than similar tidal creek drainage areas like the Duplin River, GA (7.4×10^6), but seems to be reasonable since no information is in the documents about the boundaries of the tidal water shed of Laurel View River.

We would like to offer some cautionary notes on the tidal circulation in the Laurel View River based on our experience in similar creeks in Georgia, South Carolina and overseas. While it is true that the creek is flushed by the tides, statements based solely on the tidal prism and simplified channel dimensions do not convey factors that substantially alter circulation patterns in the cross section and along the channel boundaries where the effluent will be discharged. These factors are discussed below.

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Flushing by tidal action

Tidal rivers and creeks in Georgia are typically shallow can have large depth changes across the channel. This fact coupled with the sinuous nature of most tidal rivers causes the flushing of the channels to be less efficient that a simple view of tidal prisms would indicate. There are two additional parameters that are equally important (Sanford et al., 1992; Moore et al., 2006).

The first is the *low-water volume (LWV)*. The tidal prism sits atop the low-water volume which is more-or-less permanently in the channel. If LWV is large relative to the tidal prism, flushing time increases. While we suspect that LWV in Laurel View River is relatively small compared to its tidal prism, allowing for relatively efficient flushing, we see no indication that a thorough determination of the tidal water shed including its LWV has been considered for this project.

A second factor. the *return-flow factor (RF)*, is likely to be significantly more important. The water that exits the creek on an ebb tide mixes with the receiving water, and this mixture is returned on the flood tide. The percentage of water that is carried away on ebb tide to subsequently return on the following flood is the *RF*. If this factor is zero, then no water is returned and flushing is completed in a single tidal cycle. If RF is one, then all the original water is returned to the creek and there is no flushing. Obviously the truth is somewhere in between these two extremes.

We have conducted flushing studies in the Okatee River SC (Moore et al., 2006), a creek tidal creek slightly smaller than Laurel View River. RF in the Okatee varied from 60% to 80%. The lower value yielded a flushing time of about 2.3 days; the higher value closer to 1 day. These times are also related to the fact that the ratio of LWV to the tidal prism is small. To firm-up flushing estimates for the Laurel View tidal water shed would require a more detailed assessment of the tidal prism, low-water volume and return flow factor than has apparently been done to date.

Effect of channel curvature on circulation patterns

The meandering channel of Laurel View River reduces the normal flushing efficiency of straight channels (Seim et al., 2009; Dronkers, 2005). The abrupt change in flow direction induces centrifugal forces that alter depth profiles across the channel, generally creating deeper water on the outside of the curving channel and shallower water on the inside. The proposed location of the outfall places it near a theoretical stagnation point (Fig. 1) which reduces the efficiency at which tidal action flushes dissolved material in the straighter channels upstream and downstream of the outfall.

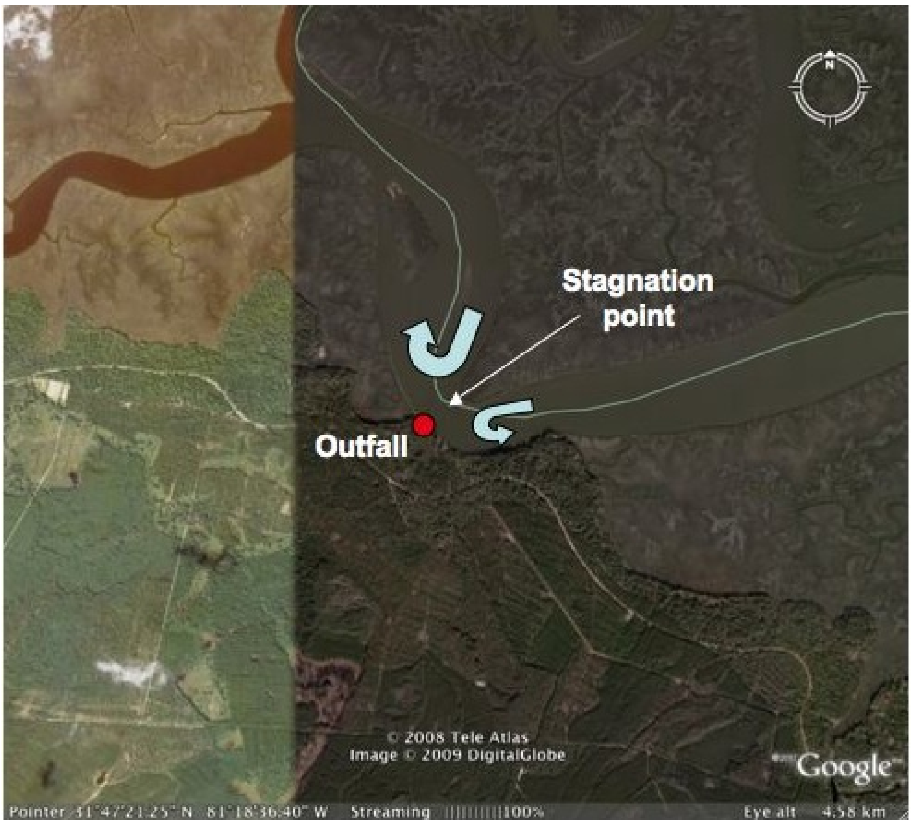

Figure 1: *Secondary circulation eddies generated by ebb and flood flow around a curving channel. The effect is to create a stagnation point that reduces flushing efficiency in the area around the outfall. The image is from Google Earth and shows the location of the outfall Laurel View River.*

Reduced efficiency causes the effluent to remain in the vicinity both upstream and downstream of the outfall plume long enough to be transported into the surrounding salt marshes. High friction in the marshes due to dense marsh grass and shallow mud flats acts to retain the effluent over many tidal cycles along the shore and into the surrounding marshes (Blanton et al., 2009). The result is to create a zone upstream and downstream of the outfall with elevated concentrations of whatever material is contained in the plume. This would likely have some impact on the ecology of the marsh.

Effect of changing water depth across the channel

It is usually assumed that the average water flow in the deep part of tidal channels is directed toward the sea. While our experience in tidal channels in the southeastern US conform to this assumption, seaward flow must be accompanied by an average flow landward in order to conserve water volume throughout many tidal cycles (Li and O'Donnell, 2005). The landward flow is theoretically found on the shallow edges of the tidal channel (Fig. 2).

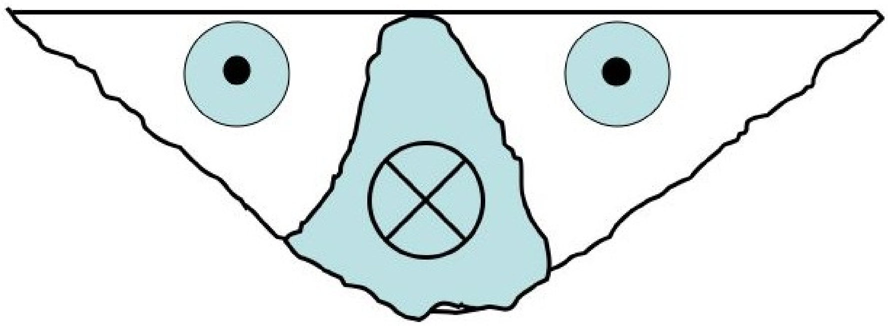

Figure 2: *Hypothetical circulation across a tidal channel showing a net landward flow along the edges (from Li and O'Donnell (2005)). The shaded zone with the "X" in a circle represents flow toward the ocean; the circles with a dot represent landward flow.*

We should not overlook this possibility since the outfall of the plant will be placed along the edge of the channel where any portion that it not transported to the center will be transported landward. The effect of this along-channel structure in the average circulation is to inhibit efficient transport to toward the ocean.

Conclusions

Local circulation patterns surrounding the outfall are more important to judging environmental impacts than the gross circulation characteristics of the Laurel View River tidal water shed. A closer examination is warranted of circulation patterns, channel morphology and the density of salt-marsh grass where the effluent may be retained by recirculating eddies in the curving channel for long time periods.

The concerns raised here can usually be tackled by off-the-shelf water quality models designed to estimate the transport and mixing of the effluent plume caused by local circulation patterns surrounding the outfall. These models are part of the toolkit of many environmental engineers and are designed specifically to address problems like those related to the proposed Tradeport East Water Reclamation Facility. Background data from accurate measurements of water depths, currents and water quality constituents in the outfall plume would be needed to get the most from these models

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