Executive Summary

Building on important research conducted by the Monmouth County Health Department, the Ramanessin Brook Nonpoint Source (NPS) Pollution Source Assessment project serves to define the link between glauconitic soils and the fecal coliform and total phosphorus impairments that have caused the Ramanessin Brook to be designated by New Jersey Department of Environmental Protection (NJDEP) as impaired in its Integrated List of Waterbodies (NJDEP, 2004). The project was proposed to the NJDEP Division of Watershed Management's 319h nonpoint source pollution mitigation grant program in September of 2002. A grant was awarded to the Monmouth County Planning Board in the summer of 2003, and the project was initiated in October of 2003 as a partnership among Monmouth County Planning Board, Navesink – Swimming River Group, and TRC Omni Environmental Corporation (TRC Omni).

TRC Omni collected and reviewed existing information, and built upon the findings of the initial study that found that properties of glauconitic soils cause phosphorus to adsorb to sediments and may create a sustainable habitat for fecal coliform bacteria. With increased flows and velocities from stormwater plaguing the Ramanessin Brook, this project was planned to better understand the degree to which erosion of glauconitic sediments in the stream channel causes the high concentrations that impair the waterway. To determine baseline water quality in the watershed, water quality sampling and analyses were performed. A total of five stream sampling station locations were sampled bi-weekly from July 2004 to June 2005, and one background station was sampled six times from July 2004 to October 2004. These samples were analyzed for total phosphorus, dissolved reactive phosphorus, fecal coliform, fecal streptococci, total suspended solids, and iron. In addition, sediment samples were collected and analyzed for total phosphorus, fecal coliform, and iron. TRC Omni also collected flow data and surveyed cross sections approximately every 500 feet along the mainstem of the stream.

To understand impacts of stormwater, TRC Omni developed hydrologic, hydraulic, and nonpoint source pollutant loading models of the watershed. Hydrologic modeling was performed in order to quantify the response of stream flows to precipitation. The Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), and the Hydrologic Engineering Center's River Analysis System (HEC-RAS), both developed by the United States Army Corps of

Engineers, were used to simulate surface runoff originating in different areas of the Ramanessin Brook watershed and route the flow of the water through the stream network under various storm events. DAFLOW, developed by USGS, and WAMIT, developed by TRC Omni, were used to simulate velocities in the stream and to perform shear stress analyses to quantify erosion potential of the stream bed under various flow conditions. Finally, a pollutant loading model based on event mean concentrations (EMCs) was used to estimate expected nonpoint source pollutant loads for total suspended solids (TSS), total phosphorus (TP), and fecal coliform (FC) from surface runoff in the watershed.

Using these watershed modeling tools, several analyses were performed, including:

- Evaluating and mapping glauconitic soil erosion potential;
- Calculating peak flows and total stormwater volumes for individual subwatersheds using pre-developed, existing, and projected build-out land use conditions;
- Calculating shear stress in the stream to understand erosion of sediment under various flow conditions;
- Evaluating pollutant loading for total suspended solids, total phosphorus; and fecal coliform in individual subwatersheds, and
- Assessing water quality for the entire watershed using all available data.

These analyses provided insight into characteristics of the watershed that impact the Ramanessin Brook. The peak flow and total stormwater volume calculations demonstrate that any changes in watershed land uses that affect runoff have a more significant impact during storms of lower intensities than during storms of higher intensities. The simulations indicate that stormwater and watershed management implemented at a sub-watershed level can significantly impact peak flow rates and volumes during the smaller, more frequent storms that contribute the majority of the rainfall in the State of New Jersey over a given year.

In addition, these analyses demonstrate that land use changes that have already occurred have produced a much larger impact on storm runoff than any changes that might result from future development. Since the analyses performed do not account for BMPs, including those required for new development, they tend to overestimate the impact of new development. Despite this, the analyses show that existing development has had a more profound impact on stormwater characteristics than new development could. As a result, retrofits of existing infrastructure might be more beneficial than additional requirements on new development.

The shear stress analysis demonstrates that the shear stress at all the sampling stations in the Ramanessin Brook is considerably higher than the shear stress that would cause erosion during nearly all the rainfall events. From this, we can conclude that the stream bed of Ramanessin Brook is eroding during most rainfall events. Our analyses show that stormwater reduction BMPs would do little to prevent the stream bed from eroding.

The pollutant loading analyses for phosphorus clearly illustrates the importance of erosion of glauconitic soils, both from the watershed and in the stream itself, as a major source of phosphorus in the Ramanessin Brook. Phosphorus is highly correlated with TSS, iron, and turbidity. These correlations get stronger at downstream locations. Furthermore, the ratio of observed instream loads to estimated runoff loads increases dramatically at downstream locations. In other words, the observed levels of phosphorus at downstream locations cannot be fully explained by runoff loads. All of these observations show the importance of instream sediment erosion as a major source of phosphorus.

Total suspended solids (TSS) is also highly correlated with flow. In fact, during high flows, TSS exceeds the FW2-TM criterion in downstream areas. Furthermore, the ratio of observed instream loads to estimated runoff loads increases dramatically in downstream locations. In other words, the observed levels of TSS at downstream locations cannot be fully explained by runoff loads. Based on all these observations, instream erosion also represents a major source of TSS.

Fecal coliform analyses illustrate that samples taken during the summer have much higher fecal coliform concentrations than those taken during the winter. In fact, the 30-day geometric mean criterion appears to be exceeded at all sites, including the reference station, during the summer. However, the fecal coliform concentrations at the stream locations are much higher than at the reference location. High levels of bacterial contamination are observed at both low and high flows. During low flows, fecal coliform concentration increases as flow decreases. This indicates a constant load that gets diluted by baseflow, such as failing septic discharges or perhaps direct deposition by resident waterfowl or other wildlife. During high flows, fecal coliform concentration also increases as flow increases. This clearly indicates high runoff loads being delivered to the stream. Fecal coliform appears to be correlated with TSS during high flows when TSS is high.

While only two sediment samples were analyzed for fecal coliform, no bacteria was observed in one sample, and in the second, bacteria was only observed at the minimum detection limit of 10 colonies/gram. Furthermore, the ratio of observed instream loads to estimated runoff loads does not increase substantially at downstream locations, and is generally less than one. In other words, the observed fecal coliform levels may be explained based on runoff and baseflow loads. This study did not find any evidence for the proposition that fecal contamination is caused by erosion of bacteria-rich sediments.

Based on these findings several recommendations are set forth for further analysis and mitigation of nonpoint source pollutants in the Ramanessin Brook watershed (See Chapter VI).