

CONCLUSIONS AND RECOMMENDATIONS

The rural communities of Lanark Village and Carabelle are representative of medium density residential communities. Under current conditions, based on the water quality results presented in this report, storm drainage discharges from these two basins do not appear to present a significant threat to receiving waters. The Carabelle drainage basin base flow indicated occasional depressed dissolved oxygen levels and moderate increases in nutrients such as ammonia nitrogen, total Kjeldahl nitrogen, and nitrate/nitrite, possibly indicative of sewage contamination, perhaps from leaking and poorly maintained septic tanks or aging treatment systems, cross connections, or illicit connections. Without future development, these basins would have continued to cause little impact, assuming that current rules requiring adequate stormwater and erosion control practices were followed. Based solely on the water quality data in this report, a plan to address aging septic tanks or sewage treatment plants may be needed, as well as a plan to locate and eliminate illicit discharges and connections. Future development and other alterations of current land use in Lanark Village will, if not carefully planned and executed, cause future water quality problems. Carrabelle, however, is currently undergoing serious development pressures, and little control is being exercised to implement stormwater controls. It is generally accepted that with increasing levels of development, water quality often suffers, and the data presented in this report generally substantiates this assumption. The less developed areas of Lanark Village and Carabelle displayed a lower pollutant loading than the more developed City of Apalachicola, suggesting that increased development often results in increased pollutant loading from nonpoint sources.

The unincorporated community of Eastpoint is a typical low to medium density residential area. Despite having a lower residential density level than either Lanark Village or Carabelle, the Eastpoint drainage basin showed greater impacts to water quality attributable to development than either of the other two basins. Elevated total and fecal coliforms, and nutrients such as ammonia nitrogen, total Kjeldahl nitrogen, nitrate/nitrite, phosphorus and orthophosphate, as well as depressed dissolved oxygen in the base flow is suggestive of contamination by sewage, possibly from leaking and poorly maintained septic tanks or a sewage treatment plant, cross connections, or illicit connections. Baskerville-Donovan and CH2M-Hill (1992) suggested that other sources of fecal contamination from the Eastpoint area included dog pens, chicken coops and pigs along the main channel. Due to the large natural areas in Eastpoint, it has been demonstrated that the coliform contamination is from both human and animal origin. Strains of *E. coli* from both sources were isolated during the MAR sampling and testing detailed earlier in this report. Increases in turbidity, suspended solids, copper, and zinc were observed during storm sampling events. The elevated turbidity and suspended solids during storm events are typically indicative of poor construction, dirt roads, or other erosion control practices. To address future growth, reevaluation and possible expansion of Eastpoint's existing Stormwater Management Master Plan (1992) should be undertaken, which might include consideration for preservation of wetland areas, adoption of best management practices, and regional stormwater management facilities

for the 877-acre drainage basin. Further efforts are needed to identify and address possible septic tank or sewer line problems, as well as illicit connections. An examination of the functionality of a sewage treatment plant sprayfield located on the north side of the watershed is also recommended, as well as investigations of a sand mine immediately above of the sampling site. For stormwater management planning and design, Eastpoint may need to consider a stormwater utility for future growth in these developing watersheds. Expansion of the Baskerville-Donovan and CH2M-Hill 1992 HYMO (US Department of Agriculture) model into that developed for the City of Apalachicola as part of this study would be extremely beneficial and is highly recommended, as the previous model used a regional equation to estimate time peaking time, and was not specific to the Eastpoint drainage basins.

The City of Apalachicola is a medium to high-density residential community, which includes several industries. There are several storm sewer outfalls within the city, two of which were used as water quality monitoring sites for this study. The storm drainage network is considered to be antiquated and unable to meet current stormwater management and treatment standards. This is not surprising, as most of the infrastructure was planned and constructed prior to the onset of stormwater quality rules, and rate controls have only recently been a consideration to designs. According to the city's local government Comprehensive Plan, the existing system has deteriorated and is undersized. Sedimentation from eroding ditches and overgrown or filled culverts also plagues the system. Direct infiltration into the municipal wastewater collection system has resulted in secondary wastewater overflows into receiving waters during sustained storms, as treatment systems are hydraulically overloaded.

Most of the stormwater outfalls in the City discharge untreated stormwater directly into the bay. This condition has resulted in degraded water quality and increased flood hazard potential, which will only increase in severity as time progresses and the system continues to degrade. Impacts to base flow are evidenced by depressed dissolved oxygen concentrations, increased specific conductance, elevated total and fecal coliform and fecal streptococci colony counts, and increased nutrient levels, such as ammonia nitrogen, total Kjeldahl nitrogen, nitrate/nitrite, phosphorus, and orthophosphate. The problem is exacerbated by storm events, which produce marked increases in turbidity, total suspended solids, copper, lead, and zinc, as well as further increases in selected nutrients such as nitrate/nitrite, phosphorus, and orthophosphate.

As part of this study, NFWMD developed a computer model to simulate stormwater quantity and pollutant loading for the "downtown" area of Apalachicola. This area corresponds to subbasins 1 through 38, or approximately 17% of the delineated subbasins identified as part of this study. Based on the results from the model and storm event monitoring, this area of the city contributes an annual average according to projections and calculations, 2458 pounds of suspended solids, 6.6 pounds of ammonia nitrogen, 56.6 pounds of Kjeldahl nitrogen, 13.5 pounds of nitrate/nitrite, 13.2 pounds of phosphorus, and 5.5 pounds of orthophosphate to the estuary. As an example to place these annual load estimates in the proper perspective, the estimated load of dissolved inorganic nitrogen at the mouth of the Apalachicola River is about 1.5×10^4 kilograms per day.

Analysis of discharge by subbasin also suggested some interesting concepts. Subbasin 2 is 18.3 acres in size, approximately ten percent of the modeled study area. It is approximately 86.9% medium density residential and 13.1% institutional, based on current land use maps. Calculations based on the estimate of discharge per subbasin suggests that Subbasin 2 may contribute an aggregate average of approximately half of the total annual pollutant load, based on an analysis of six selected pollutants (total suspended solids, total Kjeldahl nitrogen, phosphorous, copper, lead and zinc). The estimates of pollutant load per subbasin were calculated using samples at one site for each watershed. All subbasins within a watershed were given the same concentration; thus, calculated loading was a function entirely of the estimated discharge from each subbasin, which limits the reliability of the analysis. Clearly, additional investigation is needed to fully investigate the discharges from this subbasin and others like it.

Deteriorating neighborhoods and crumbling infrastructure all contribute to the stormwater contamination problem from the City. Percentage of impervious surface, lack of ground covers, omission of erosion controls during and after construction, and inappropriate land uses all contribute to the annual pollution load. As previously mentioned, Subbasin 2 may contribute an inordinate share of the annual average pollutant load from the City to the bay. This basin is categorized as an economically depressed area, with decaying, substandard housing and crumbling infrastructure. Subbasins 39, 41 and 42 were not included in the model development, but are adjacent to Subbasin 2 and similar in characterization. It is reasonable to assume that the discharges from these basins would be similar in nature to that of Subbasin 2, and may also contribute large amounts of stormwater contamination to the Bay. Explorations into potentially available funding sources for urban renewal as a nonstructural type of control measure, along with drainage basin retrofits in these areas could help to alleviate a large percentage of the total annual pollutant loading entering the Apalachicola Bay from the City.

The computer model previously referenced also simulated stormwater volumes and return frequencies for the City of Apalachicola, and modeled the stormwater management system's response to a variety of real and synthesized storms. As mentioned, the model simulated the city's stormwater management system as though the pipes, swales and ditches were clean and unobstructed. The model predicted that, even with this optimizing assumption, a rainfall of only 1.4 inches was sufficient to cause flooding in the majority of manhole junctions, demonstrating the magnitude of the system undersizing issue. The flooding problem is exacerbated by the current condition of the system. According to the city's Comprehensive Plan, the system is clogged with sedimentation and vegetation, which further reduces its carrying capacity. Additionally, the surcharging of the conveyance system can cause excessive pressure on old, brittle pipe walls, which ultimately may lead to collapse of the pipes and further sedimentation and aggravation of the problem.

Future stormwater management programs initiated for the City should include water quality considerations, repair and expansion of the system, additional investigation into the suspected sewage contamination of the streams via cross connections or illicit connections, and retrofitting drainage basins. The SWMM model of Apalachicola

developed for this project is capable of being expanded and enhanced to include subbasins not previously modeled, and can be a valuable tool to assist in the development of these management efforts. A program to address the clogging of storm sewers with sand and vegetation could realize some level of immediate relief for flooding and pollution problems, although the system would remain undersized to carry anticipated flows.

The SWMM model has been developed with a number of capabilities for future analyses. It is a powerful evaluation and design tool to quantify loading to the bay from local municipal sources. It would be highly beneficial to apply these modeling techniques for the communities of Eastpoint, Lanark Village, and Carrabelle, as well as areas that may continue to develop or in need of repair in the vicinity of Apalachicola. These models more completely categorize the discharges from the drainage basins and identify and prioritize potential problem areas prior to making large expenditures to retrofit these areas with stormwater controls. Time, effort and resources can be saved by identification and characterization of problems prior to the implementation of structural and nonstructural improvements to the stormwater management system.

With regard to SWIM program managers and other state and local resource managers, the following actions are immediately recommended:

1. Additional investigation into upland sources of sewage and other sources of coliform contamination, and further testing of the MAR techniques to finalize their usefulness in identifying sources.
2. Assist the Cities of Apalachicola and Eastpoint in finding funds for urban renewal programs, waterfront revitalization attempts, and in the development of stormwater retrofit plans.
3. Identify, map and field verify possible sources of sewage contamination entering the stormwater management systems of all communities through illicit connections, cross connections, and sewage overflows.
4. Based on the loading data and techniques presented herein, efforts should be made to evaluate future cumulative impacts of development throughout the Bay area.
5. Investigation into upstream riverine anthropogenic inputs into the study area.

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