Water Resources Management in the Halifax River Watershed

Denver J. Stutler, Jr., Scott H. Martin, Michael F. Schmidt and Brett A. Cunningham

Volusia County obtains its potable water supply from a sole source aquifer that makes water resource management an important issue to the residents. In 1990 the county began a comprehensive Stormwater Control, Conservation, and Aquifer Recharge Program (SCCARP) to protect and enhance water resources in the county.

The primary goals of the SCCARP were to:

- Resolve current flooding problems and property manage new development;
- Address the complex water quality issues of nonpoint source (urban runoff) pollutant loading to receive waters on a coordinated multi-jurisdiction basis;
- Conserve water resources where possible, including wetlands management; and
- Increase the level of groundwater recharge to the sole-source aquifer to protect and enhance public water supplies.

In September 1993, the Halifax River Watershed Management Plan was begun as a part of the implementation of the SCCARP. The purpose of this study is to identify and prioritize water quantity (flooding), water quality (nonpoint source pollution), water conservation, and aquifer recharge needs in the watershed, as well as to provide estimates of the associated costs required to provide the levels of service (LOS) the county desires.

Levels of Service

In the last decade, stormwater management has become a complex national issue. In the past, ditching and draining to convey stormwater away from development, coupled with filling of floodplains and wetlands, was the accepted practice. Over the years, flood damages along with adverse impacts to water quality, fisheries, scenic areas, recharge areas, and wildlife habitats have forced a change in the accepted approaches to manage stormwater.

Volusia County is similar in characteristics to other coastal communities regarding stormwater service. Many of the county's older stormwater systems provide inadequate flood protection for streets and little or no treatment of the runoff due mainly to a "piecemeal approach" to stormwater management and the age of the existing infrastructure.

Proper LOS decisions for water quantity (flooding) and water quality protection are essential for an implementing entity because those decisions set the goals for a Capital Improvement Program (CIP) that establishes the intent of public and agency involvement.

Water Quantity Retrofit

The LOS for water quantity (flood control) retrofit is an essential decision within the SCCARP. It will directly affect the size and cost of facilities. For example, Class D provides for flood protection of first-floor elevations (FFE), evacuation routes, and arterial roads, while Class C provides control of flood waters to less than 0.5 feet over the arterial/evacuation road crowns. Table 1 provides a lost of water quantity LOS goals used in the alternatives evaluations.

Water Quality Retrofit

Water quality LOS are generally based on a "first flush" abatement of pollutants for new developments. Retrofit LOS are often established separately due to technical and financial constraints. In general, water quality retrofits are required if flooding solutions are implemented or if a clear cause-and-effect relationship of water quality degradation or impaired use can be attributed to a source. Recent revisions to the State Water Policy (Chapter 17-40, Florida Administrative Code) defines goals that require existing development to retrofit for water quality treatment within a framework of basin-specific goals or rules.

Physical Description

The study area contains the Halifax River Watershed. The Primary Stormwater Management System (PSWMS) in the

Table 1. Water Quantity Levels of Service—Flood Protection Goals and Classes(1)

	10-Year		25-Year		100-Year	
Structure/Facility	**10-Year**	**Class**	**25-Year**	**Class**	**100-Year**	**Class**
Houses/Buildings	<FFE(2)	D	<FFE	D	<FFE	D
Evacuation Routes(3)	1/2 W(4)	B	1/2 W	B	1/2 W	B
Arterial Roads(5)	1/2 W	B	1/2 W	B	1/2 W	b
Other Roads(6)	<0.5 ft	C	<0.75 ft	D	<1 ft	NA

(1) All storm durations are 24 hours.
(2) Peak flood stages less than the FFE based on available data.
(3) Evacuation routes as defined by the county and East Central Florida Regional Planning Council.
(4) Flood inundation limited to each side of the road such that half of the roadway width (W) or one travel land width is not flooded.
(5) Roads with four or more travel lanes, or roads that are the only access to a respective area/development (secondary evacuation routes).
(6) Other roads that are not critical for evacuation, but that will be used to estimate encroachment of FFEs.

study area consists primarily of storm sewers and facilities 36 inches in diameter or larger.

The Halifax River Watershed is located along the eastern portion of Volusia County. The watershed contributing area is approximately 47.7 square miles. Elevations in the watershed range from a high of approximately 30 feet NGVD (referenced to National Geodetic Vertical Datumof 1929) to a low of mean sea level. The watershed is highly developed with commercial and high density residential land uses in the southern portion and mixed development in the northern portion.

The Halifax River system is a coastal estuary. Its tidal outlet to the Atlantic Ocean is at Ponce Inlet where it interconnects with the Indian River Lagoon, Mosquito Lagoon, Spruce Creek, and Turnbull Creek watersheds. Significant drainage influences by man have altered natural hydrologic cycle processes such as the 1927 United States Department of the Interior construction of the Halifax Canal which is comprised of the Nova Road, Eleventh Street, and Halifax segments.

Nonpoint source pollutant sources include the numerous directly connected stormwater outfalls to the Halifax River as well as the canal systems that discharge to the Halifax River.

Methodology

Evaluation tools included the EPA Stormwater Management Model (SWMM) for water quantity and the CDM Watershed Management Model (WMM) for water quality. Both are accepted public-domain models well suited to the types of analyses in this program. SWMM and WMM are accepted by EPA, SJRWMD, and DEP.

Alternatives Evaluation

Four alternative solutions were considered to establish a phased prioritization of improvements in each study area. In accordance with the water quality retrofit goals of this study and with permit requirements, BMPs were sited to the extent practicable. The cost of retrofitting the hydrologic units with onsite BMPs was also evaluated to use as a comparison to the cost of other alternatives.

Potential water quality impacts on receiving waters were evaluated by comparing annual and seasonal pollutant loads to the Halifax River under present and future conditions as well as under the proposed alternatives.

The evaluation of the alternatives is based on providing the county with a desired LOS for the Halifax River Watershed. The alternative evaluations are based on the following factors:

- Implementation constraints for both structural and non-structural alternatives, including present condition retrofits and/or modifications, and future growth planning; and
- The ability to implement regional, integrated water quantity and quality management alternatives for the watershed.

Findings

Once alternatives were identified, the models were used to consider the effectiveness of each proposed alternative.

Non-structural controls aid in the control of both the water quantity and water quality aspects of stormwater. Non-structural controls are not capital projects that are constructed but rather are source controls, ordinances, and regulations which depend on participation by municipalities and residents to minimize the water quantity and quality impacts associated with development.

A summary of recommended non-structural controls includes public information program, fertilizer application control, pesticide and herbicide control, solid waste management and control of illegal dumping, directly-connected impervious areas (DCIA) minimization, water conservation landscaping, NPDES illicit connections—identification and removal, erosion and sediment control on construction sites, stormwater management ordinance requirements, and stormwater management system maintenance.

The structural controls recommended for the study area were evaluated based on benefits provided versus need, costs, and contributing area to develop relative cost-benefit comparisons. The relative benefits compared include:

- Flood control based on problems solved;
- Nonpoint source pollution control based on the reduction of nonpoint source pollutant loads;
- Wetlands management based on the potential for beneficial use of wetlands;
- Aquifer recharge based on increased annual infiltration volume;
- Recreation/parks based on multi-purpose facilities;
- Potential for coordination with ongoing projects or programs with other governmental entities or developers; and,
- Amount of DCIA as an indicator or urbanization and population served.

Conclusions

The most cost-effective alternative evaluated utilized shallow grassed swales with raised inlets and other retention type facilities as a principal component in the Best Management Practices (BMP) treatment train as a retrofit in this highly urbanized watershed. The alternatives were also evaluated using Corps of Engineers Storage, Treatment, Overflow Runoff Model (STORM). The results of the STORM analysis indicated a capture of approximately 90 percent of the average annual runoff.

The recommended alternative, in order to be implemented on a watershed wide scale, must include a thorough public information program to help overcome possible misconceptions by residents located in areas where retrofit is required to achieve the SCCARP goals.

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Denver J. Stutler Jr. P.E. was with Camp Dresser & McKee, Orlando, at the time of the study. He is now with ECOBANK, Winter Park. Scott H. Martin, P.E., is Volusia County drainage engineer. Michael F. Schmidt, P.E. is a senior water resources engineer and Brett A. Cunningham, P.E., is a water resources engineer with CDM, Jacksonville.

One More Way to Estimate Pollutant Loading Rates

Ronald L. Bartel, Ruben A. Arteaga, and Felton B. Ard

Estimating stormwater pollutant load from various land use types is commonly an over simplified process for which there is no universally accepted approach. Of the two conventional approaches, the most common estimating procedure relies on a mass-per-unit-area value. The other computes loads based on very simple runoff volume estimates. Neither approach was used in this study because the resulting estimates would have been too coarse for determining the amount of treatment required to meet pollutant load reduction goals and observed loading data was not available.

The alternative was to simulate runoff from each individual land use area as a subwatershed and estimate loads based on locally available event mean concentration data. A geographical information system (GIS) data base was used to differentiate all the runoff model parameters and pollutant characteristics for each individual land use subarea. The result was not only an improvement in pollutant loading data for analyses of treatment processes, but also an improvement in runoff estimates. This loading rate estimating procedure is recommended over the conventional types mainly because the error attributed to runoff can be minimized and the process used is relatively effortless with the use of modern data bases and computer facilities.

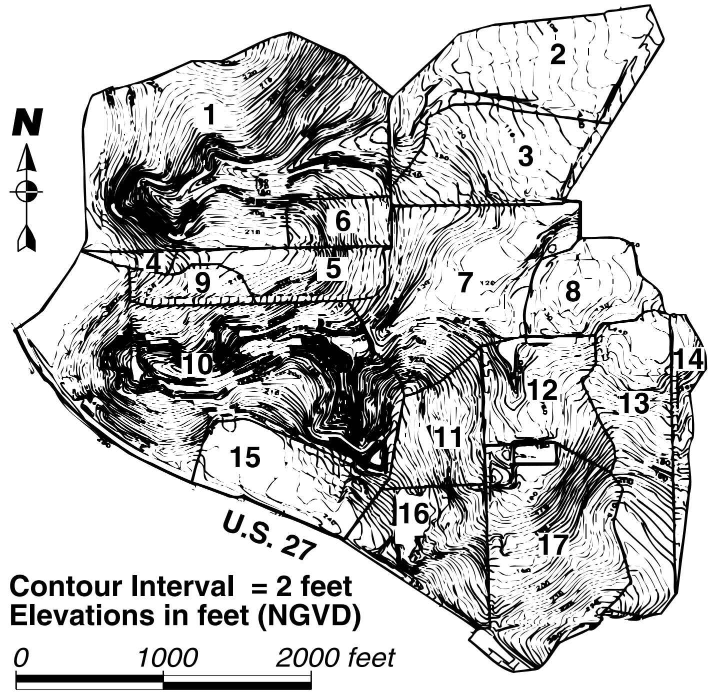

Figure 1. Subbasins Overlay on the Example Watershed Topography

Loading Rate Estimating Procedure

The loading rate estimating procedure described in this report is computationally straight forward. The concept employed is to make use of modern day computers, data bases with large amounts of geographical data, and a stormwater model. The model of choice in this case is the EPA Stormwater Management Model (SWMM). Although a nontraditional modeling approach is used for delineating subbasins, the steps involved are simple. The input data set for the stormwater model is obtained as overlays from a GIS. The GIS overlays processed for data development are topography, impervious area, land use, channel locations, pond delineations, and wetlands. As an example, a watershed was initially subdivided for model development into 17 areas as shown in Figure 1. These 17 subbasin delineations were based on topographic and channel data. The model data was then further refined and aggregated to smaller model subareas based on the land use within each subbasin. Figure 2 is the land use overlay which represents the 49 subarea delineations used in the model. For each of the subareas the GIS was used to compute model parameters of basin area, slope, imperviousness, and soil properties.

Without the GIS the 49 subarea delineations used in the model would normally not have been tried, because it would have been a very time consuming manual process. Typically, the stormwater model would have been used to compute the volume of runoff from the individual subbasins and the runoff volume would be multiplied by the percentage area of a particular land use. This approach is often taken simply for convenience or due to SWMM limits on the number of land

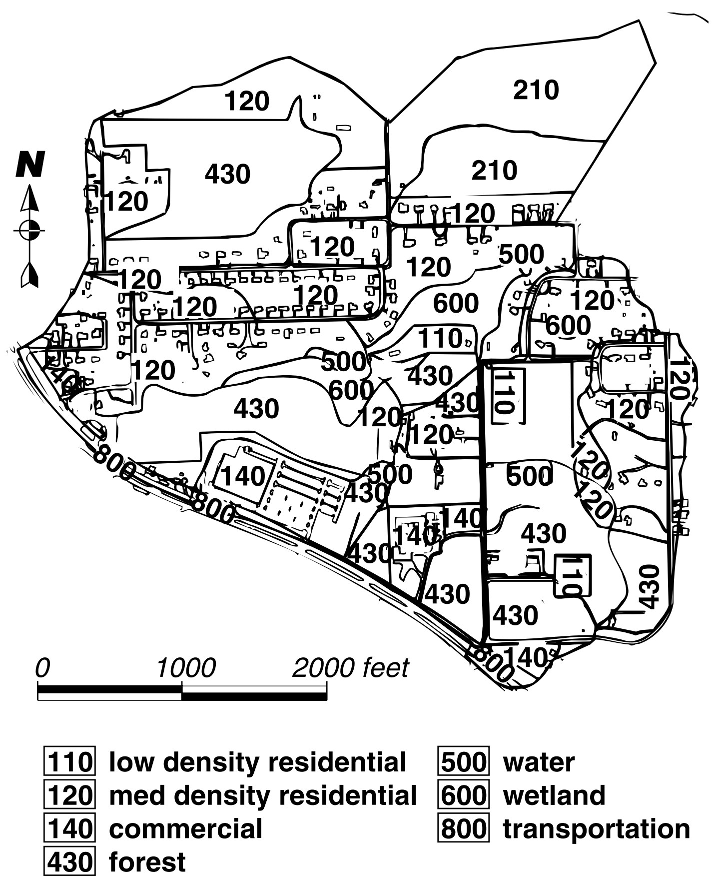

Figure 2. Land Use Subareas

uses that can be specified. However, it totally disregards the variability in runoff amounts which occur between different land use types.

Another influencing factor in the use of a more refined modeling approach is the possibility of improvements in the simulation of runoff amounts. The accuracy of the model with 49 subbasins was verified with model tests using the observed hydrograph data that was originally used to calibrate the model with only 17 subbasins. Side by side comparisons between each of the model results were within about 1 percent of each other, and the 49 subbasins' model compared slightly better with the observed data (5.6 percent error versus 6.1 percent error for hydrograph peaks). Figure 3 provides comparisons of the model simulated hydrographs with observed data at one of the downstream pond locations used for model calibration.

There are other more common approaches (EPA, 1992) for estimating stormwater loads, but these are much simpler than the approach applied here. Literature based loading rates are often applied with no hydrologic data. Some are a function of very crude estimates of the annual runoff amount derived from average rainfall. Depending on the hydrologic conditions and the desired level of analysis, these loading estimates are likely to be very inaccurate. For the 49 subarea example the pollutant load calculations were all performed by using SWMM to simulate runoff volumes within a specified time step and multiplying by the event mean concentration of the corresponding land use type. There were a number of advantages to using this method. Pollutant loads could be analyzed during individual storm events as well as for a series of storms. Evaluation of pollutant loading effects during individual storm events were particularly useful when considering the hydraulic efficiency or storage capacity of a stormwater treatment facility.

Table 1. Model Estimated Loading Rate Results for Selected Land Uses

Sub-Basin #	Area (ac)	Land Use Code (acre*ft)	Avg. Annual Flow (ft)	Avg. Annual Runoff	Con. (mg/l) P P	Annual Load (lb)	Rate (lbs/acre) P
1	13.6	110	3.218	0.2366	0.45	3.974	0.292
1	20.13	120	9.939	0.4937	0.6	16.365	0.813
1	22.44	430	4.021	0.1792	0.08	0.883	0.039
2	22.63	200	8.804	0.3890	0.32	7.732	0.342
3	5.96	120	2.557	0.4291	0.6	4.211	0.706
3	11.9	200	1.658	0.1393	0.32	1.456	0.122
4	1.52	120	0.762	0.5015	0.6	1.255	0.826
5	9.64	120	13.918	1.4438	0.6	22.917	2.377
6	6.29	120	9.663	1.5362	0.6	15.910	2.529
7	15.46	120	10.912	0.7058	0.6	17.967	1.162
7	3.52	430	1.483	0.4213	0.08	0.326	0.092

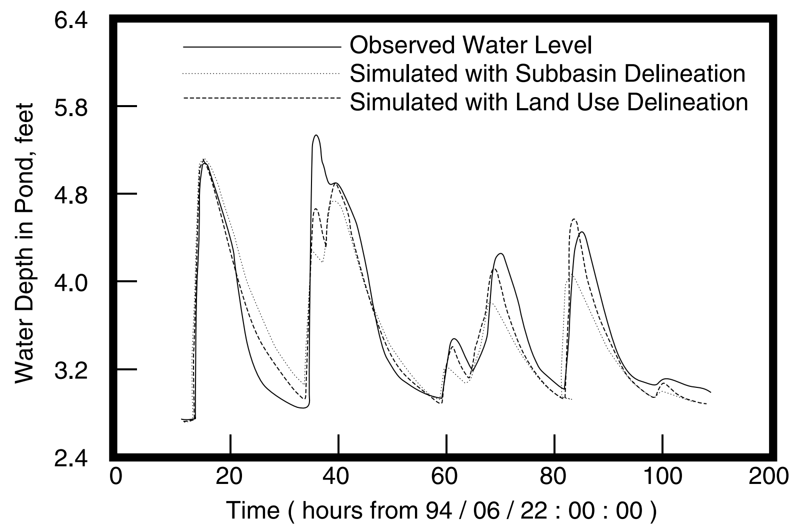

Figure 3. Results of 17 and 49 Subarea Models vs. Observed Data

Long-term estimates of pollutant load were obtained by adding events from a long-term continuous simulation. Because the long-term data is a hydrologic series, it could be statistically summarized to reflect the variability in pollutant load due to system hydrology. The long-term loading estimates were included in the analysis to evaluate the long-term treatment effectiveness of a stormwater treatment facility. The mix of land use as a non-structural pollution control alternative could also be analyzed.

Table 1 provides the land use concentration data and long term average loading results for phosphorus. The concentration data were based on average event mean concentration values searched in the literature to fit the description of each land use category used. The concentration data were weighted according to locally observed event mean concentration data. The hydrologic sensitivity between similar or dissimilar land use types can easily be seen by viewing the runoff per acre figures in Table 1. It is obvious from viewing these figures that no two subareas are alike.

Conclusion

The major variables for computing stormwater pollutant loads were event mean concentration and hydrology. The variability in loading estimates due to the hydrology of individual land use types was easily accounted for. Given the hydrologic models and geographical data that are increasingly becoming available in urban or high growth areas and availability of computer hardware and software there is no longer an excuse for limiting the level of sophistication in performing loading rate calculations. The procedure outlined herein is straightforward and is a step towards enhancing the level of detail and information provided from loading rate analyses.

The authors acknowledge all of the government participants involved in the Lake Jackson Surface Water Improvement and Management (SWIM) program who helped supply data and provided support for this study.

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The authors are with the North West Florida Water Management District. Ronald L. Bartel is chief of the Surface Water Bureau. Ruben A. Arteaga, Ph D. is a senior hydrologist. Felton B. Ard is an assistant hydrologist.

How the Federal Clean Air Act Amendments of 1990 Affect Your Plant's Operations

The deadline for submitting Title V applications in Florida is June 15, 1996

David E. Lindberg

The Federal Clean Air Act (CAAA) Amendments of 1990 can have a significant effect on water and wastewater treatment plants. If not in compliance with federal and state regulations mandated by the CAAA, including submission of Title V operating permit applications for major sources of air pollution, plants risk both civil and criminal penalties. The deadline for submitting Title V applications in Florida is June 15, 1996, so plant operators do not have much time to determine if their facility is in compliance. This article provides a brief description of the sections of the CAAA that may apply to publicly owned treatment works, including an approach to bringing the plants into compliance.

Clean Air Act Amendments of 1990

There are four titles under the CAAA of 1990 that could apply to WTPs and WWTPs:

- Title I: Nonattainment
- Title III: Hazardous Air Pollutants
- Title V: Operating Permits
- Title VII: Enforcement

The CAAA designates responsibility for administration and enforcement of the CAAA to EPA on the federal level. Each state is required to develop its own Title V operating permits program that is consistent with EPA guidelines, and to assume the responsibility for administering Title V on the state level. In Florida, the Florida DEP administers the Title V program.

Summary of Issues Facing WTPs and WWTPs

The CAAA directly affects WTPs and WWTPs that are major sources of regulated pollutant emissions, as well as facilities that store more than threshold quantities of acutely hazardous materials. The CAAA forces facilities to ascertain and quantify their plant emissions, under four distinct titles.

- Title I requires determination of a Reasonably Available Control Technology for major sources of particulate matter, oxides of nitrogen, and volatile organic compounds. The Reasonably Available Control Technology defines control requirements and compliance schedules for new, modified, and existing air emission sources.
- Title III requires determination of a Maximum Achievable Control Technology for major sources of hazardous air pollutants at WWTPs. The Maximum Achievable Control Technology defines control requirements for new, modified, and existing hazardous air pollutant emission sources.
- Section 112(r) of Title III requires the development of Risk Management Plans for facilities that store acutely hazardous materials in excess of threshold quantities.
- Title V requires submittal of operating permit applications for all facilities that are defined as major sources under either Title I or Title III. The Title V operating permit specifies allowable emissions, how the facility can operate during the 5-year term of the permit, and dictates the requirements for demonstrating compliance with local, state, and federal regulations. Facilities can avoid the Title V operating permit by obtaining a federally enforceable synthetic minor operating permit prior to the Title V submittal deadline. DEP has established June 15, 1996, as the deadline for submission of the permit application.

Further details of these regulations follow.

Title I: Nonattainment

Title I applies to all major stationary sources of carbon monoxide, oxides of nitrogen, oxides of sulfur, particulate matter, and volatile organic compound emissions. A major source is defined as a facility that has the potential to emit at least 100 tons/year of any of these criteria pollutants. Typically, combustion processes are the primary sources of criteria pollutant emissions from WTPs and WWTPs. Sources commonly found at these plants that may exceed Title I trigger levels include:

- Incinerators, boilers, and lime kilns
- Internal combustion engine driven pumps, blowers, and generators
- Waste gas flares for anaerobic digestion processes

Title III: Hazardous Air Pollutants

Title III applies to all facilities that are major sources of hazardous air pollutants, which include facilities that have the potential to emit at least 10 tons per year of any individual hazardous air pollutant, or 25 tons per year of total hazardous air pollutants. EPA has currently designated 189 compounds and elements as federal hazardous air pollutants.

Title III contains two provisions that apply to WTPs and WWTPs: the development of a Presumptive Maximum Achievable Control Technology for WWTPs, and the Accidental Release Prevention Program.

All facilities are required to inventory both point and fugitive sources of hazardous air pollutant emissions to determine Title III applicability. In addition, major sources of hazardous air pollutants are required to comply with Maximum Achievable Control Technology standards and to obtain an operating permit under Title V.

Presumptive Maximum Achievable Control Technology

To control emissions of hazardous air pollutants from WWTPs, EPA has developed a Presumptive Maximum Achievable Control Technology standard, which is expected to be finalized this year. In the interim, EPA has issued a Maximum Achievable Control Technology Guidance Document for WWTPs to follow if they plan to expand or modify their facility before the final Maximum Achievable Control Technology standard is promulgated. The guidance document states that any facility undergoing expansion or modification and meeting two of the three criteria listed below is required to install the Presumptive Maximum Achievable Control Technology, unless the facility can demonstrate through an emissions inventory that it is not a major source of air pollution under Title III:

- WWTPs with capacities greater than 50 million gpd
- WWTPs with greater than 30 percent industrial contribution
- WWTPs with influent priority pollutant volatile organic compound concentrations greater than 5 mg/L

Accidental Release Prevention Program

Section 112(r) of Title III also includes an Accidental Release Prevention Program, which is directed at preventing the release of acutely hazardous materials. Four acutely hazardous materials commonly found at WTPs and WWTPs and their corresponding threshold quantities are listed below:

Acutely Hazardous Material	***Threshold Limits***
Chlorine	2,500 lbs.
Ammonia (Anhydrous)	10,000 lbs.
Sulfur Dioxide (Anhydrous)	5,000 lbs.
Methane	10,000 lbs.

Federal Clean Air Act Amendments of 1990

This table lists water and wastewater treatment plant sources that may emit pollutants at levels exceeding major source thresholds. Plants that operate any of these sources should conduct an emissions inventory to make a determination of Title V applicability.

Emissions Unit	***Pollutant of Concern***	***Capacity or Rating***
Criteria Air Pollutants		
Incinerators, Boilers, or Lime Kilns		
Natural Gas	oxides of nitrogen	170 million Btu/hr
No. 2 Fuel Oil	oxides of sulfur	40 million Btu/hr
Digester Gas (Scrubbed)*	carbon monoxide	40 million Btu/hr
Internal Combustion Engines (Pumps, Cogeneration, Standby Generators)[1]		
Natural Gas	oxides of nitrogen	860 Horsepower
No. 2 Fuel Oil	oxides of nitrogen	840 Horsepower
Dual Fuel (95% Gas, 5% Diesel)	oxides of nitrogen	1,100 Horsepower
Digester Gas (Scrubbed)*	oxides of sulfur	0.20 million ft^3/hr
Waste Gas Flares**	oxides of sulfur	16 million Btu/hr (25,000 ft^3/hr)
Hazardous Air Pollutants		
Plant Capacity	hazardous air pollutants	50 million gpd
Industrial Contribution	hazardous air pollutants	greater than 30%
Influent volatile organic compound concentrations	hazardous air pollutants	greater than 5 mg/L
Acutely Hazardous Materials		
Anhydrous Ammonia		10,000 lbs
Anhydrous Sulfur Dioxide		5,000 lbs
Chlorine		2,500 lbs
Methane (including digester gas)		10,000 lbs

Nitrogen oxide and carbon monoxide emissions from internal combustion engines can vary widely depending on fuel-to-air ratio, combustion temperatures, fuel composition, and the present of emissions control equipment. The internal combustion engine ratings listed in this table were obtained using EPA publication AP-42 emission factors and typical digester gas sulfide concentrations.

* Based on sulfur content in scrubbed gas of 0.4 grH_2S/ft^3

** Based on sulfur content in unscrubbed gas of 3.5 grH_2S/ft^3

The Accidental Release Prevention Program mandates all facilities that use or store acutely hazardous materials in excess of threshold quantities to develop a Risk Management Plan, regardless of whether they are defined as a major source under Title III. However, minor sources of air pollution subject to the Accidental Release Prevention Program are not required to obtain Title V operating permits.

Title V: Operating Permits

All publicly owned treatment works in Florida that are defined as major sources under Title I or Title III are regulated under Title V, and are required to submit a Title V operating permit application to DEP. (EPA has granted Florida "final interim approval" status to administer the Title V program.) The Title V application submittal deadlines are as follows:

- July 1, 1996, for all minor sources regulated by the National Emission Standard for Hazardous Air Pollutants; or
- June 15, 1996, for all major sources of air pollution under Titles I and III.

If operators want to avoid Title V requirements, they can do so by using a synthetic minor operating permit to establish federally enforceable permit limitations below major source trigger levels. However, the synthetic minor operating permit must be obtained prior to the Title V submittal dates listed above in order to use its permit limitations to avoid Title V compliance requirements.

Title VII: Enforcement

While the mandates under CAAA are self-governing, the provisions of Title VII allow for enforcement provisions that have serious consequences, including:

- $25,000/day administrative penalties
- $10,000/day bounty provisions
- $5,000/day field citations
- Criminal sanctions, including fines and prison terms

What You Should Do To Be In Compliance

The accompanying table can be used to identify potentially major sources of emissions, and to determine if a detailed emissions inventory is necessary for a plant. If any of the sources listed in the table are present, the plant may be a major source of air pollution subject to regulation under Title V.

While the state or local air pollution agency may not be aware of a plant's major or minor source status under Title V, federal regulations ultimately assign the responsibility of Title V applicability determination to the facility owner. The following steps should be taken to determine how the CAAA affects a facility.

- If the plant does not operate any sources larger than those listed in the table, actual and potential emissions from the various processes at your facility should be inventoried using simplified, conservative approaches. Estimation of potential hazardous air pollutant emissions from liquid and solids handling processes can be done by quantifying total volatile organic compound loadings to the plant. Criteria pollutant emissions from combustion sources can be estimated using fuel usage and EPA publication AP-42 emission factors.

- If there are sources at the plant included in the following table, a detailed emissions inventory should be conducted to quantify actual and potential emissions, determine applicability of Titles I (greater than 100 tons per year criteria pollutants) and III (greater than 10 tons per year of any individual hazardous air pollutant, or 25 tons per year total hazardous air pollutants), and assess compliance with existing air quality regulations.

The CAAA can have a significant effect on both water and wastewater treatment plants, with non-compliance resulting in possible civil and criminal penalties. It is important to act on these issues soon, since the deadline for submitting Title V applications in Florida is June 15, 1996.

David Lindberg, P.E., is a chemical engineer with CH2M HILL, Inc., in Deerfield Beach, Florida, specializing in air quality. He earned a bachelor of chemical engineering from the University of Minnesota in 1989, and a master of environmental engineering from the University of Cincinnati in 1991. He is a professional engineer licensed in Florida.