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EPA Ground-Truthing of the Air Pathway Component of OPPT's Risk-Screening Environmental Indicators Model

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This report evaluates the air pathway component of the Office of Pollution Prevention and Toxics' (OPPT's) Risk-Screening Environmental Indicators Model. This report is one of many products of the OPPT's Risk-Screening Environmental Indicators Model Project. The project, initiated in 1991, has resulted in the Risk-Screening Environmental Indicators Model, a unique and powerful analytical tool for risk communication. The Indicators Model has the potential to make a significant contribution to environmental improvement. We wish to thank our contractor, Abt Associates Inc., for their support and creativity throughout the development of this project.

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EXECUTIVE SUMMARY

EPA's Science Advisory Board (SAB) advised the Office of Pollution Prevention and Toxics (OPPT) to conduct a "ground-truthing" analysis of the exposure model components of OPPT's Risk-Screening Environmental Indicators Model. The objective of the Indicators Model is the analysis of Toxics Release Inventory (TRI) releases and their relative risk-related impacts, which can be used for relative ranking purposes.

In this ground-truthing analysis, the air model component of the Indicators Model was evaluated. Air pollutant concentrations estimated by the Indicators Model were compared to concentrations obtained from Air Guide-1 (AG-1), an air dispersion model used by the New York State Department of Environmental Conservation for regulatory purposes. The air pollutant concentrations calculated by the Indicators Model are based on a combination of median data (e.g., stack height and exit gas velocity) and generic assumptions, whereas the AG-1 model relies on a greater variety of facility- and stack-specific data. The differences in pollutant concentrations predicted by both models were analyzed for 24 test cases in New York. This representative sample was designed to capture the variability observed in three input variables. Four metropolitan areas were selected to sample different meteorological conditions, and two types of pollutants, with and without decay rates, were modeled in each metropolitan area. The distribution of stack heights was represented by three discrete bins, each containing about a third of the stack heights reported by all TRI facilities in New York. Two test cases (one for a pollutant with a decay rate and one for a pollutant without a decay rate) were selected from each stack height bin for each metropolitan area.

The Indicators Model estimates air pollutant concentrations for each 1 km^2 cell in a 21-km by 21-km grid surrounding a TRI facility. Each TRI facility is represented with a single stack located at the center of the central cell in the grid. Cell by cell concentrations predicted by the Indicators Model and AG-1 were compared by calculating a concentration ratio for each cell (a ratio of one indicates perfect agreement between the models). Two sets of tests were conducted: in the first, the Indicators Model used facility-specific median stack heights and exit gas velocities; in the second, the Indicators Model used stack heights and exit gas velocities corresponding to the median values for the facility's 3-digit Standard Industrial Classification (SIC) code. These SIC code-based values were nationally derived, based on available data.

Concentration ratios for individual cells ranged from 0.23 to 3.1 when using facility-specific parameters, and from 0.25 to 3.4 when using SIC code-based parameters. Average concentration ratios computed over all 440 cells surrounding a single facility differed by 48 percent or less when using facility-specific parameters, and by 35 percent or less when using SIC code-based parameters. Average ratios computed over the 24 test cases were within two percent of unity (with a standard deviation of 13 percent) when using facility-specific parameters, and within six percent of unity (with

a standard deviation of 13 percent) when using SIC code-based parameters. Thus, the Indicators Model does not seem to consistently overpredict or underpredict pollutant concentrations.

Average concentration ratios were also computed over concentric square rings around the central cell. These averages show a pattern consistent across most facilities: concentration ratios converge to within a narrow band around one as distance from the stack increases. Average concentration ratios in the innermost ring, where air pollutant concentrations are highest, ranged from 0.6 to 1.7 when using facility-specific parameters, and from 0.5 to 1.8 when using SIC code-based parameters. Average ratios at the outermost ring ranged from 0.8 to 1.5 when using facility-specific parameters, and from 0.6 to 1.2 when using SIC code-based parameters. Overall, the results obtained demonstrate that predictions of pollutant concentrations are not only comparable, but are extremely close, even though key input data to the two models are not the same. Although the Indicators Model is not designed as a substitute for more comprehensive, site-specific risk assessments, the results of this ground-truthing analysis indicate that the air exposure pathway of the Indicators Model provides very good estimates of air pollutant concentrations at the facility-specific level.

Pollutant concentration is one component in the calculation of an Indicator Element, which can be used to rank facilities. An Indicator Element is the product of three components: the surrogate dose, which is based on pollutant concentration and exposure assumptions; the toxicity weight for the chemical of interest; and, the exposed population. Besides pollutant concentration, for a given chemical with one toxicity weight and one set of exposure assumptions, it is only the variation in population which influences the value of the Indicator Element. To ascertain the possible impact of population on the Indicator Element, the relative contribution of each ring to the Indicator Element was examined. Results indicate that population around a TRI facility can have a significant impact on Indicator Element values, depending on the population size and distribution relative to the predicted pollutant concentrations. The accuracy of the Indicator Elements, however, is directly dependent on the accuracy of the pollutant concentration estimates.

As done in the Indicators Model, Indicator Elements were used to rank facilities. Facilities corresponding to the 24 test cases were ranked using each set of available concentration estimates: AG-1, ISCLT3 with facility-specific median stack heights and exit gas velocities, and ISCLT3 with SIC code-based median stack heights and exit gas velocities. Separate rankings were obtained for facilities emitting chemicals that decay and those emitting chemicals which do not decay. With only one exception, the rankings corresponding to different input parameters were identical for both categories of chemicals, for all three sets of input parameters. This result lends further support to the use of the Indicators Model to develop relative rankings of TRI facilities.

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1. INTRODUCTION

The Science Advisory Board (SAB) of the U.S. Environmental Protection Agency (EPA) advised the Office of Pollution Prevention and Toxics (OPPT) to conduct a "ground-truthing" analysis of the exposure model components of OPPT's Risk-Screening Environmental Indicators Model (the Indicators Model). The Indicators Model is intended for analysis of trends in Toxics Release Inventory (TRI) releases and their relative risk-related impacts. The Indicators Model is not the equivalent of site-specific risk assessment, in part because a number of simplifying assumptions have been made to limit the data requirements of the model. These assumptions do not inhibit the use of the Indicators Model at the national level, but may have the potential to restrict the usefulness of the model at a site-specific level. To explore the use of the model for more site-specific analyses, OPPT requested a ground-truthing analysis of the air model component of the Indicators Model. The purpose of this ground-truthing analysis was to compare air pollutant concentrations predicted using a combination of median data (e.g., stack height and exit gas velocity) and generic assumptions in the Indicators Model to pollutant concentrations predicted using facility- and stack-specific data in a model used for regulatory purposes.

For this analysis, pollutant concentrations estimated by the Indicators Model were compared to concentrations obtained from an air dispersion model used by the New York State Department of Environmental Conservation. Section 2 of this memo describes the design of the ground-truthing analysis. Section 3 presents preliminary model comparisons which were conducted to assess the default assumptions built into each model. Sections 4 and 5 then present the results of the ground-truthing analysis and discuss them, respectively.

2. DESIGN OF GROUND-TRUTHING ANALYSIS FOR NEW YORK

Personnel from the New York State Department of Environmental Conservation (NY DEC) indicated an interest in providing assistance to EPA in this ground-truthing exercise. The NY DEC provided EPA with a copy of the model Air Guide 1 (AG-1), and assisted in making the model operational. AG-1 contains facility-specific data, such as stack heights, for New York facilities, including TRI reporting facilities. AG-1 is used by NY DEC to verify facility compliance with air quality standards (NY DEC, 1991; 1995). AG-1 is composed of two models: a simple model for screening analyses, and a more complex model for refined analyses. The screening analysis produces a single worst-case concentration for the facility, while the refined analysis can predict concentrations at multiple locations chosen by the user. The refined analysis is far more comparable to the air model component of the Indicators Model, and therefore was chosen for the ground-truthing analysis.

Both the Indicators Model and the more complex model in AG-1 use the same analytical algorithm to predict air concentrations of pollutants emitted from industrial point sources. Both models implement the long-term Gaussian plume algorithm included in EPA's Industrial Source Complex (ISC) models (U.S. EPA, 1992a; 1995a, b). Because the two models were developed at different times, they use different versions of ISCLT (AG-1 uses ISCLT2, while the Indicators Model uses ISCLT3). However, the same algorithm is used to model dispersion from point sources in both versions of ISCLT. Thus, identical results should be obtained when both models are used with the same input data set. The major difference between ISCLT2 and ISCLT3 lies in the treatment of area sources, for fugitive emissions. The algorithm for area sources was significantly improved in ISC3.

In this ground-truthing exercise, the results obtained from the Indicators Model are compared to results obtained from a model which uses more facility-specific data. The results from the Indicators Model are *not* being compared to air monitoring data because the ISC series of models (versions 1, 2, and 3) have already been validated. The EPA and others (e.g., Bowers and Anderson, 1981; Bowers et al., 1982; Heron et al. 1984; Moore et al., 1982) have repeatedly tested separate components and features of the ISC models. Tests have included comparisons with experimental (wind tunnel) and site-specific (air quality monitoring) data. These studies have validated improvements in model algorithms and confirmed that the ISC models can adequately reproduce field observations of pollutant concentrations. Currently, ISC3 is one of nine models recommended by EPA for refined air quality analyses (U.S. EPA, 1995c). Recently, ISC3 was used as a benchmark to which the performances of other models were compared (U.S. EPA, 1995d).

2.1 SCOPE OF THE ANALYSIS

The overall objective of the ground-truthing exercise was to assess the degree to which results from the Indicators Model differ from those of another state-of-the-art air model currently used for regulatory purposes. Given that the Indicators Model uses a combination of facility-specific median data, where available, and generic assumptions, while the AG-1 model uses almost all facility-specific data, different air pollutant concentrations are predicted for emissions from the same facility. By analyzing the differences in pollutant concentrations for a number of facilities, the degree to which predictions differ between the two models was quantified.

Because many input variables affect model predictions, the tests conducted for this ground-truthing analysis assessed the combined impact of those variables used in the air exposure pathway of the Indicators Model. Uncertainty and sensitivity analyses would be needed to obtain a complete perspective on the range of variability in model concentrations that occurs for alternative combinations of input parameters. Such analyses were not included in this ground-truthing comparison. Instead, results from a preliminary sensitivity analysis conducted using ISCLT3 were reviewed to identify the relative impact of different input variables. In that analysis, a single input variable was varied over a range of values while holding all other variables constant; the process was repeated for all stack-specific variables (stack height, stack diameter, exit gas velocity, and exit gas temperature). Relative impacts were measured in terms of the average air concentration over a grid identical to that used by the Indicators Model. The results indicated that the pollutant concentrations predicted by ISCLT3 are most sensitive to the stack height value used; exit gas velocity also has a measurable, although smaller, impact on predicted concentrations. Both stack height and exit gas velocity are negatively correlated with the average air concentration; that is, larger values of these parameters will yield smaller concentrations, and vice-versa. More extensive tests conducted by the NY DEC have reached similar conclusions (NY DEC, 1991).[1]

2.2 SAMPLING FRAMEWORK

This ground-truthing analysis compares air pollutant concentrations estimated by using a combination of facility-specific (e.g., median stack height and median exit gas velocity) and generic (e.g., stack diameter and exit gas temperature) air modeling parameters in the Indicators Model to concentrations estimated using facility-specific data. Specifically, 24 test cases were constructed to evaluate the impact of Indicators Model parameters for facilities with different stack heights, geographic location, and chemical characteristics of emissions (see Table 1).

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[1] NY DEC quantified the impact of stack height on pollutant concentrations under different conditions, including a range of downwind distances, varying building dimensions, and differing numbers of stacks (NY DEC, 1991).

Test cases were designed to capture the variability in stack heights, because this input variable has the largest impact on predicted air concentrations. The Indicators Model uses either the median stack height of all stacks (regardless of the chemical emitted) for TRI facilities with this information or an SIC code-based median stack height for facilities without stack data (Bouwes and Hassur, 1998). The latter is based on the median of stack heights for facilities in a particular 3-digit SIC code (or in the 2-digit SIC code if the 3-digit SIC code is invalid. If no valid 2-digit SIC code is available, the median of all stack heights in SIC codes 20 through 39 is used). Stack height data were obtained from the AIRS Facility Subsystem (AFS) within the Aerometric Information Retrieval System (AIRS), the National Emission Trends Database, and databases from three individual states (California, New York, and Wisconsin). In the calculation of median stack height for facilities with a particular SIC code, statistical analyses were conducted to determine whether heights for stacks not emitting any TRI chemicals should be included. For some SIC codes, significant height differences did not exist between stacks emitting TRI chemicals and stacks not emitting TRI chemicals. Thus, in those test cases, all stack heights for all facilities in that SIC code were used to estimate the median stack height for that SIC code. For other SIC codes, a significant height difference between the two groups of stacks did exist, and only those stacks emitting TRI chemicals were used in the calculation of a median stack height for that SIC code.

When running AG-1, NY DEC uses actual stack height data for those individual stacks emitting chemicals of concern at a selected facility. The sampling framework for the ground-truthing analysis was designed to evaluate in part the impact of using a facility-specific median stack height in the Indicators Model versus using multiple stack-specific heights in the AG-1 model. Three categories of facilities were represented: (1) TRI facilities with median stack heights less than seven meters, (2) TRI facilities with median stack heights between seven meters and ten meters, and (3) TRI facilities with median stack heights greater than ten meters. These categories reflect the distribution of facility-specific median stack heights for TRI facilities in New York: approximately one-third of these facilities are found in each of the stack height bins. Once the test cases were chosen for analysis, the facility-specific median stack height was used in the Indicators Model runs and the actual stack-specific heights were used in the AG-1 model runs. To evaluate the impact of using stack heights based on SIC codes, a further comparison was made, using the stack heights based on each facility's SIC code in the Indicators Model.

As previously indicated, the preliminary sensitivity analysis showed that exit gas velocity also has a measurable impact on predicted concentrations. The Indicators Model uses either the median exit gas velocity of all stacks (regardless of the chemical emitted) for TRI facilities with this information or an SIC code-based median exit gas velocity for facilities without exit gas velocity data (Bouwes and Hassur, 1998). The latter is based on the median of exit gas velocities for facilities in a particular 3-digit SIC code (or in the 2-digit SIC code if the 3-digit SIC code is invalid. If no valid 2-digit SIC code is available, the median of all exit gas velocities in SIC codes 20 through 39 is used). Exit gas velocity data were obtained from AFS within AIRS, the National Emission Trends Database,

and databases from two individual states, New York and Wisconsin. The same statistical analyses as described above for stack heights were conducted before a median exit gas velocity was calculated for each SIC code. Again, the facility-specific median exit gas velocity was used in the Indicators Model runs and the actual stack-specific exit gas velocities were used in the AG-1 model runs for one comparison; a second comparison was made using exit gas velocities based on SIC codes.

Specific TRI facilities were selected from urban and rural areas covered by meteorological stations in Albany, Buffalo, Rochester, and Syracuse.[2] These four metropolitan areas were chosen to determine if particular air modeling parameters have greater impacts in certain areas due to possible interactive effects with different meteorological conditions. For each metropolitan area and stack height bin, two facilities were selected: one to represent stacks emitting chemicals with decay rates and the other to represent stacks emitting chemicals without decay rates. The distinction was intended to reflect another difference between the Indicators Model and AG-1: the Indicators Model incorporates chemical decay rates (based on photo-oxidation), while AG-1 does not. These decay rates reduce the resultant air concentrations predicted by the Indicators Model.

An attempt was made to construct the sample of test cases by selecting one chemical with a decay rate and one without a decay rate, as well as facilities that emitted both chemicals, to minimize the variability across sites. However, these restrictions yielded an insufficient number of facilities for analysis. The final set of 24 test cases reflects a compromise: a single chemical (toluene) with a decay rate and four of the most commonly released chemicals without decay rates (mercury, aluminum, lead, and nickel) for New York TRI facilities in the four locations. Four of the facilities represented in the sample discharge both types of chemicals: Facility A (Albany), Facility G (Syracuse), Facility Q (Rochester), and Facility S (Rochester). Although the information on these facilities was used for the analysis of both chemicals with decay rates and those without decay rates, each facility is considered to be two separate test cases because different sets of stacks are evaluated by AG-1 and, therefore, results do not represent the effect of changing *only* chemical characteristics.

2.3 TESTING STRATEGY

To conduct this ground-truthing analysis, the ISCLT3 model (U.S. EPA, 1995a, b) was used directly, rather than as implemented in the Indicators Model. Because of this choice, a three-way model comparison was necessary. First, the Indicators Model and ISCLT3 were compared to verify that the ISCLT3 algorithm was successfully incorporated into the Indicators Model. Second, AG-1 and ISCLT3 were compared to verify that they yielded the same results with identical inputs for point sources. Although both models implement the same ISCLT point-source algorithm, this comparison was necessary to test whether other assumptions were built into AG-1. Third, AG-1 and ISCLT3

[2] "Urban" areas are defined in the Indicators Model as having populations greater than 119,070 people. In this ground-truthing analysis, fifteen facilities are located in urban areas and five are in rural areas.

were compared, with AG-1 using all available facility-specific data and ISCLT3 using the combination of facility-specific data and generic assumptions used in the Indicators Model. This third test evaluated how model predictions of pollutant air concentrations from point sources differ when facility-specific data (e.g., building parameters, such as height and area dimensions, and stack parameters, such as height, exit gas velocity, and temperature) are used as compared to median stack height and exit gas velocity data and generic assumptions.

3. PRELIMINARY TESTS

This section describes the first two model comparisons conducted prior to the actual comparison of results from the Indicators Model and AG-1 model. First, EPA already conducted several tests in the past that verified that the Indicators Model yielded results identical to those of the ISCLT3 model when predicting air concentrations from point sources.

Second, tests were conducted to compare results from AG-1 and ISCLT3. These tests were conducted with Facility A in Albany, for which all facility-specific data were available in the AG-1 database. A single chemical (mercury) was selected from all the TRI compounds emitted by this facility. All input data from AG-1 were used as input to ISCLT3, and two tests were run, one for the urban mode and one for the rural mode. In both tests perfect agreement was obtained between the two models' predictions for all nodes in a 21-km by 21-km grid. In the Indicators Model, each node is centered in a 1-km by 1-km cell, and the concentration at the node is assigned to that cell. The facility is located in the center cell of the 441 cells, and no concentration is attributed to that cell. The grid size is not finer because the Indicators Model assesses general population exposures, not risk to a Most Exposed Individual (MEI).

Although one facility was used to test both the urban and rural modes, only one mode is used for a given facility in the Indicators Model. If the total population in a 21-km by 21-km grid centered at the facility is larger than 119,070, the urban mode is used. Different dispersion algorithms are used for the rural and urban modes (U.S. EPA, 1995a, b), but for a given mode, the same algorithms are used in both AG-1 and ISCLT3. The two models, however, make different assumptions about building dimensions. When site-specific data are available, AG-1 calculates individual stack heights as the sum of two variables: building height and stack height above structure. When site-specific data are not available, AG-1 assumes that all building dimensions (height, width, and length) are equal to the stack height; this assumption is intended to make the model more conservative. ISCLT3 makes no specific dimension assumptions, and adopts zero building dimensions. By forcing ISCLT3 to make the same assumptions about building dimensions as AG-1, perfect agreement was obtained under both rural and urban modes. However, in the actual ground-truthing tests reported in the next section, no such correction was made. Therefore, this difference in assumptions accounts for a fraction of the total difference in air concentrations observed at each facility. Different concentrations are predicted because the presence of a building produces higher concentrations near the source due to building downwash. After downwash, there is less pollutant mass to be distributed further away from the building, because the total pollutant mass being emitted into the air is the same regardless of building dimensions. Thus, when all other inputs are the same, the Indicators Model will produce slightly higher air pollutant concentrations further away from the source than AG-1 and lower concentrations nearer the source. However, the differences in predicted concentrations are small for the range of distances sampled by the computational grid used in the Indicators Model (1 to 14.8 km, where 14.8 km is the diagonal distance from the source to the corner of the 21-km by 21-km grid).

Typical maximum differences are on the order of one to two percent, and decrease to insignificant levels with increasing distance from the source.

4. MODEL COMPARISON: AG-1 VERSUS ISCLT3

As indicated in Section 2, ISCLT3 was used directly for this ground-truthing exercise. All facility-specific median data and generic assumptions used in the Indicators Model were also used in ISCLT3, to obtain the same model predictions that would be produced by the Indicators Model. In the remainder of this section these results are referred to as the "Indicators Model results" for convenience.

4.1 INPUT DATA

AG-1 and ISCLT3 share the same input parameters, but assign different values to them, as summarized in Table 2. For stack diameter, exit temperature, and building dimensions, the Indicators Model uses constant, generic values, whereas AG-1 uses facility-specific data (if available). In addition, AG-1 computes concentrations from all individual stacks that emit a particular chemical, while the Indicators Model treats all such emissions as emanating from a single stack at a central location, with stack height equal to the median height of all stacks at the facility and exit gas velocity equal to the median exit gas velocity from all stacks at the facility. For chemicals which may decay through photodegradation, the Indicators Model uses a decay rate, whereas AG-1 assumes no chemical decay occurs. Both models use comparable meteorological data, i.e., STability ARray (STAR) data from local meteorological stations.[3] For a given meteorological station, the Indicators Model uses average conditions computed over many years (typically 25 years or more), while AG-1 uses one year's worth of data corresponding to the most recent year with valid STAR data. For purposes of this ground-truthing exercise, both models used STAR data from AG-1.

The stack coordinates of the TRI facilities selected for the model comparison are listed in Table 3. All coordinates are in meters, with values corresponding to the Universal Transverse Mercator (UTM) coordinate system. Two sets of coordinates are listed, corresponding to the NY DEC and national TRI databases. The national TRI database contains a single pair of coordinates for each facility, while the NY DEC database contains stack-specific coordinates. The values listed for the latter in Table 3 are the coordinates of the point located in the middle of all stacks that emit the particular chemical selected for the model comparison. AG-1 centers the computational grid at this middle point. Note that some of the TRI database and NY DEC coordinates included in Table 3 differ by hundreds or thousands of meters, which would cause the contaminant plumes to be mapped

[3] ISCLT uses as input meteorological data that have been summarized into joint frequencies of occurrence for particular wind speed classes, wind direction sectors, and atmospheric stability categories. These STAR summaries may include frequency distributions over a monthly, seasonal, or annual basis.

in non-overlapping locations. Therefore, the single stack for the ISCLT3 runs was placed at the same middle point that AG-1 uses to center the grid.[4]

Tables 4 to 8 display the input data used by each model for the following parameters: stack height, exit gas velocity, stack diameter, exit temperature, and chemical emission rate. For stack diameter and exit temperature, the Indicators Model has single default values (Table 2), while AG-1 uses stack-specific values. Because the AG-1 emissions data are from different years for different stacks, reported releases from the TRI database could not be used. Instead, as indicated in Table 2, for a given facility the sum of the emission rates of a particular chemical from all relevant stacks in AG-1 was used as the chemical emission rate for that facility in the Indicators Model (ISCLT3). Although AG-1 uses unique chemical emission-stack combinations, the mean and median stack heights and exit gas velocities are presented in Tables 4 and 5 for purposes of comparison to ISCLT3 inputs. As shown in Tables 4 and 5, the number of stacks used in the calculation differ, as AG-1 mean and median values are based only on those stacks which emit the chemical being analyzed, whereas mean and median values in ISCLT3 are based upon all stacks at the facility.

4.2 RESULTS

Three sets of Indicators Model runs were conducted to explore the impact of having facility-specific median data or relying on assumptions when such data are not available. The first set uses facility-specific median stacks heights and exit gas velocities, representing the case with most stack-specific data. The second set uses facility-specific median stacks heights and a constant exit gas velocity of 0.01 m/sec. The third set uses median stacks heights and exit gas velocities corresponding to the 3-digit or 2-digit SIC code of the facility, representing the case with the least stack-specific data. Results from the three sets of tests are described below.

Both the Indicators Model and AG-1 report pollutant concentrations on a discrete grid. The Indicators Model uses a 21-cell by 21-cell grid composed of 1 km^2 cells, with a total of 441 cells. The same grid dimensions were chosen for the AG-1 model runs to compare results at the same locations. Figure 1A displays the pollutant concentrations in each cell predicted by AG-1 for an example facility, while Figure 1B displays the concentrations predicted by the Indicators Model. Figure 1C displays the ratio of concentrations predicted by each model for each cell (i.e., ISCLT3 concentration/AG-1 concentration); a ratio of one indicates perfect agreement between the Indicators Model and AG-1. The arrays of results shown in these figures provide a wealth of information, but they are not the most convenient means to analyze spatial patterns. Instead, concentrations can be displayed as a pollutant concentration plume with the aid of a contour plot. Figures 2A and 2B display contour plots of the pollutant plumes predicted by each model for the example facility. Figure

[4] In the Indicators Model, the facility stack is centered in the model cell that contains the facility coordinates from the national TRI database.

2C displays a contour plot of the concentration ratios shown in Figure 1C. Figure 2C reveals that concentration ratios in about 20 cells around the stack range in value from 0.6 to 0.9; concentration ratios in all other cells located further away from the stack are between 0.9 and 1.0.

Without reference to the location of individual cells, a histogram of all cell ratios provides a more compact way of comparing plumes and illustrates the variability within and among test cases. Figures 3 to 6 display such histograms for all 24 test cases, individually and averaged by metropolitan area. While some of the histograms (e.g., test case 3 in Albany) are narrowly clustered around a single value (usually one), others display more dispersion (e.g., test case 1 in Rochester), with the maximum value for any single cell ratio being 3.1 (for test case 4 in Rochester). The histograms in Figures 3 to 6 show that the average concentrations calculated by the Indicators Model for an individual facility may differ from those calculated by AG-1 by up to 48 percent, with the largest deviation corresponding to test case 4 in Albany (average concentrations are calculated over the 440 cells surrounding each facility).

In addition to the contour plots and histograms, another type of plot was developed to examine the variability of model results with distance from the source. Because the computational grid used by the Indicators Model is made up of square cells surrounding the source, a surrogate measure was used to approximate the radial distance from the source. The grid can be visualized as being made up of concentric square rings located around the central cell containing the source; in a 21-km by 21-km grid, there are ten such rings, with ring one being closest to the source and ring ten being the outermost ring. The ring number serves as a surrogate measure of distance in kilometers from the source. For each of the ten concentric square rings, an average concentration ratio was calculated; because of averaging effects, these concentration ratios display a narrower range of values than the variations depicted by the histograms in Figures 3 to 6. Figures 7 to 10 display the average concentration ratios over concentric square rings for individual test cases, grouped by metropolitan area. The shapes of the plots for test cases in the same metropolitan area are somewhat similar, but not enough to define distinct patterns for each metropolitan area. Instead, two patterns are apparent for individual test cases: concentration ratios decrease with distance when there is a maximum at ring one, or increase with distance when there is a minimum at ring one. For the second ring and further, ratios for individual test cases are within ten percent of unity for Albany, and within about 20 percent of unity for Buffalo, Rochester, and Syracuse, except for two test cases discussed below. Within the first ring, ratios for individual test cases are within 35 percent of unity, except for the two test cases discussed below.

In two of the cities there is a single curve that displays consistently higher concentrations for all rings: test case 4 in Albany (mercury) and test case 4 in Rochester (nickel). These same test cases can be identified using the histograms in Figures 3 and 5. Inspection of Table 4 reveals that test case 4 in Albany and test case 4 in Rochester share a common characteristic: the facility-specific median stack height used in the Indicators Model is significantly shorter than the corresponding median height

of the stacks that actually emit the given chemical (although AG-1 uses individual stack heights, their median was computed to allow a simple comparison; other measures, such as the emission-weighted mean or median, could be used as well). The differences are 26 meters (m) and 6 m for the Albany and Rochester test cases, respectively. Calculations using the shorter stack height from the Indicators Model result in higher concentrations predicted by the Indicators Model, and therefore, higher concentration ratios. Test case 4 in Albany, which has the largest discrepancy between median stack heights, produces the largest ratios over the entire grid in the 24 test cases. These results are consistent with previous sensitivity analyses of the influence of stack heights on pollutant concentrations. However, the tests conducted for this ground-truthing analysis were not designed to isolate the influence of a single variable. Hence, the range of variability in calculated pollutant concentrations reflects the combined effect of all input variables that take different values in each model (this includes not only all stack parameter data, but also building dimensions and treatment of chemical decay).

In interpreting the average concentration ratios over concentric rings, it is important to note that the inner rings have fewer cells (e.g., 8 cells for ring 1 of an individual test case), as compared to outer rings (e.g., 80 cells for ring 10 of an individual test case). Therefore, the statistics for the inner rings are more sensitive to single high values. In contrast, the ratio statistics for the outer rings are more stable and seem to approach a constant value, typically very close to unity. In subsequent figures similar "ring" curves are used to examine the variability of concentration ratios by stack height bin, chemical, and metropolitan area.

Figure 11 displays the average concentration ratio computed for each ring for the three stack height bins. Agreement between the Indicators Model and AG-1 seems to be independent of stack height bin, because most ratios are within five percent of unity; even within the two innermost rings, ratios are within fifteen percent of unity.

Figure 12 compares the ring statistics grouped by chemical type (each group has twelve test cases). The ratios for the chemical with a decay rate are consistently lower than those for chemicals without a decay rate, which is expected, given that the Indicators Model accounts for decay rates, while AG-1 does not. Figure 12 indicates that ratios for the chemical with a decay rate are about five percent lower than unity on average, while those for the chemical without a decay rate are about two percent higher than unity. However, this figure should be taken as indicative only. Evaluating the effect of this individual variable would require running each test case with both chemical types, holding all other parameters constant.

Figure 13 shows the average ring statistics for each metropolitan area (six test cases each, averaged over both chemical types). Except for Syracuse, the ratios for all rings in the four curves shown in Figure 13 are within ten percent of unity. The concentration ratios in the first ring of Syracuse are within 17 percent of unity.

Table 9 contains similar information, but also provides the standard deviations, minimum values, and maximum values of the concentration ratio for each metropolitan area, by chemical characteristic and by stack height bin. The mean concentration ratio for the entire sample is 0.984, indicating that on average, the predictions of the Indicators Model are virtually the same as those of AG-1. Subsample average ratios (e.g., by metropolitan area, chemical characteristic, and stack height bin), shown in Table 9, vary between 0.935 and 1.05, again representing very good agreement. Table 10 contains the statistics corresponding to the concentration ratios by ring for all locations together and by metropolitan area. A complementary view is provided by the histograms in Figures 3 to 6. These figures show that the average histograms of concentration ratios for each metropolitan area have most cells clustered around one, with the highest frequency corresponding to ratios between 0.95 and 1.05.

4.2.1 Impact of Exit Gas Velocity Assumptions

When this ground-truthing exercise was initiated, the corresponding version of the Indicators Model assumed a constant exit gas velocity (0.01 m/s) for all stacks. Given that the preliminary sensitivity analysis indicated that exit gas velocity had a measurable impact on predicted concentrations, and that the default value of 0.01 m/s was three orders-of-magnitude smaller than most available data on exit gas velocities, the way in which exit gas velocities are treated in the Indicators Model was changed (Bouwes and Hassur, 1998). Tables 11 and 12 contain a summary of results for the constant exit gas velocity case, in the same format as Tables 9 and 10. Although each single statistic in Tables 11 and 12 can be compared to its counterpart in Tables 9 and 10, only the mean concentration ratio calculated over the whole sample (all rings, all metropolitan areas) is analyzed here. The mean ratio in Tables 11 and 12 equals 0.980, approximately equivalent to the mean ratio (0.984) shown in Tables 9 and 10; the corresponding standard deviations are virtually the same (0.136 and 0.134, respectively). Although these statistics are very similar, EPA believes that it is more defensible to use available data on exit gas velocities and to treat the data in the same manner that stack height data are treated than to use a default value that is three orders-of-magnitude smaller than most available data.

4.2.2 Impact of SIC Code-based Stack Height and Exit Gas Velocity Assumptions

The results presented so far correspond to the case in which facility-specific data are available to calculate median stack heights and exit gas velocities. However, only a small fraction of facilities nationwide (about ten percent) have such data in the Indicators Model database. For the vast majority of the facilities, the Indicators Model uses the median stack height and exit gas velocity corresponding to the 3-digit SIC code of the facility. Table 13 contains the median stack heights and exit gas velocities corresponding to the 3-digit SIC codes of the 24 facilities in the sample, along with the facility-specific median values (used in the previous comparison) and the chemical-specific median values (which summarize the stack by stack emissions calculated by AG-1). A brief inspection of

Table 14 reveals that stack heights for individual facilities may differ by as much as a factor of seven.

To test the performance of the Indicators Model when data based on SIC codes are used, the 3-digit SIC code median values in Table 13 were used in ISCLT3 and the results were compared to AG-1. Results are displayed in Figures 14 through 24 and Tables 14 and 15. Because the figures and tables contain results parallel to those previously discussed, a side-by-side comparison is possible. For example, the histograms in Figures 14 to 17 show a summary of cell-by-cell concentration ratios similar to those in Figures 3 to 6. Overall, the histograms in Figures 14 to 17 show more scatter than those in Figures 3 to 6. This scatter is consistent with the larger differences in input parameters (stack heights) for some facilities, as shown in Table 13. An inspection of the histograms in Figures 14 to 17 shows that the average concentrations calculated by the Indicators Model for an individual facility may differ from those calculated by AG-1 by less than 35 percent (the largest average deviations correspond to test case 1 in Albany and test case 4 in Rochester). The maximum value for any single cell ratio is 3.4 (for test case 4 in Rochester).

The summary statistics in Tables 14 and 15 can be readily compared to those in Tables 11 and 12 (and Tables 9 and 10). The mean concentration ratio calculated over the entire sample (all rings, all facilities) equals 0.936 (Tables 14 and 15), somewhat lower than the mean ratio (0.984) obtained when using facility-specific median stack heights and exit gas velocities (Tables 9 and 10). This result is consistent with the inputs shown in Table 13: given that a majority of 3-digit SIC median stack heights are larger than the corresponding facility-specific median values, the Indicators Model predicts smaller concentrations and therefore the concentration ratios are lower on average. (This result in turn is consistent with the findings from sensitivity analyses already discussed.) The standard deviation of the concentration ratio (0.131) is approximately equivalent to the previous one (0.134).

A majority of the 24 test cases have 3-digit SIC code median values significantly higher than the corresponding facility-specific median values. On a nationwide basis, the Indicators Model could be expected to sometimes overpredict and sometimes underpredict, depending on the discrepancies between actual and assumed parameter values. To assess the range of discrepancies on a larger sample, parameter values for all facilities with site-specific data were compared to SIC code based values. The comparison was performed by subtracting facility-specific median values from SIC code based median values, for stack heights (1504 facilities) and exit gas velocities (1063 facilities). The results are displayed in Figures 25 and 26 for stack heights and exit gas velocities, respectively. SIC code based median stack heights range from 69 m less to 29 m more than the facility-specific median stack heights. The 95th and 5th percentiles are 18 m less and 7.0 m more, respectively. SIC code based median exit gas velocities range from 295 m/s less to 17 m/s more than the facility-specific median exit gas velocities. The 95th and 5th percentiles are 49 m/s less and 7.1 m/s more, respectively. Ground-truthing analyses were not repeated for these additional facilities, although

previous results show that using median values based on SIC codes yields a wider range of concentration ratios (subsample statistics in Table 14 vary between 0.871 and 1.00, a range only slightly wider than the corresponding ranges in Tables 9 and 11). Because the concentration ratio statistics (overall average and standard deviation) are reasonably close to the values obtained when using facility-specific median values, it is concluded that the Indicators Model performs very well when using 3-digit SIC code median values for stack heights and exit gas velocities.

4.3 FUGITIVE EMISSIONS ANALYSIS

Fugitive releases, which are modeled as area sources, are a significant fraction of the total reported air emissions of TRI chemicals. The ISCLT model used by AG-1 and the Indicators Model can predict fugitive emissions from area sources as well as stack emissions from point sources. Thus, it is theoretically possible to conduct a ground-truthing exercise for fugitive emissions to test the area source component of the Indicators Model.

A ground-truthing exercise for fugitive emissions using AG-1, however, would not be very useful. Recall that AG-1 uses ISCLT2, and the Indicators Model uses ISCLT3; the area source algorithm in ISCLT3 has been improved over that used in ISCLT2 to calculate pollutant concentrations from fugitive emissions (U.S. EPA, 1992a, 1995b). Therefore, predictions made by the two models will differ even when identical input data are used. In addition, AG-1 and the Indicators Model use different data to characterize the dimensions of area sources. While AG-1 uses site-specific data for the surface area and height of an area source, the Indicators Model uses default values. Hence, comparing the fugitive emission component of AG-1 and the Indicators Model would require separate evaluations of the differences due to model algorithms and due to input data.

The essential difference in the area source algorithms used in ISC2 and ISC3 can be summarized as follows. Both algorithms are based on integrations of the Gaussian plume formula used for point sources, but the integration is carried out over different area geometries to describe the shape of an actual area source. In ISC2 the integration is carried out over a crosswind line, and calculations assume square area sources. Actual area sources may have irregular shapes; they can be represented with many small squares that approximately overlay the actual area. In ISC3 the integration is carried out over a rectangular area, and calculations allow arbitrary dimensions for each rectangle. By using rectangles of variable dimensions (aspect ratios can be as high as ten to one), area sources of irregular shape can be represented more accurately than in ISC2. (Note that these integrations cover the area source itself and therefore are independent of the computational grid used in the Indicators Model to estimate pollutant concentrations in square cells.) The revised area source algorithm included in ISC3 has been thoroughly evaluated and its predictions compared to wind tunnel data (U.S. EPA, 1992b, c, d). Because the computational algorithms are different, ISC2 and ISC3 will predict different concentrations for an identical area source, square or otherwise. However, the differences between predictions of ISC2 and ISC3 are more significant close to the source. ISC2

(and therefore AG-1) can underestimate concentrations close to the source by as much as a factor of three (NY DEC, 1995).

If the area source algorithms were identical in ISCLT2 and ISCLT3, as the point source algorithms are, a ground-truthing analysis would compare the results obtained from site-specific data on area source sizes with results obtained using default assumptions. The Indicators Model uses default values for the dimensions of all area sources: a surface area of 10 m^2 and a height of 3 m. The AG-1 Guidelines (NY DEC, 1991) recommend using a surface area of 84 m^2 in the absence of site-specific data; no default value is recommended for the height of the area source.

Sensitivity analyses conducted on ISCLT2 demonstrate that for an arbitrary area source size, there is a distance from the source at which the concentrations approach those of a point source (NY DEC, 1991). As would be intuitively expected, this distance decreases for smaller area sources. For an area source of the size used in the Indicators Model (10 m^2), this distance is about 50 m; for an area source of the size recommended in the AG-1 Guidelines (84 m^2), this distance is about 400 m (NY DEC, 1991). Therefore, at the distances sampled by the Indicators Model grid (one kilometer and larger), both models yield practically identical results (NY DEC, 1991). These results from ISCLT2 only reflect the impact due to different area sizes, not the impact of different area source heights. A similar sensitivity analysis was conducted using the ISCLT3 model to evaluate the impact of both area source size (10 m^2 and 84 m^2) and height (3 m and 0 m). From this analysis it was determined that the distances from the source at which the concentrations approach those of a point source are also less than one kilometer. Thus, a separate ground-truthing exercise for area sources would be redundant with the analysis of point sources already conducted.

5. PERSPECTIVE ON FINDINGS

This ground-truthing analysis shows that pollutant concentrations predicted by the Indicators Model are in excellent agreement with those predicted by AG-1, even though the models use different input data (median and generic values versus stack-specific data) and assumptions (e.g., building dimensions and treatment of chemical decay). Although the range of concentration ratios for individual cells is 0.23 to 3.4, the vast majority of individual cells in all 24 test cases have concentration ratios that are close to unity (within five percent of unity when facility-specific median parameters are used, and within ten percent of unity when SIC code based parameters are used). Because any one individual cell contributes very little to the impact of the facility as a whole, average concentration ratios over concentric rings around the stack were analyzed. For the majority of the test cases in the sample, average concentrations within each ring predicted by the two models are within 20 percent of each other. In the rings closest to the source, in which the largest discrepancies occur, average concentrations within each ring predicted by the two models are within a factor of 0.5 to two of each other, even when SIC code based parameters are used. Thus, although the Indicators Model is not designed as a substitute for more comprehensive, site-specific risk assessments, the results of this ground-truthing analysis indicate that the air exposure pathway of the Indicators Model provides very good estimates of air pollutant concentrations at the facility-specific level.

Not surprisingly, this ground-truthing analysis showed that the Indicators Model performs best when facility-specific median stack heights and exit gas velocities are available, rather than when median stack heights and exit gas velocities based on SIC codes are used. When facility-specific median values were used, results indicated a very close agreement between the Indicators Model and AG-1: average concentrations calculated over the approximately 10,560 cell concentrations estimated by each model for all 24 test cases differ by less than two percent, with a standard deviation of approximately 13 percent. Even when parameters based on SIC codes are used, the results of the Indicators Model compare very well to those of AG-1: average concentrations computed by both models for the 24 test cases differ by approximately six percent, with a standard deviation of approximately 13 percent.

Average ring concentrations predicted by the two models are within a factor of 0.5 to two of each other near the facility; these concentration ratios become smaller and often converge within a narrow band around unity with increasing distance from the source. Only two of the 24 test cases departed from this general pattern when using facility-specific median parameter values. As previously mentioned, such disagreements are probably due to the markedly different stack heights used by each model in these two test cases. Similar discrepancies are expected to occur in a fraction of the cases nationwide, because the facility-specific stack statistics (e.g., median) may not always accurately approximate the corresponding statistics for the subset of stacks that emit a particular chemical. This may happen regardless of whether facility-specific or SIC code based parameters are used. The sample is too small to allow precise inferences of how often this may occur, but the fact

that such discrepancies occurred only twice in the 24-case sample gives some indication that this situation may occur in only a small fraction of cases on a nationwide basis as well.

5.1 CALCULATION OF INDICATOR ELEMENTS

Although the ground-truthing exercise has affirmed the accuracy of the pollutant concentrations predicted by the Indicators Model, pollutant concentration is only part of the calculation of an Indicator Element, which can be used to rank facilities. Therefore, it is imperative to ascertain the contribution of pollutant concentration, as well as other components, to the estimation of Indicator Elements. An Indicator Element is the product of three components: the surrogate dose, which is based on pollutant concentration and exposure assumptions; the toxicity weight for the chemical of interest; and, the exposed population. For each of the 440 cells surrounding a TRI facility, cell-level products, called Indicator Sub-Elements, are calculated and then added to yield the Indicator Element. Consideration of these other Indicator Element components while taking into account the increased predictive accuracy of the ISCLT3 model at greater distances from a facility will aid the analyst when interpreting Indicators Model results at the facility-level.

5.1.1 Toxicity

Toxicity weights are chemical and pathway-specific; each facility emitting a given chemical will receive that same pathway-specific weighting factor for that chemical release. Weights range from 0.1 to 1,000,000 for carcinogens and from 0.001 to 100,000 for non-carcinogens. The impact of toxicity weights on Indicator Elements will be irrelevant only when comparing facilities emitting the same chemical. In all other cases they may account for a significant fraction of the total Indicator Elements value calculated for a facility.

5.1.2 Surrogate Dose

The air pollutant concentration estimated by the Indicators Model is converted to a surrogate dose using standard assumptions for body weight and inhalation rate. These exposure assumptions are the same from facility to facility and will not influence the ranking of facilities. Thus, the surrogate dose can be viewed as the ISCLT3 concentration multiplied by a constant. As discussed above, the results of this ground-truthing exercise demonstrated that the methods employed by the Indicators Model to estimate facility stack heights and exit gas velocities result in pollutant concentrations that compare very favorably to those of the AG-1 model, which uses much more facility-specific data. Generally, the results of the two models converged at approximately 2 kilometers from the facility, resulting in only a small percentage of the 1-km by 1-km cells being prone to over or underestimation of pollutant concentrations by an appreciable amount. These cells with an appreciable amount of over or underestimation are usually located in the immediate vicinity of the source. While pollutant concentrations are also highest near the source, one cannot conclude

that these cells have the greatest impact on Indicator Elements without considering the impact of population distribution.

5.1.3 Population

In addition to pollutant concentration, population is the other component of the Indicator Element that is of interest for this ground-truthing exercise. Unlike exposure assumptions and toxicity weight, which are applied consistently across all cells surrounding a facility, population is not distributed evenly around a facility. Generally speaking, it would be ideal if population was distributed at distances from the facility where the correspondence between ISCLT3 and AG-1 concentration estimates was nearly identical. Then the resulting facility rankings would be a fair representation of facilities' relative risk. If the population was concentrated primarily within 2 km of a facility, the resultant relative-risk rankings would be subject to greater error because the potential for discrepancies in estimated pollutant concentrations is higher nearer to the facility.

To consider this issue, revisit Figures 18 through 21, which show the concentration ratios using SIC code based parameters for the 24 test cases for the four metropolitan areas in New York State. Generally, concentration ratios become relatively constant at approximately 2 km. Within 1 km the ring-average estimates of the concentration ratios for the 24 test cases range from 50 percent below unity to almost 80 percent above unity. As seen in Table 15, the largest concentration ratio for a single cell of the 192 cells composing the 1 km rings of these 24 test cases (8 cells x 24 sites) was 3.4; the average of these 192 concentration ratios was 0.89.

To calculate an Indicator Element, it is necessary to multiply pollutant concentration in each cell by the number of people living in each cell. Therefore, population distribution in concentric rings around each facility was examined to see whether higher pollutant concentrations closer to the facility were counterbalanced by lower populations closer to the facility. The number of people living in each of the 440 cells surrounding the 24 facilities was obtained from the Indicators Model (AG-1 does not have a population database); these numbers were then added over all cells in a given ring for a given facility. The resulting population distributions do not display a consistent pattern, but rather vary significantly from facility to facility. While some facilities have the majority of the population living in rings 1 to 3, many facilities have increasing numbers of people living at greater distances. There is also significant variability among metropolitan areas: in Albany, most people live relatively far away from TRI facilities, while in Buffalo a high percentage of people live close to TRI facilities. In an attempt to obtain a national perspective of this, a nationwide distribution of exposure events, i.e., persons impacted by multiple TRI facilities with non-zero air releases, was also analyzed. Table 16 presents the exposure events within specific "distance rings" of TRI facilities reporting air releases. The values shown in this table are derived by assigning each person in the U.S. to each TRI facility located within a specified distance; this procedure allows a person to be counted multiple times, as is done in the Indicators Model, depending on how many TRI facilities potentially impact them.

Thus, the total exceeds the U.S. population, because of individuals experiencing multiple exposures. Although approximately 28 percent of the U.S. population resides within 2 km of TRI reporting facilities, Table 16 shows that only five percent of all exposure events occur within 2 km.

When a large percentage of the population lives close to a TRI facility and when significant discrepancies exist between the AG-1 and ISCLT3 predictions of pollutant concentrations near that facility, the generated Indicator Elements could conceivably influence relative rankings of facilities. In those instances where significant discrepancies exist between the AG-1 and ISCLT3 concentration predictions close to the facility but only a small percentage of the population live close to the facility, the impacts on the Indicator Elements and the associated facility rankings will be negligible.

5.2 COMPARISON OF INDICATOR SUB-ELEMENTS' CONTRIBUTIONS BY RING

As described above, Indicator Elements are the sum of Indicator Sub-Elements calculated for each of the 440 cells surrounding a TRI facility. To investigate the relative contribution of cell rings to the total Indicator Element value, Indicator Sub-Elements were calculated for each ring around each facility by multiplying just the population and the pollutant concentration in each cell, and adding the products over all cells in a ring. (These results were not multiplied by toxicity because the focus was only on analyzing a single pollutant in a given case.) The percent contributions of each ring to a facility's Indicator Element are displayed in Figures 27 to 30 (one figure per metropolitan area), along with the corresponding concentration ratio (ISCLT3/AG1) distributions by ring (these distributions are identical to those shown in Figures 7 to 10).

Inspection of Figures 27 to 30 reveals the absence of a typical profile. In fact, the distribution of the percent contribution by ring varies widely, as a consequence of the cell-by-cell combination of population and pollutant concentrations. While there are test cases where the largest contribution to a facility's Indicator Element comes from the first few rings (e.g., test case 1 in Syracuse), the converse is true in other test cases (e.g., test case 1 in Rochester). These two test cases illustrate the correlation between the distributions of population and Indicator Sub-Elements, and help visualize the impact that discrepancies in concentration estimates (measured by concentration ratios) may have on Indicator Elements. When there is a high population density near the facility, discrepancies in concentration estimates can translate into discrepancies of similar magnitude in Indicator Elements. In the worst case, the same factor of 0.5 to two that bounds discrepancies in pollutant concentrations will apply to Indicator Elements as well. This case is exemplified by case 4 in Albany, where concentration discrepancies in excess of 40 percent occur for all rings, and therefore the Indicator Element value is also 40 percent overestimated. This case was previously identified as unique, because of significant differences in median stack height input parameters. When a small percentage of the population lives near the facility, discrepancies in concentration estimates in the first few rings will have a much smaller impact on the total Indicator Element value. An extreme case is exemplified by case 4 in Rochester (Figure 29); although the concentration ratio indicates discrepancies between

30 and 60 percent for the first two rings, these discrepancies do not impact the Indicator Element because there is no population living in the first two rings. Correspondingly, in those instances where concentrations are correctly estimated, so will be the Indicator Elements, regardless of population distribution.

As with pollutant concentration analyses, these conclusions cannot necessarily be extrapolated to the U.S. as a whole. This sample reveals the wide variability in the distributions of Indicator Sub-Elements and the significant impact on Indicator Sub-Elements that results from the particular population distribution around a facility (although higher concentrations occur close to the source, their impact on the Indicator Sub-Elements is greatly dependent on the size of the population living in that area). Because of the wide variability observed from test case to test case, the Indicators Model needs to be employed to capture the unique population distribution around each modeled facility to ensure proper treatment of population and exposure.

5.3 FACILITY RANKINGS BASED ON INDICATOR ELEMENTS

The objective of the Indicators Model is to perform relative rankings of risk-related impacts. To evaluate the use of different assumptions concerning stack heights and exit gas velocities, a ranking exercise was performed on the 24 New York test cases. Facilities were ranked by each set of available concentration estimates, generated by AG-1, by ISCLT3 with facility-specific median stack heights and exit gas velocities, and by ISCLT3 with SIC code-based median stack heights and exit gas velocities. Using the Indicator Elements calculated above, facilities were ranked in two groups, those emitting chemicals that decay (toluene) and those emitting chemicals which do not decay (aluminum, mercury, nickel, or lead). Note that because toxicity weights for individual chemicals are not included in the above Indicator Elements, it is possible to group and rank all facilities emitting chemicals which do not have decay rates, because the dispersion of inorganic chemicals is modeled without any chemical-specific data (i.e., for a given facility, a pound of lead released to the air is predicted to undergo the exact same dispersion as a pound of aluminum). The two sets of rankings are listed in Tables 17 and 18, one for the chemical with decay and one for the chemicals without, respectively.

Inspection of Tables 17 and 18 reveals that the rankings corresponding to different input parameters are virtually identical for both categories of chemicals. The only exception is the rankings of facilities F and Q. Facilities F and Q were assigned the same rankings (3 and 2, respectively) when using ISCLT3 with both sets of input parameters, but were assigned slightly different rankings (2 and 3, respectively) when using AG-1. Indicator Element values for facility F are 2633 when facility-specific parameters are used, 2729 when SIC code-based parameters are used, and 3226 when using AG-1. Indicator Element values for facility Q are 2736 when facility-specific parameters are used, 2919 when SIC code-based parameters are used, and 3097 when using AG-1. In all three cases, Indicator Elements values for facility Q are very close (within four percent, seven percent, and four

percent, respectively) of the values corresponding to facility F. This suggests that relative rankings depend not only on the Indicator Element values of a given facility, but also upon the corresponding values of facilities with similar Indicator Element values. Differences in rankings may not be meaningful when the corresponding Indicator Elements are very close in magnitude.

6. CONCLUSION

This comparison of the Indicators Model to the AG-1 model was designed to measure whether the Indicators Model yields air pollutant concentrations comparable to an air dispersion model (AG-1) currently in use by a state agency, and to give an indication of the discrepancies in predictions. The air pollutant concentrations calculated by the Indicators Model are based on a combination of median and generic data and assumptions, whereas the AG-1 model relies on a greater variety of facility- and stack-specific data. The differences in pollutant concentrations predicted by both models were analyzed for 24 test cases in New York. The results obtained demonstrate that predictions of pollutant concentrations are not only comparable, but are extremely close, even though key input data to the two models are not the same. Average ratios computed over the 24 test cases were within two percent of unity (with a standard deviation of 13 percent) when using facility-specific parameters, and within six percent of unity (with a standard deviation of 13 percent) when using SIC code-based parameters. The accuracy of concentration estimates close to a facility is usually less than the accuracy observed further away from the facility, but the Indicators Model does not seem to consistently overpredict or underpredict pollutant concentrations.

The impact of population distributions around TRI facilities on the Indicator Element was also examined. Population around a TRI facility can have a significant impact on Indicator Element values, depending on the population size and distribution relative to the predicted pollutant concentrations and on the accuracy of the pollutant concentration estimates. The impact of population on the accuracy of the Indicator Element depends on the cell-by-cell combination of population and pollutant concentrations. Indicator Element values of lesser accuracy result from a combination of less accurate concentration estimates near the facility and a majority of the population living near the facility. When the concentration estimates are accurate, so are the Indicator Elements, regardless of population distribution. When a small percentage of the population lives near the facility, discrepancies in concentration estimates near the facility will have only a small impact on the Indicator Element value. Thus, the Indicators Model needs to be employed to capture the unique population distribution around each modeled facility to ensure proper treatment of population and exposure.

Indicator Elements were used to rank the facilities that correspond to the 24 test cases in New York. Facilities were ranked using each set of available concentration estimates: AG-1, ISCLT3 with facility-specific median stack heights and exit gas velocities, and ISCLT3 with SIC code-based median stack heights and exit gas velocities. Separate rankings were obtained for facilities emitting chemicals that decay and those emitting chemicals which do not decay. With the exception of one facility, the rankings corresponding to different input parameters were identical for both categories

of chemicals, for all three sets of input parameters. This finding supports the use of the Indicators Model to develop relative rankings of TRI facilities based on their risk-related impacts.

7. REFERENCES

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TABLES

TABLE 1
Ground-Truthing Test Cases

Urban Area	Case	Facility	Indicators Model Median Stack Height (m)	Chemical With Decay Rate	Chemical Without Decay Rate	Land Use Mode
Albany	1	A	10.06	Toluene		Urban
	2	B	9.45	Toluene		Urban
	3	C	1.22	Toluene		Urban
	4	A	10.06		Mercury	Urban
	5	D	8.08		Aluminum	Urban
	6	E	4.88		Mercury	Urban
Syracuse	1	F	11.43	Toluene		Rural
	2	G	9.14	Toluene		Rural
	3	H	3.96	Toluene		Urban
	4	I	28.35		Lead	Rural
	5	G	9.14		Lead	Rural
	6	J	5.49		Lead	Urban
Buffalo	1	K	14.63	Toluene		Urban
	2	L	9.14	Toluene		Urban
	3	M	6.10	Toluene		Urban
	4	N	11.73		Nickel	Urban
	5	O	8.53		Nickel	Rural
	6	P	3.66		Nickel	Urban
Rochester	1	Q	15.24	Toluene		Urban
	2	R	7.92	Toluene		Urban
	3	S	6.10	Toluene		Urban
	4	Q	15.24		Nickel	Urban
	5	T	7.92		Nickel	Rural
	6	S	6.10		Nickel	Urban

TABLE 2

Parameter Values Used by Each Model in the Ground-Truthing Exercise [1]

Parameter	Indicators Model (ISCLT3)	AG-1
stack height (SH)	single value; median stack height for each facility; calculation based on all stacks at the facility	single or multiple values; actual height for each stack-chemical combination
stack diameter	1 m (d)	actual stack-specific value
exit gas velocity	single value; median exit gas velocity for each facility; calculation based on all stacks at the facility	actual stack-specific value
exit temperature	293 K (d)	actual stack-specific value
decay rate	chemical-specific	no decay (d)
emission rate	total of all stack emissions for the selected chemical, from AG-1 database	actual stack-specific value
wind speed and direction	same as AG-1 (both models use the same type of meteorological data)	AG-1 STAR database
building height (BH)	assume BH=0 (d)	actual stack-specific value; in the absence of stack-specific data, assume BH=SH (d)
building width (BW)	assume BW=0 (d)	actual stack-specific value; in the absence of stack-specific data, assume BW=SH (d)
building length (BL)	assume BL=0 (d)	actual stack-specific value; in the absence of stack-specific data, assume BL=SH (d)
location coordinates (latitude, longitude)	single value for each facility (TRI database)	single or multiple; stack-specific, as reported in AG-1 database

[1] Default values are indicated with (d).

TABLE 3

Location and Stack Coordinates of TRI Facilities in New York Selected for the Model Comparison Exercise [1]

Urban Area	Case	Facility	UTME from TRI[2,3]	UTMN from TRI[2,3]	Central UTME from AG-1[2,4]	Central UTMN from AG-1[2,4]
Albany	1	A	606266	734199	606300	734200
	2	B	605871	732227	605800	732200
	3	C	605972	729363	606100	730200
	4	A	606266	734199	606200	734050
	5	D	604574	729742	604600	729400
	6	E	597218	726925	597100	727000
Syracuse	1	F	419367	761384	419400	761500
	2	G	407979	770435	403500	767200
	3	H	409308	767507	409400	767500
	4	I	371672	756557	371600	756500
	5	G	407979	770435	403500	767200
	6	J	602462	773533	402500	773700
Buffalo	1	K	188265	759084	188300	758750
	2	L	192038	755007	192100	755300
	3	M	179187	766125	179800	766300
	4	N	187367	753204	187400	753300
	5	O	171697	782845	171600	785000
	6	P	182600	765699	182500	765600
Rochester	1	Q	286491	781069	285250	786200
	2	R	284606	784275	284600	784200
	3	S	290572	783821	291000	784100
	4	Q	286491	781069	285250	786200
	5	T	269772	764903	291000	784100
	6	S	290572	783821	291000	784100

[1] Note that certain facilities are used for the evaluation of chemicals both with and without decay rates. However, these two types of chemicals may be emitted from different stacks within the facility.

[2] All coordinates are in meters, with values corresponding to the Universal Transverse Mercator (UTM) coordinate system.

[3] TRI coordinates are a single pair for each facility, contained in the TRI database.

[4] Although each stack is provided with its own coordinates in AG-1, for the purposes of comparison to the single pair of coordinates used in the Indicators Model, a single pair of coordinates was calculated for AG-1. Coordinates listed for AG-1 are the arithmetic average of the individual coordinates of the set of stacks that emit the particular chemical elected for the model comparison.

TABLE 4

Facility-Specific Stack Heights (m)

					AG-1 Parameters[1]				Indicators Model Parameters		
Urban Area	**Case**	**Facility**	**Chemical**	**# Stacks Emitting Selected Chemical**	**Mean Stack Height**	**Median Stack Height**	**Minimum**	**Maximum**	**Stack # (Total)**	**Median Stack Height**	**Mean Stack Height**
Albany	1	A	Toluene	2	5.49	5.49	3.66	7.32	19	10.06	12.48
	2	B	Toluene	3	9.45	9.45	9.45	9.45	3	9.45	9.04
	3	C	Toluene	1	1.83	1.83	1.83	1.83	3	1.22	5.28
	4	A	Mercury	2	36.58	36.58	36.58	36.58	19	10.06	12.48
	5	D	Aluminum	6	7.37	9.14	3.05	9.14	24	8.08	11.96
	6	E	Mercury	2	4.88	4.88	3.05	6.71	2	4.88	4.88
Syracuse	1	F	Toluene	7	12.63	12.80	11.58	12.80	12	11.43	10.19
	2	G	Toluene	7	6.57	7.01	3.96	8.84	17	9.14	8.53
	3	H	Toluene	1	2.44	2.44	2.44	2.44	5	3.96	3.35
	4	I	Lead	1	28.35	28.35	28.35	28.35	3	28.35	24.38
	5	G	Lead	3	7.47	8.23	7.92	9.75	17	9.14	8.53
	6	J	Lead	1	5.49	5.49	5.49	5.49	3	5.49	5.49
Buffalo	1	K	Toluene	2	10.97	10.97	10.36	11.58	40	14.63	14.67
	2	L	Toluene	1	14.94	14.94	14.94	14.94	7	9.14	10.32
	3	M	Toluene	12	4.75	3.35	1.83	9.14	21	6.10	11.57
	4	N	Nickel	1	8.23	8.23	8.23	8.23	24	11.73	15.19
	5	O	Nickel	1	3.66	3.66	3.66	3.66	99	8.53	8.57
	6	P	Nickel	8	3.39	2.44	2.44	7.62	14	3.66	4.68
Rochester	1	Q	Toluene	121	12.51	12.19	1.83	35.05	859	15.24	17.97
	2	R	Toluene	1	7.92	7.92	7.92	7.92	11	7.92	8.40
	3	S	Toluene	4	8.31	8.84	3.96	11.58	47	6.10	6.94
	4	Q	Nickel	3	20.93	21.34	17.68	23.77	859	15.24	17.97
	5	T	Nickel	1	9.14	9.14	9.14	9.14	31	7.92	9.48
	6	S	Nickel	1	6.10	6.10	6.10	6.10	47	6.10	6.94

[1]Although AG-1 uses unique chemical emission-stack combinations, the mean and median heights are presented for model input comparison purposes. The number of stack heights used in the calculation differ, as AG-1 averages are based only on those stacks which emit chemicals being analyzed, whereas average stack heights in ISCLT are based upon all stacks at the test case site.

TABLE 5
Facility-Specific Exit Gas Velocities (m/s)

					AG-1 Parameters[1]				Indicators Model Parameters		
Urban Area	**Case**	**Facility**	**Chemical**	**# Stacks Emitting Selected Chemical**	**Mean Exit Gas Velocity**	**Median Exit Gas Velocity**	**Minimum**	**Maximum**	**Stack # (Total)**	**Median Exit Gas Velocity**	**Mean Exit Gas Velocity**
Albany	1	A	Toluene	2	12.21	12.21	4.36	20.06	19	4.36	8.64
	2	B	Toluene	3	15.79	15.79	15.79	15.79	4	15.79	12.44
	3	C	Toluene	1	23.32	23.32	23.32	23.32	1	23.16	23.16
	4	A	Mercury	2	24.54	24.54	11.89	37.19	19	4.36	8.64
	5	D	Aluminum	6	20.26	19.51	17.01	26.52	25	14.72	13.56
	6	E	Mercury	2	20.13	20.13	20.13	20.13	2	20.13	20.13
Syracuse	1	F	Toluene	7	8.26	8.63	6.10	8.63	13	8.63	11.66
	2	G	Toluene	7	19.19	10.88	1.19	80.77	32	5.82	7.85
	3	H	Toluene	1	9.14	9.14	9.14	9.14	5	20.42	15.95
	4	I	Lead	1	2.77	2.77	2.77	2.77	3	7.50	95.37
	5	G	Lead	3	6.28	8.05	0.70	10.09	32	5.82	7.85
	6	J	Lead	1	4.57	4.57	4.57	4.57	3	3.57	3.90
Buffalo	1	K	Toluene	2	15.03	15.03	13.11	16.95	40	15.76	15.21
	2	L	Toluene	1	10.79	10.79	10.79	10.79	7	10.79	11.12
	3	M	Toluene	12	0.17	0.07	0.00	0.61	21	0.076	1.07
	4	N	Nickel	1	8.23	8.23	8.23	8.23	27	8.23	10.68
	5	O	Nickel	1	10.51	10.51	10.51	10.51	99	12.80	14.42
	6	P	Nickel	8	15.57	16.73	7.44	16.73	14	16.73	15.18
Rochester	1	Q	Toluene	121	11.01	10.67	0.00	39.32	873	11.67	14.69
	2	R	Toluene	1	3.96	3.96	3.96	3.96	11	10.06	12.91
	3	S	Toluene	4	14.32	16.57	2.59	21.55	48	8.18	8.20
	4	Q	Nickel	3	13.72	18.90	2.44	19.81	873	11.67	14.69
	5	T	Nickel	1	30.48	30.48	30.48	30.48	32	12.12	27.01
	6	S	Nickel	1	11.58	11.58	11.58	11.58	48	8.18	8.20

[1]Although AG-1 uses unique chemical emission-stack combinations, the mean and median exit gas velocities are presented for model input comparison purposes. The number of exit gas velocities used in the calculation differ, as AG-1 averages are based only on those stacks which emit chemicals being analyzed, whereas average exit gas velocities in ISCLT are based upon all stacks at the test case site.

TABLE 6
Facility-Specific Stack Diameters (m)

Urban Area	Case	Facility	Chemical	# Stacks Emitting Selected Chemical	Mean Stack Diameter	Median Stack Diameter	Minimum	Maximum
Albany	1	A	Toluene	2	0.18	0.18	0.10	0.25
	2	B	Toluene	3	0.91	0.91	0.91	0.91
	3	C	Toluene	1	0.05	0.05	0.05	0.05
	4	A	Mercury	2	1.30	1.30	1.07	1.52
	5	D	Aluminum	6	0.49	0.61	0.20	0.61
	6	E	Mercury	2	0.15	0.15	0.15	0.15
Syracuse	1	F	Toluene	7	1.05	1.07	0.97	1.07
	2	G	Toluene	7	0.26	0.36	0.10	0.36
	3	H	Toluene	1	0.10	0.10	0.10	0.10
	4	I	Lead	1	0.10	0.10	0.10	0.10
	5	G	Lead	3	0.66	0.61	0.51	0.86
	6	J	Lead	1	0.15	0.15	0.15	0.15
Buffalo	1	K	Toluene	2	0.43	0.43	0.25	0.61
	2	L	Toluene	1	0.91	0.91	0.91	0.91
	3	M	Toluene	12	0.21	0.15	0.10	0.48
	4	N	Nickel	1	0.61	0.61	0.61	0.61
	5	O	Nickel	1	0.33	0.33	0.33	0.33
	6	P	Nickel	8	0.22	0.20	0.20	0.30
Rochester	1	Q	Toluene	121	0.43	0.23	0.03	2.69
	2	R	Toluene	1	0.10	0.10	0.10	0.10
	3	S	Toluene	4	0.86	0.91	0.20	1.42
	4	Q	Nickel	3	0.59	0.36	0.10	1.32
	5	T	Nickel	1	0.10	0.10	0.10	0.10
	6	S	Nickel	1	0.20	0.20	0.20	0.20

Note: The default value for stack diameter in the Indicators Model is 1 m.

TABLE 7

Facility-Specific Stack Exit Temperatures (K)

Urban Area	Case	Facility	Chemical	# Stacks Emitting Selected Chemical	Mean Stack Exit Temperature	Median Stack Exit Temperature	Minimum	Maximum
Albany	1	A	Toluene	2	302	302	294	311
	2	B	Toluene	3	311	311	311	311
	3	C	Toluene	1	294	294	294	294
	4	A	Mercury	2	333	333	333	333
	5	D	Aluminum	6	293	293	293	294
	6	E	Mercury	2	294	294	294	294
Syracuse	1	F	Toluene	7	294	294	294	294
	2	G	Toluene	7	303	297	293	315
	3	H	Toluene	1	294	294	294	294
	4	I	Lead	1	408	408	408	408
	5	G	Lead	3	371	326	297	489
	6	J	Lead	1	366	366	366	366
Buffalo	1	K	Toluene	2	296	296	294	297
	2	L	Toluene	1	294	294	294	294
	3	M	Toluene	12	325	311	284	363
	4	N	Nickel	1	294	294	294	294
	5	O	Nickel	1	294	294	294	294
	6	P	Nickel	8	293	293	293	293
Rochester	1	Q	Toluene	121	299	294	284	394
	2	R	Toluene	1	450	450	450	450
	3	S	Toluene	4	296	295	295	300
	4	Q	Nickel	3	383	295	294	561
	5	T	Nickel	1	366	366	366	366
	6	S	Nickel	1	300	300	300	300

Note: The default value for stack exit temperature in the Indicators Model is 293 K.

TABLE 8
Facility-Specific Chemical Emission Rates (g/sec)

Urban Area	Case	Facility	Chemical	# Stacks Emitting Selected Chemical	Mean Chemical Emission Rate	Median Chemical Emission Rate	Minimum	Maximum
Albany	1	A	Toluene	2	2.20E-05	2.20E-05	1.41E-05	3.00E-05
	2	B	Toluene	3	1.97E+00	1.97E+00	1.97E+00	1.97E+00
	3	C	Toluene	1	3.79E-04	3.79E-04	3.79E-04	3.79E-04
	4	A	Mercury	2	1.19E-04	1.19E-04	1.19E-04	1.19E-04
	5	D	Aluminum	6	3.44E-04	4.73E-04	4.32E-05	4.73E-04
	6	E	Mercury	2	7.03E-06	7.03E-06	7.03E-06	7.03E-06
Syracuse	1	F	Toluene	7	5.22E-02	4.44E-02	7.20E-03	8.88E-02
	2	G	Toluene	7	1.76E-02	1.18E-02	1.02E-03	4.43E-02
	3	H	Toluene	1	1.08E-06	1.08E-06	1.08E-06	1.08E-06
	4	I	Lead	1	3.39E-02	3.39E-02	3.39E-02	3.39E-02
	5	G	Lead	3	7.85E-03	4.60E-03	6.10E-04	1.83E-02
	6	J	Lead	1	5.76E-05	5.76E-05	5.76E-05	5.76E-05
Buffalo	1	K	Toluene	2	3.31E-02	3.31E-02	9.50E-03	5.67E-02
	2	L	Toluene	1	9.07E-04	9.07E-04	9.07E-04	9.07E-04
	3	M	Toluene	12	1.39E-03	1.86E-04	5.26E-06	1.36E-02
	4	N	Nickel	1	1.15E-06	1.15E-06	1.15E-06	1.15E-06
	5	O	Nickel	1	7.20E-07	7.20E-07	7.20E-07	7.20E-07
	6	P	Nickel	8	1.44E-05	1.44E-05	1.44E-05	1.44E-05
Rochester	1	Q	Toluene	121	2.04E-02	1.27E-03	4.32E-08	5.88E-01
	2	R	Toluene	1	1.16E-01	1.16E-01	1.16E-01	1.16E-01
	3	S	Toluene	4	8.15E-05	1.90E-05	1.44E-08	2.88E-04
	4	Q	Nickel	3	2.16E-05	1.15E-07	1.44E-08	6.48E-05
	5	T	Nickel	1	1.18E-04	1.18E-04	1.18E-04	1.18E-04
	6	S	Nickel	1	1.44E-08	1.44E-08	1.44E-08	1.44E-08

Note: These values were used in both AG-1 and ISCLT3 for this analysis. The Indicators Model uses annual emissions reported to TRI.

TABLE 9

Summary Statistics for (ISCLT3/AG1) Ratio by Metropolitan Area, Chemical Characteristic, and Stack Height

Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

	Average	Standard Deviation	Minimum	Maximum	Number of Cells
All Cases	0.984	0.134	0.231	3.101	10539
By Metropolitan Area:					
Albany	1.049	0.196	0.810	1.731	2640
Syracuse	0.935	0.067	0.527	1.097	2640
Buffalo	0.962	0.071	0.518	1.097	2640
Rochester	0.989	0.135	0.231	3.101	2619
By Chemical Characteristic:					
Chemical with Decay Rate	0.948	0.066	0.231	1.417	5259
Chemical without Decay Rate	1.020	0.171	0.347	3.101	5280
By Stack Height:					
0m<x<=7m	0.972	0.023	0.841	1.008	3520
7m<x<=10m	0.958	0.076	0.518	1.097	3520
>10m	1.021	0.214	0.231	3.101	3499

TABLE 10

Summary Statistics for (ISCLT3/AG1) Ratio by Ring for All Locations and by Metropolitan Area

Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

OVERALL Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.955	0.258	0.347	3.101	192
2nd	0.973	0.180	0.231	2.182	384
3rd	0.981	0.142	0.472	1.879	576
4th	0.984	0.125	0.348	1.672	768
5th	0.986	0.113	0.590	1.546	960
6th	0.986	0.106	0.701	1.497	1152
7th	0.986	0.101	0.754	1.491	1344
8th	0.985	0.098	0.790	1.485	1536
9th	0.984	0.095	0.810	1.482	1728
10th	0.984	0.094	0.845	1.478	1899
Overall	0.984	0.134	0.231	3.101	10539

Rochester Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	1.053	0.450	0.347	3.101	48
2nd	1.007	0.280	0.231	2.182	96
3rd	0.996	0.189	0.472	1.879	144
4th	0.991	0.153	0.348	1.672	192
5th	0.989	0.124	0.590	1.546	240
6th	0.988	0.106	0.701	1.462	288
7th	0.987	0.095	0.754	1.402	336
8th	0.985	0.086	0.790	1.356	384
9th	0.983	0.081	0.810	1.322	432
10th	0.986	0.075	0.887	1.295	459
Overall	0.989	0.135	0.231	3.101	2619

Albany Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	1.041	0.281	0.810	1.731	48
2nd	1.056	0.227	0.904	1.595	96
3rd	1.057	0.207	0.928	1.547	144
4th	1.057	0.199	0.936	1.521	192
5th	1.055	0.194	0.935	1.505	240
6th	1.053	0.192	0.931	1.497	288
7th	1.050	0.190	0.925	1.491	336
8th	1.048	0.190	0.919	1.485	384
9th	1.045	0.190	0.912	1.482	432
10th	1.042	0.190	0.906	1.478	480
Overall	1.049	0.196	0.810	1.731	2640

Buffalo Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.899	0.137	0.518	1.091	48
2nd	0.940	0.101	0.680	1.097	96
3rd	0.954	0.084	0.759	1.097	144
4th	0.960	0.076	0.805	1.096	192
5th	0.963	0.071	0.833	1.094	240
6th	0.965	0.067	0.855	1.092	288
7th	0.965	0.065	0.859	1.089	336
8th	0.966	0.063	0.862	1.087	384
9th	0.965	0.061	0.860	1.084	432
10th	0.965	0.060	0.857	1.081	480
Overall	0.962	0.071	0.518	1.097	2640

Syracuse Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.828	0.162	0.527	1.097	48
2nd	0.891	0.113	0.603	1.076	96
3rd	0.915	0.087	0.709	1.056	144
4th	0.928	0.073	0.754	1.045	192
5th	0.936	0.064	0.787	1.039	240
6th	0.940	0.057	0.819	1.033	288
7th	0.942	0.054	0.833	1.030	336
8th	0.943	0.051	0.840	1.027	384
9th	0.944	0.050	0.843	1.024	432
10th	0.943	0.050	0.845	1.023	480
Overall	0.935	0.067	0.527	1.097	2640

TABLE 11

Summary Statistics for (ISCLT3/AG1) Ratio by Metropolitan Area, Chemical Characteristic, and Stack Height

Scenario: Facility-Specific Median Stack Height and Exit Gas Velocity of 0.01 m/sec

	Average	Standard Deviation	Minimum	Maximum	Number of Cells
All Cases	0.980	0.136	0.232	3.032	10539
By Metropolitan Area:					
Albany	1.047	0.191	0.829	1.658	2640
Syracuse	0.935	0.069	0.459	1.001	2640
Buffalo	0.964	0.069	0.549	1.097	2640
Rochester	0.976	0.147	0.232	3.032	2619
By Chemical Characteristic:					
Chemical with Decay Rate	0.946	0.072	0.232	1.434	5259
Chemical without Decay Rate	1.015	0.170	0.336	3.032	5280
By Stack Height:					
0m<x<=7m	0.973	0.022	0.840	1.008	3520
7m<x<=10m	0.942	0.093	0.406	1.097	3520
>10m	1.027	0.206	0.232	3.032	3499

TABLE 12

Summary Statistics for (ISCLT3/AG1) Ratio by Ring for All Locations and by Metropolitan Area

Scenario: Facility-Specific Median Stack Height and Exit Gas Velocity of 0.01 m/sec

OVERALL Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.944	0.252	0.336	3.032	192
2nd	0.966	0.181	0.232	2.160	384
3rd	0.975	0.144	0.473	1.866	576
4th	0.979	0.128	0.348	1.663	768
5th	0.982	0.116	0.591	1.540	960
6th	0.983	0.109	0.702	1.487	1152
7th	0.983	0.104	0.755	1.482	1344
8th	0.983	0.100	0.790	1.478	1536
9th	0.982	0.098	0.800	1.475	1728
10th	0.982	0.096	0.805	1.472	1899
Overall	0.980	0.136	0.232	3.032	10539

Rochester Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	1.017	0.467	0.336	3.032	48
2nd	0.982	0.299	0.232	2.160	96
3rd	0.975	0.208	0.473	1.866	144
4th	0.974	0.169	0.348	1.663	192
5th	0.974	0.139	0.591	1.540	240
6th	0.975	0.120	0.702	1.457	288
7th	0.975	0.107	0.755	1.398	336
8th	0.974	0.097	0.790	1.353	384
9th	0.973	0.091	0.811	1.319	432
10th	0.976	0.084	0.838	1.292	459
Overall	0.976	0.147	0.232	3.032	2619

Albany Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	1.028	0.254	0.829	1.658	48
2nd	1.050	0.215	0.913	1.555	96
3rd	1.054	0.200	0.934	1.521	144
4th	1.054	0.193	0.941	1.504	192
5th	1.053	0.190	0.938	1.492	240
6th	1.051	0.188	0.933	1.487	288
7th	1.049	0.187	0.927	1.482	336
8th	1.046	0.187	0.920	1.478	384
9th	1.044	0.187	0.914	1.475	432
10th	1.041	0.188	0.907	1.472	480
Overall	1.047	0.191	0.829	1.658	2640

Buffalo Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.907	0.131	0.549	1.090	48
2nd	0.945	0.096	0.706	1.097	96
3rd	0.957	0.081	0.780	1.097	144
4th	0.963	0.074	0.823	1.096	192
5th	0.965	0.069	0.848	1.094	240
6th	0.967	0.066	0.860	1.092	288
7th	0.967	0.063	0.859	1.089	336
8th	0.967	0.062	0.862	1.087	384
9th	0.967	0.061	0.860	1.084	432
10th	0.966	0.059	0.857	1.081	480
Overall	0.964	0.069	0.549	1.097	2640

Syracuse Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.822	0.157	0.459	0.994	48
2nd	0.888	0.112	0.570	1.001	96
3rd	0.914	0.088	0.665	1.001	144
4th	0.927	0.074	0.715	1.001	192
5th	0.935	0.066	0.744	1.001	240
6th	0.940	0.060	0.771	1.001	288
7th	0.942	0.057	0.782	1.001	336
8th	0.943	0.055	0.795	1.001	384
9th	0.944	0.054	0.800	1.001	432
10th	0.943	0.053	0.805	1.001	480
Overall	0.935	0.069	0.459	1.001	2640

TABLE 13
Comparison of AG-1, Indicators Model, and 3-digit SIC Code Parameters

Urban Area	Case	Facility	SIC Code	Chemical	AG-1 Median Stack Height[1]	Indicators Median Stack Height[1]	3-Digit SIC Median Stack Height[1]	Ratio of 3-Digit SIC to Indicators Stack Height	AG-1 Median Exit Gas Velocity[2]	Indicators Median Exit Gas Velocity[2]	3-Digit SIC Median Exit Gas Velocity[2]	Ratio of 3-Digit SIC to Indicators Exit Gas Velocity
Albany	1	A	324	Toluene	5.49	10.06	32.00	3.18	12.21	4.36	12.19	2.80
	2	B	329	Toluene	9.45	9.45	12.19	1.29	15.79	15.79	12.10	0.77
	3	C	295	Toluene	1.83	1.22	9.14	7.49	23.32	23.16	14.01	0.60
	4	A	324	Mercury	36.58	10.06	32.00	3.18	24.54	4.36	12.19	2.80
	5	D	331	Aluminum	9.14	8.08	24.38	3.02	19.51	14.72	8.96	0.61
	6	E	281	Mercury	4.88	4.88	13.11	2.69	20.13	20.13	9.08	0.45
Syracuse	1	F	251	Toluene	12.80	11.43	9.14	0.80	8.63	8.63	10.72	1.24
	2	G	326	Toluene	7.01	9.14	9.45	1.03	10.88	5.82	9.28	1.59
	3	H	356	Toluene	2.44	3.96	9.14	2.31	9.14	20.42	8.37	0.41
	4	I	331	Lead	28.35	28.35	24.38	0.86	2.77	7.50	8.96	1.19
	5	G	326	Lead	8.23	9.14	9.45	1.03	8.05	5.82	9.28	1.59
	6	J	367	Lead	5.49	5.49	9.14	1.66	4.57	3.57	8.10	2.27
Buffalo	1	K	371	Toluene	10.97	14.63	12.19	0.83	15.03	15.76	10.76	0.68
	2	L	344	Toluene	14.94	9.14	9.14	1.00	10.79	10.79	8.63	0.80
	3	M	331	Toluene	3.35	6.10	24.38	4.00	0.07	0.076	8.96	117.89
	4	N	326	Nickel	8.23	11.73	9.45	0.81	8.23	8.23	9.28	1.13
	5	O	329	Nickel	3.66	8.53	12.19	1.43	10.51	12.80	12.10	0.95
	6	P	344	Nickel	2.44	3.66	9.14	2.50	16.73	16.73	8.63	0.52
Rochester	1	Q	386	Toluene	12.19	15.24	12.19	0.80	10.67	11.67	9.71	0.83
	2	R	267	Toluene	7.92	7.92	9.14	1.15	3.96	10.06	10.79	1.07
	3	S	383[3]	Toluene	8.84	6.10	9.14	1.50	16.57	8.18	8.00	0.98
	4	Q	386	Nickel	21.34	15.24	12.19	0.80	18.90	11.67	9.71	0.83
	5	T	334	Nickel	9.14	7.92	12.19	1.54	30.48	12.12	9.30	0.77
	6	S	383[3]	Nickel	6.10	6.10	9.14	1.50	11.58	8.18	8.00	0.98

[1]Stack height in meters.

[2]Exit gas velocity in meters per second.

[3]Facility S reported an incorrect SIC code (there is no code 383). The median stack height and exit gas velocity used are those of SIC code 38.

TABLE 14

Summary Statistics for (ISCLT3/AG1) Ratio by Metropolitan Area, Chemical Characteristic, and Stack Height

Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

	Average	Standard Deviation	Minimum	Maximum	Number of Cells
All Cases	0.936	0.131	0.248	3.385	10539
By Metropolitan Area:					
Albany	0.871	0.125	0.479	1.079	2640
Syracuse	0.940	0.065	0.484	1.002	2640
Buffalo	0.930	0.113	0.439	1.099	2640
Rochester	1.001	0.169	0.248	3.385	2619
By Chemical Characteristic:					
Chemical with Decay Rate	0.912	0.119	0.248	1.565	5259
Chemical without Decay Rate	0.959	0.138	0.383	3.385	5280
By Stack Height:					
0m<x<=7m	0.934	0.076	0.639	1.008	3520
7m<x<=10m	0.898	0.105	0.439	1.099	3520
>10m	0.974	0.178	0.248	3.385	3499

TABLE 15

Summary Statistics for (ISCLT3/AG1) Ratio by Ring for All Locations and by Metropolitan Area

Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

OVERALL Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.889	0.252	0.383	3.385	192
2nd	0.917	0.177	0.248	2.354	384
3rd	0.928	0.141	0.505	2.016	576
4th	0.933	0.125	0.371	1.790	768
5th	0.937	0.114	0.630	1.653	960
6th	0.938	0.107	0.662	1.561	1152
7th	0.939	0.103	0.663	1.496	1344
8th	0.939	0.100	0.664	1.447	1536
9th	0.938	0.097	0.662	1.409	1728
10th	0.938	0.096	0.660	1.380	1899
Overall	0.936	0.131	0.248	3.385	10539

Rochester Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	1.081	0.520	0.383	3.385	48
2nd	1.025	0.324	0.248	2.354	96
3rd	1.011	0.227	0.505	2.016	144
4th	1.005	0.187	0.371	1.790	192
5th	1.003	0.158	0.630	1.653	240
6th	1.001	0.140	0.748	1.561	288
7th	0.999	0.129	0.803	1.496	336
8th	0.997	0.120	0.822	1.447	384
9th	0.995	0.114	0.830	1.409	432
10th	0.995	0.111	0.836	1.380	459
Overall	1.001	0.169	0.248	3.385	2619

Albany Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.816	0.170	0.479	1.079	48
2nd	0.857	0.144	0.596	1.061	96
3rd	0.869	0.133	0.633	1.054	144
4th	0.873	0.128	0.649	1.050	192
5th	0.874	0.125	0.656	1.048	240
6th	0.875	0.123	0.662	1.046	288
7th	0.874	0.122	0.663	1.045	336
8th	0.873	0.121	0.664	1.044	384
9th	0.872	0.120	0.662	1.043	432
10th	0.871	0.119	0.660	1.043	480
Overall	0.871	0.125	0.479	1.079	2640

Buffalo Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.858	0.179	0.439	1.095	48
2nd	0.904	0.142	0.601	1.099	96
3rd	0.919	0.126	0.676	1.099	144
4th	0.927	0.119	0.722	1.097	192
5th	0.930	0.114	0.736	1.095	240
6th	0.933	0.111	0.736	1.093	288
7th	0.934	0.108	0.736	1.090	336
8th	0.934	0.107	0.735	1.087	384
9th	0.934	0.105	0.733	1.084	432
10th	0.934	0.104	0.732	1.082	480
Overall	0.930	0.113	0.439	1.099	2640

Syracuse Summary

	Average	Average Standard Deviation	Minimum	Maximum	Number of Cells
1st ring:	0.801	0.141	0.484	0.948	48
2nd	0.880	0.100	0.590	0.976	96
3rd	0.912	0.077	0.681	0.984	144
4th	0.929	0.066	0.730	0.988	192
5th	0.939	0.058	0.757	0.992	240
6th	0.945	0.054	0.783	0.998	288
7th	0.949	0.052	0.793	0.999	336
8th	0.951	0.051	0.804	1.001	384
9th	0.952	0.050	0.809	1.002	432
10th	0.952	0.050	0.814	1.001	480
Overall	0.940	0.065	0.484	1.002	2640

TABLE 16
Exposure Event Counts Surrounding TRI Facilities

		Distance to Facility (+/- 500m)										Total
		<1 km	**1-2 km**	**2-3 km**	**3-4 km**	**4-5 km**	**5-6 km**	**6-7 km**	**7-8 km**	**8-9 km**	**9-10 km**	**(0-10 km)**
All persons	*count*	36,359	116,782	187,508	246,084	297,454	339,672	377,853	413,268	449,694	470,159	2,934,834
	%	1.2%	4.0%	6.4%	8.4%	10.1%	11.6%	12.9%	14.1%	15.3%	16.0%	100.0%
Race sub-populations												
White	*count*	25,598	81,439	128,781	168,139	202,677	231,605	258,394	282,899	308,878	323,517	2,011,927
	%	1.3%	4.0%	6.4%	8.4%	10.1%	11.5%	12.8%	14.1%	15.4%	16.1%	100.0%
Black	*count*	6,632	21,605	35,750	47,300	57,411	65,952	72,971	79,173	84,926	87,440	559,159
	%	1.2%	3.9%	6.4%	8.5%	10.3%	11.8%	13.1%	14.2%	15.2%	15.6%	100.0%
Native American	*count*	197	611	948	1,212	1,424	1,595	1,735	1,850	1,971	2,029	13,571
	%	1.5%	4.5%	7.0%	8.9%	10.5%	11.8%	12.8%	13.6%	14.5%	14.9%	100.0%
Asian/Pacific Islander	*count*	1,027	3,700	6,579	9,260	11,787	13,611	15,291	17,153	19,454	20,903	118,765
	%	0.9%	3.1%	5.5%	7.8%	9.9%	11.5%	12.9%	14.4%	16.4%	17.6%	100.0%
Hispanic	*count*	5,472	18,134	29,737	38,909	46,750	52,553	57,933	63,641	68,652	72,224	454,006
	%	1.2%	4.0%	6.5%	8.6%	10.3%	11.6%	12.8%	14.0%	15.1%	15.9%	100.0%
Age sub-populations												
Age <18	*count*	9,492	30,177	48,086	62,773	75,553	86,163	95,519	104,133	112,815	117,843	742,554
	%	1.3%	4.1%	6.5%	8.5%	10.2%	11.6%	12.9%	14.0%	15.2%	15.9%	100.0%
Age >65	*count*	4,668	14,779	23,360	30,321	36,533	41,603	46,172	50,354	54,669	56,949	359,409
	%	1.3%	4.1%	6.5%	8.4%	10.2%	11.6%	12.8%	14.0%	15.2%	15.8%	100.0%

Notes:
1. Data are from facilities reporting air releases in 1996.
2. Counts are in thousands. Percentages are of subpopulation totals.
3. Each person in the U.S. is assigned to each TRI facility within a specified distance ring of them, but is not removed from the Census database. Therefore, due to multiple impacts on one person of facilities located at varying distances, the total number of exposure events exceeds the U.S. population.

TABLE 17
Facility Rankings Based on Indicator Elements for Chemical with Decay Rate (Toluene)

AG-1				ISCLT 3-Facility-Specific Median Values				ISCLT 3- SIC-Code Based Median Values			
Facility	**Indicator Element[1]**	**Percent of Total**	**Rank**	**Facility**	**Indicator Element[1]**	**Percent of Total**	**Rank**	**Facility**	**Indicator Element[1]**	**Percent of Total**	**Rank**
B	16671	69.45%	1	B	16642	72.75%	1	B	15767	70.87%	1
F	3226	13.44%	2	Q	2736	11.96%	2	Q	2919	13.12%	2
Q	3097	12.90%	3	F	2633	11.51%	3	F	2729	12.27%	3
G	801	3.34%	4	G	670	2.93%	4	G	638	2.87%	4
R	144	0.60%	5	R	138	0.60%	5	R	137	0.62%	5
K	47	0.20%	6	K	41	0.18%	6	K	44	0.20%	6
M	14	0.06%	7	M	14	0.06%	7	M	10	0.05%	7
L	1.4	0.01%	8	L	1.5	0.01%	8	L	1.5	0.01%	8
C	0.78	0.003%	9	C	0.74	0.003%	9	C	0.74	0.003%	9
S	0.49	0.002%	10	S	0.48	0.002%	10	S	0.48	0.002%	10
A	0.13	0.001%	11	A	0.12	0.001%	11	A	0.08	0.0004%	11
H	0.0019	0.00001%	12	H	0.0018	0.00001%	12	H	0.0018	0.00001%	12
Total	24003	100.00%		**Total**	22876	100.00%		**Total**	22248	100.00%	

[1]Indicator Elements are the product of pollutant concentration and population in each cell, summed over all 440 cells surrounding a TRI facility.

TABLE 18
Facility Rankings Based on Indicator Elements for Chemicals without Decay Rates

AG-1				ISCLT 3-Facility-Specific Median Values				ISCLT 3- SIC-Code Based Median Values			
Facility	**Indicator Element[1]**	**Percent of Total**	**Rank**	**Facility**	**Indicator Element[1]**	**Percent of Total**	**Rank**	**Facility**	**Indicator Element[1]**	**Percent of Total**	**Rank**
G	130	54.45%	1	G	133	61.47%	1	G	127	58.91%	1
L	101	42.45%	2	L	76	35.11%	2	L	83	38.47%	2
D	6.3	2.66%	3	D	6.1	2.84%	3	D	4.6	2.15%	3
A	0.42	0.18%	4	A	0.66	0.30%	4	A	0.44	0.20%	4
J	0.28	0.12%	5	J	0.27	0.12%	5	J	0.26	0.12%	5
T	0.15	0.06%	6	T	0.13	0.06%	6	T	0.12	0.05%	6
P	0.09	0.04%	7	P	0.08	0.04%	7	P	0.08	0.04%	7
Q	0.06	0.03%	8	Q	0.07	0.03%	8	Q	0.08	0.04%	8
E	0.05	0.02%	9	E	0.04	0.02%	9	E	0.04	0.02%	9
O	0.003	0.001%	10	O	0.002	0.00%	10	O	0.002	0.001%	10
N	0.0015	0.001%	11	N	0.0014	0.001%	11	N	0.0014	0.001%	11
S	0.000022	0.00001%	12	S	0.000021	0.00001%	12	S	0.000021	0.00001%	12
Total	238	100.00%		**Total**	216	100.00%		**Total**	215	100.00%	

[1]Indicator Elements are the product of pollutant concentration and population in each cell, summed over all 440 cells surrounding a TRI facility.

FIGURES

FIGURE 1A
Example Concentrations (ug/m3) Predicted by AG1
Scenario: Facility-Specific Median Stack Height and Constant Exit Gas Velocity of 0.01 m/sec

	409400	410400	411400	412400	413400	414400	415400	416400	417400	418400	419400	420400	421400	422400	423400	424400	425400	426400	427400	428400	429400
751500	3.6E-03	3.8E-03	4.0E-03	4.3E-03	4.5E-03	4.7E-03	5.0E-03	6.7E-03	8.6E-03	1.0E-02	1.2E-02	1.4E-02	1.5E-02	1.6E-02	1.6E-02	1.5E-02	1.4E-02	1.3E-02	1.2E-02	1.0E-02	9.5E-03
752500	4.4E-03	4.2E-03	4.5E-03	4.8E-03	5.0E-03	5.3E-03	5.5E-03	7.2E-03	9.5E-03	1.2E-02	1.4E-02	1.6E-02	1.7E-02	1.8E-02	1.8E-02	1.7E-02	1.5E-02	1.4E-02	1.2E-02	1.1E-02	1.0E-02
753500	5.4E-03	5.2E-03	4.9E-03	5.3E-03	5.7E-03	6.1E-03	6.4E-03	7.5E-03	1.1E-02	1.4E-02	1.7E-02	1.9E-02	2.1E-02	2.2E-02	2.1E-02	1.9E-02	1.7E-02	1.5E-02	1.3E-02	1.2E-02	1.2E-02
754500	6.5E-03	6.5E-03	6.4E-03	5.9E-03	6.5E-03	7.1E-03	7.6E-03	7.9E-03	1.2E-02	1.6E-02	2.0E-02	2.4E-02	2.6E-02	2.7E-02	2.4E-02	2.1E-02	1.8E-02	1.6E-02	1.5E-02	1.4E-02	1.3E-02
755500	7.9E-03	8.1E-03	8.2E-03	8.0E-03	7.4E-03	8.2E-03	9.0E-03	9.7E-03	1.3E-02	1.9E-02	2.5E-02	3.0E-02	3.3E-02	3.2E-02	2.8E-02	2.4E-02	2.0E-02	1.9E-02	1.7E-02	1.5E-02	1.4E-02
756500	9.4E-03	9.9E-03	1.0E-02	1.1E-02	1.1E-02	9.6E-03	1.1E-02	1.2E-02	1.4E-02	2.3E-02	3.3E-02	4.0E-02	4.4E-02	3.8E-02	3.2E-02	2.7E-02	2.4E-02	2.1E-02	1.9E-02	1.7E-02	1.5E-02
757500	1.2E-02	1.2E-02	1.3E-02	1.4E-02	1.5E-02	1.5E-02	1.3E-02	1.5E-02	1.7E-02	2.8E-02	4.5E-02	5.7E-02	5.7E-02	4.7E-02	3.7E-02	3.2E-02	2.8E-02	2.4E-02	2.1E-02	1.9E-02	1.7E-02
758500	1.8E-02	1.8E-02	1.8E-02	1.8E-02	2.0E-02	2.2E-02	2.2E-02	2.0E-02	2.4E-02	3.4E-02	6.8E-02	8.9E-02	7.6E-02	5.7E-02	4.7E-02	3.9E-02	3.2E-02	2.7E-02	2.4E-02	2.2E-02	2.0E-02
759500	2.4E-02	2.6E-02	2.9E-02	3.1E-02	3.3E-02	3.2E-02	3.6E-02	4.0E-02	3.5E-02	4.6E-02	1.2E-01	1.5E-01	1.0E-01	7.8E-02	5.9E-02	4.7E-02	4.0E-02	3.5E-02	3.0E-02	2.7E-02	2.4E-02
760500	3.1E-02	3.5E-02	4.0E-02	4.6E-02	5.5E-02	6.5E-02	7.8E-02	8.8E-02	9.6E-02	9.0E-02	2.9E-01	2.8E-01	1.6E-01	1.1E-01	8.3E-02	6.5E-02	5.2E-02	4.3E-02	3.6E-02	3.1E-02	2.7E-02
761500	3.7E-02	4.3E-02	5.1E-02	6.2E-02	7.7E-02	1.0E-01	1.4E-01	2.0E-01	3.5E-01	8.3E-01		7.2E-01	2.9E-01	1.7E-01	1.1E-01	8.1E-02	6.2E-02	5.0E-02	4.1E-02	3.5E-02	3.0E-02
762500	3.5E-02	4.1E-02	4.8E-02	5.7E-02	6.9E-02	8.7E-02	1.1E-01	1.5E-01	2.1E-01	2.5E-01	2.5E-01	2.0E-01	1.8E-01	1.3E-01	9.4E-02	7.1E-02	5.6E-02	4.6E-02	3.8E-02	3.3E-02	2.8E-02
763500	3.3E-02	3.7E-02	4.3E-02	5.0E-02	5.9E-02	7.1E-02	8.4E-02	9.9E-02	1.1E-01	8.8E-02	9.9E-02	8.2E-02	7.9E-02	8.0E-02	7.0E-02	5.9E-02	4.9E-02	4.1E-02	3.5E-02	3.0E-02	2.6E-02
764500	3.0E-02	3.4E-02	3.8E-02	4.3E-02	4.9E-02	5.4E-02	6.0E-02	6.2E-02	5.9E-02	4.8E-02	5.5E-02	4.8E-02	4.8E-02	4.5E-02	4.6E-02	4.3E-02	3.9E-02	3.5E-02	3.1E-02	2.7E-02	2.4E-02
765500	2.7E-02	3.0E-02	3.3E-02	3.6E-02	3.9E-02	4.1E-02	4.2E-02	4.1E-02	3.5E-02	3.4E-02	3.7E-02	3.3E-02	3.1E-02	3.2E-02	3.0E-02	3.1E-02	3.0E-02	2.8E-02	2.6E-02	2.4E-02	2.2E-02
766500	2.4E-02	2.6E-02	2.8E-02	2.9E-02	3.0E-02	3.1E-02	3.0E-02	2.8E-02	2.3E-02	2.5E-02	2.6E-02	2.5E-02	2.2E-02	2.3E-02	2.3E-02	2.1E-02	2.2E-02	2.2E-02	2.1E-02	2.0E-02	1.9E-02
767500	2.1E-02	2.2E-02	2.3E-02	2.4E-02	2.4E-02	2.4E-02	2.3E-02	2.0E-02	1.8E-02	2.0E-02	2.0E-02	1.9E-02	1.8E-02	1.7E-02	1.8E-02	1.7E-02	1.6E-02	1.7E-02	1.7E-02	1.7E-02	1.6E-02
768500	1.8E-02	1.9E-02	1.9E-02	1.9E-02	1.9E-02	1.9E-02	1.7E-02	1.5E-02	1.5E-02	1.6E-02	1.6E-02	1.6E-02	1.5E-02	1.3E-02	1.4E-02	1.4E-02	1.4E-02	1.3E-02	1.4E-02	1.4E-02	1.4E-02
769500	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.5E-02	1.3E-02	1.2E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02	1.2E-02	1.1E-02	1.1E-02	1.2E-02	1.2E-02	1.1E-02	1.1E-02	1.1E-02	1.1E-02
770500	1.4E-02	1.4E-02	1.4E-02	1.3E-02	1.3E-02	1.2E-02	1.0E-02	1.0E-02	1.1E-02	1.1E-02	1.1E-02	1.1E-02	1.0E-02	9.8E-03	9.4E-03	9.8E-03	9.8E-03	9.7E-03	9.5E-03	9.2E-03	9.5E-03
771500	1.2E-02	1.2E-02	1.2E-02	1.1E-02	1.1E-02	9.7E-03	8.7E-03	9.1E-03	9.4E-03	9.5E-03	9.5E-03	9.4E-03	9.0E-03	8.6E-03	8.0E-03	8.3E-03	8.4E-03	8.5E-03	8.3E-03	8.1E-03	7.9E-03

NOTE: Row and column headings represent Universal Transverse Mercator (UTM) coordinates in meters.

FIGURE 1B
Example Concentrations (ug/m3) Predicted by ISCLT3
Scenario: Facility-Specific Median Stack Height and Constant Exit Gas Velocity of 0.01 m/sec

	409400	410400	411400	412400	413400	414400	415400	416400	417400	418400	419400	420400	421400	422400	423400	424400	425400	426400	427400	428400	429400
751500	3.27E-03	3.48E-03	3.70E-03	3.92E-03	4.11E-03	4.28E-03	4.60E-03	6.21E-03	7.91E-03	9.62E-03	1.13E-02	1.26E-02	1.37E-02	1.44E-02	1.48E-02	1.40E-02	1.29E-02	1.18E-02	1.08E-02	9.80E-03	8.90E-03
752500	4.04E-03	3.81E-03	4.08E-03	4.37E-03	4.63E-03	4.87E-03	5.06E-03	6.59E-03	8.76E-03	1.10E-02	1.31E-02	1.49E-02	1.62E-02	1.70E-02	1.70E-02	1.56E-02	1.42E-02	1.29E-02	1.16E-02	1.04E-02	9.85E-03
753500	4.96E-03	4.82E-03	4.51E-03	4.88E-03	5.25E-03	5.60E-03	5.89E-03	6.88E-03	9.71E-03	1.27E-02	1.55E-02	1.78E-02	1.95E-02	2.04E-02	1.93E-02	1.75E-02	1.57E-02	1.40E-02	1.24E-02	1.17E-02	1.09E-02
754500	6.03E-03	6.04E-03	5.88E-03	5.45E-03	5.97E-03	6.47E-03	6.93E-03	7.28E-03	1.07E-02	1.48E-02	1.87E-02	2.19E-02	2.40E-02	2.47E-02	2.22E-02	1.97E-02	1.73E-02	1.52E-02	1.41E-02	1.30E-02	1.20E-02
755500	7.27E-03	7.49E-03	7.57E-03	7.40E-03	6.79E-03	7.53E-03	8.25E-03	8.86E-03	1.17E-02	1.75E-02	2.32E-02	2.78E-02	3.05E-02	2.94E-02	2.58E-02	2.23E-02	1.91E-02	1.75E-02	1.59E-02	1.45E-02	1.32E-02
756500	8.68E-03	9.18E-03	9.62E-03	9.86E-03	9.70E-03	8.79E-03	9.93E-03	1.10E-02	1.23E-02	2.10E-02	2.98E-02	3.67E-02	4.01E-02	3.54E-02	3.00E-02	2.50E-02	2.25E-02	2.01E-02	1.79E-02	1.60E-02	1.44E-02
757500	1.08E-02	1.11E-02	1.20E-02	1.29E-02	1.35E-02	1.35E-02	1.20E-02	1.39E-02	1.55E-02	2.54E-02	4.03E-02	5.15E-02	5.21E-02	4.32E-02	3.48E-02	3.04E-02	2.64E-02	2.29E-02	2.00E-02	1.75E-02	1.58E-02
758500	1.63E-02	1.68E-02	1.67E-02	1.65E-02	1.83E-02	1.99E-02	2.04E-02	1.78E-02	2.13E-02	2.99E-02	5.88E-02	7.91E-02	6.91E-02	5.28E-02	4.42E-02	3.66E-02	3.05E-02	2.57E-02	2.30E-02	2.08E-02	1.89E-02
759500	2.22E-02	2.43E-02	2.65E-02	2.86E-02	3.00E-02	2.94E-02	3.25E-02	3.56E-02	3.03E-02	3.83E-02	9.75E-02	1.33E-01	9.40E-02	7.18E-02	5.49E-02	4.36E-02	3.76E-02	3.25E-02	2.83E-02	2.48E-02	2.20E-02
760500	2.82E-02	3.21E-02	3.68E-02	4.26E-02	4.99E-02	5.88E-02	6.92E-02	7.74E-02	8.30E-02	6.95E-02	2.10E-01	2.41E-01	1.44E-01	9.96E-02	7.56E-02	5.93E-02	4.79E-02	3.96E-02	3.34E-02	2.87E-02	2.50E-02
761500	3.42E-02	3.97E-02	4.69E-02	5.65E-02	6.99E-02	8.96E-02	1.20E-01	1.74E-01	2.83E-01	5.73E-01	[redacted]	5.33E-01	2.43E-01	1.45E-01	9.94E-02	7.34E-02	5.71E-02	4.59E-02	3.80E-02	3.21E-02	2.76E-02
762500	3.23E-02	3.72E-02	4.34E-02	5.14E-02	6.22E-02	7.68E-02	9.71E-02	1.25E-01	1.57E-01	1.71E-01	2.00E-01	1.58E-01	1.53E-01	1.13E-01	8.40E-02	6.48E-02	5.17E-02	4.24E-02	3.55E-02	3.03E-02	2.63E-02
763500	3.00E-02	3.41E-02	3.92E-02	4.53E-02	5.29E-02	6.20E-02	7.23E-02	8.27E-02	8.64E-02	7.05E-02	8.54E-02	6.96E-02	6.87E-02	7.10E-02	6.30E-02	5.37E-02	4.47E-02	3.77E-02	3.23E-02	2.80E-02	2.45E-02
764500	2.75E-02	3.07E-02	3.45E-02	3.87E-02	4.33E-02	4.81E-02	5.22E-02	5.32E-02	4.99E-02	4.18E-02	4.96E-02	4.22E-02	4.25E-02	4.01E-02	4.21E-02	3.97E-02	3.61E-02	3.24E-02	2.86E-02	2.53E-02	2.25E-02
765500	2.48E-02	2.71E-02	2.96E-02	3.22E-02	3.47E-02	3.66E-02	3.69E-02	3.60E-02	3.06E-02	3.04E-02	3.34E-02	3.02E-02	2.81E-02	2.87E-02	2.70E-02	2.84E-02	2.76E-02	2.60E-02	2.41E-02	2.22E-02	2.03E-02
766500	2.19E-02	2.34E-02	2.50E-02	2.64E-02	2.74E-02	2.75E-02	2.72E-02	2.50E-02	2.06E-02	2.31E-02	2.44E-02	2.28E-02	2.01E-02	2.11E-02	2.09E-02	1.97E-02	2.07E-02	2.05E-02	1.97E-02	1.87E-02	1.75E-02
767500	1.91E-02	2.01E-02	2.09E-02	2.15E-02	2.15E-02	2.15E-02	2.04E-02	1.80E-02	1.68E-02	1.81E-02	1.88E-02	1.79E-02	1.63E-02	1.60E-02	1.63E-02	1.60E-02	1.52E-02	1.59E-02	1.59E-02	1.55E-02	1.49E-02
768500	1.66E-02	1.71E-02	1.75E-02	1.74E-02	1.74E-02	1.69E-02	1.56E-02	1.32E-02	1.39E-02	1.47E-02	1.50E-02	1.45E-02	1.35E-02	1.24E-02	1.30E-02	1.31E-02	1.28E-02	1.22E-02	1.27E-02	1.28E-02	1.26E-02
769500	1.43E-02	1.45E-02	1.45E-02	1.45E-02	1.42E-02	1.35E-02	1.21E-02	1.10E-02	1.17E-02	1.22E-02	1.24E-02	1.20E-02	1.14E-02	1.05E-02	1.06E-02	1.08E-02	1.07E-02	1.05E-02	1.01E-02	1.05E-02	1.06E-02
770500	1.23E-02	1.23E-02	1.23E-02	1.22E-02	1.17E-02	1.09E-02	9.57E-03	9.55E-03	1.00E-02	1.03E-02	1.04E-02	1.02E-02	9.73E-03	9.12E-03	8.74E-03	9.06E-03	9.14E-03	9.04E-03	8.80E-03	8.49E-03	8.80E-03
771500	1.06E-02	1.06E-02	1.06E-02	1.03E-02	9.73E-03	8.88E-03	7.94E-03	8.36E-03	8.68E-03	8.88E-03	8.92E-03	8.75E-03	8.43E-03	8.00E-03	7.47E-03	7.68E-03	7.84E-03	7.84E-03	7.72E-03	7.53E-03	7.28E-03

NOTE: Row and column headings represent Universal Transverse Mercator (UTM) coordinates in meters.

FIGURE 1C
Example Concentration Ratios (ISCLT3/AG1)
Scenario: Facility-Specific Median Stack Height and Constant Exit Gas Velocity of 0.01 m/sec

	409400	410400	411400	412400	413400	414400	415400	416400	417400	418400	419400	420400	421400	422400	423400	424400	425400	426400	427400	428400	429400
751500	0.956	0.958	0.959	0.960	0.961	0.961	0.962	0.964	0.965	0.965	0.966	0.967	0.968	0.968	0.968	0.970	0.972	0.973	0.974	0.975	0.975
752500	0.959	0.959	0.960	0.961	0.962	0.962	0.962	0.963	0.964	0.965	0.966	0.967	0.968	0.969	0.970	0.972	0.974	0.976	0.977	0.978	0.976
753500	0.961	0.962	0.961	0.962	0.962	0.962	0.962	0.962	0.963	0.963	0.964	0.965	0.967	0.968	0.971	0.974	0.977	0.978	0.980	0.978	0.977
754500	0.963	0.964	0.964	0.962	0.962	0.961	0.960	0.959	0.960	0.960	0.961	0.963	0.965	0.967	0.972	0.976	0.979	0.982	0.980	0.979	0.978
755500	0.965	0.965	0.965	0.964	0.961	0.959	0.957	0.956	0.955	0.954	0.955	0.958	0.962	0.967	0.972	0.977	0.982	0.981	0.981	0.979	0.978
756500	0.966	0.967	0.967	0.965	0.962	0.957	0.953	0.949	0.946	0.944	0.945	0.949	0.956	0.965	0.973	0.980	0.980	0.980	0.980	0.979	0.978
757500	0.967	0.968	0.968	0.966	0.963	0.958	0.948	0.940	0.933	0.929	0.930	0.937	0.948	0.962	0.975	0.977	0.978	0.979	0.979	0.979	0.978
758500	0.966	0.966	0.967	0.967	0.964	0.957	0.947	0.929	0.915	0.906	0.905	0.918	0.942	0.963	0.968	0.973	0.976	0.978	0.978	0.978	0.977
759500	0.965	0.965	0.964	0.961	0.959	0.956	0.946	0.927	0.894	0.866	0.858	0.893	0.943	0.951	0.961	0.968	0.971	0.973	0.975	0.976	0.976
760500	0.964	0.964	0.962	0.959	0.953	0.944	0.930	0.912	0.888	0.795	0.752	0.880	0.916	0.934	0.947	0.958	0.966	0.970	0.973	0.975	0.975
761500	0.964	0.963	0.961	0.957	0.951	0.940	0.922	0.894	0.839	0.704		0.766	0.869	0.914	0.937	0.953	0.963	0.968	0.972	0.974	0.974
762500	0.962	0.961	0.958	0.954	0.946	0.932	0.909	0.872	0.807	0.717	0.806	0.802	0.871	0.911	0.935	0.951	0.962	0.967	0.971	0.973	0.974
763500	0.961	0.960	0.956	0.951	0.943	0.928	0.909	0.885	0.863	0.840	0.892	0.878	0.904	0.922	0.940	0.954	0.963	0.967	0.971	0.973	0.974
764500	0.960	0.959	0.955	0.950	0.945	0.935	0.922	0.912	0.897	0.901	0.928	0.920	0.926	0.938	0.948	0.957	0.965	0.969	0.971	0.973	0.974
765500	0.959	0.958	0.956	0.953	0.948	0.944	0.938	0.929	0.923	0.931	0.947	0.942	0.943	0.949	0.957	0.962	0.966	0.969	0.972	0.973	0.973
766500	0.960	0.959	0.958	0.956	0.953	0.951	0.947	0.942	0.943	0.948	0.959	0.956	0.957	0.959	0.963	0.965	0.968	0.970	0.972	0.973	0.973
767500	0.960	0.960	0.960	0.959	0.958	0.956	0.953	0.953	0.955	0.959	0.967	0.965	0.965	0.966	0.966	0.968	0.969	0.971	0.972	0.972	0.973
768500	0.960	0.961	0.961	0.962	0.960	0.959	0.958	0.959	0.961	0.965	0.971	0.969	0.969	0.969	0.969	0.970	0.971	0.971	0.971	0.972	0.972
769500	0.961	0.962	0.962	0.962	0.962	0.962	0.962	0.963	0.965	0.969	0.973	0.972	0.972	0.972	0.972	0.972	0.971	0.971	0.970	0.970	0.970
770500	0.960	0.962	0.962	0.963	0.963	0.963	0.964	0.966	0.968	0.970	0.974	0.973	0.973	0.973	0.973	0.972	0.971	0.971	0.970	0.968	0.968
771500	0.960	0.961	0.962	0.963	0.963	0.964	0.965	0.967	0.968	0.971	0.973	0.973	0.973	0.973	0.973	0.972	0.971	0.970	0.969	0.968	0.966

NOTE: Row and column headings represent Universal Transverse Mercator (UTM) coordinates in meters.

FIGURE 2
Example Contour Plots of Concentrations Predicted By Each Model and Example Contour Plot of the Concentration Ratios
Scenario: Facility-Specific Median Stack Height and Constant Exit Gas Velocity of 0.01 m/sec

FIGURE 2A
ISCLT-3 Concentration (ug/m^3)

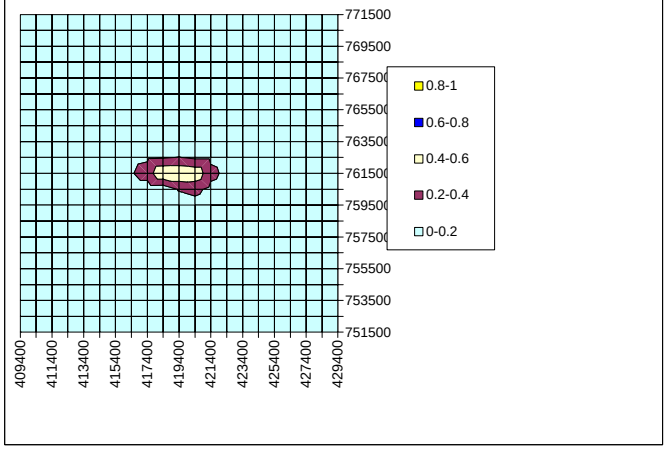


FIGURE 2B
AG-1 Concentration (ug/m^3)

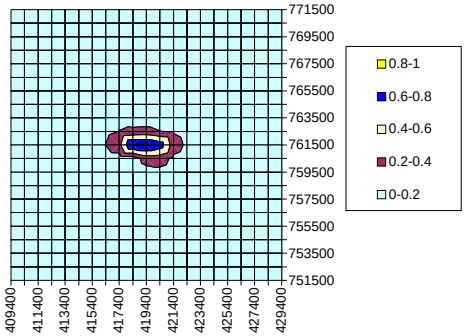
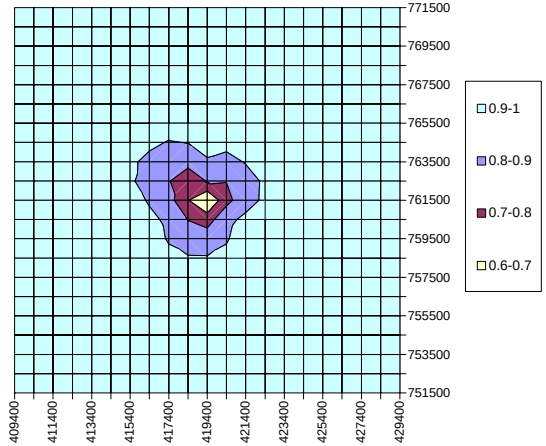


FIGURE 2C
(ISCLT3/AG1) Ratio



NOTE: All axes represent Universal Transverse Mercator (UTM) coordinates in meters.

FIGURE 3
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Albany Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

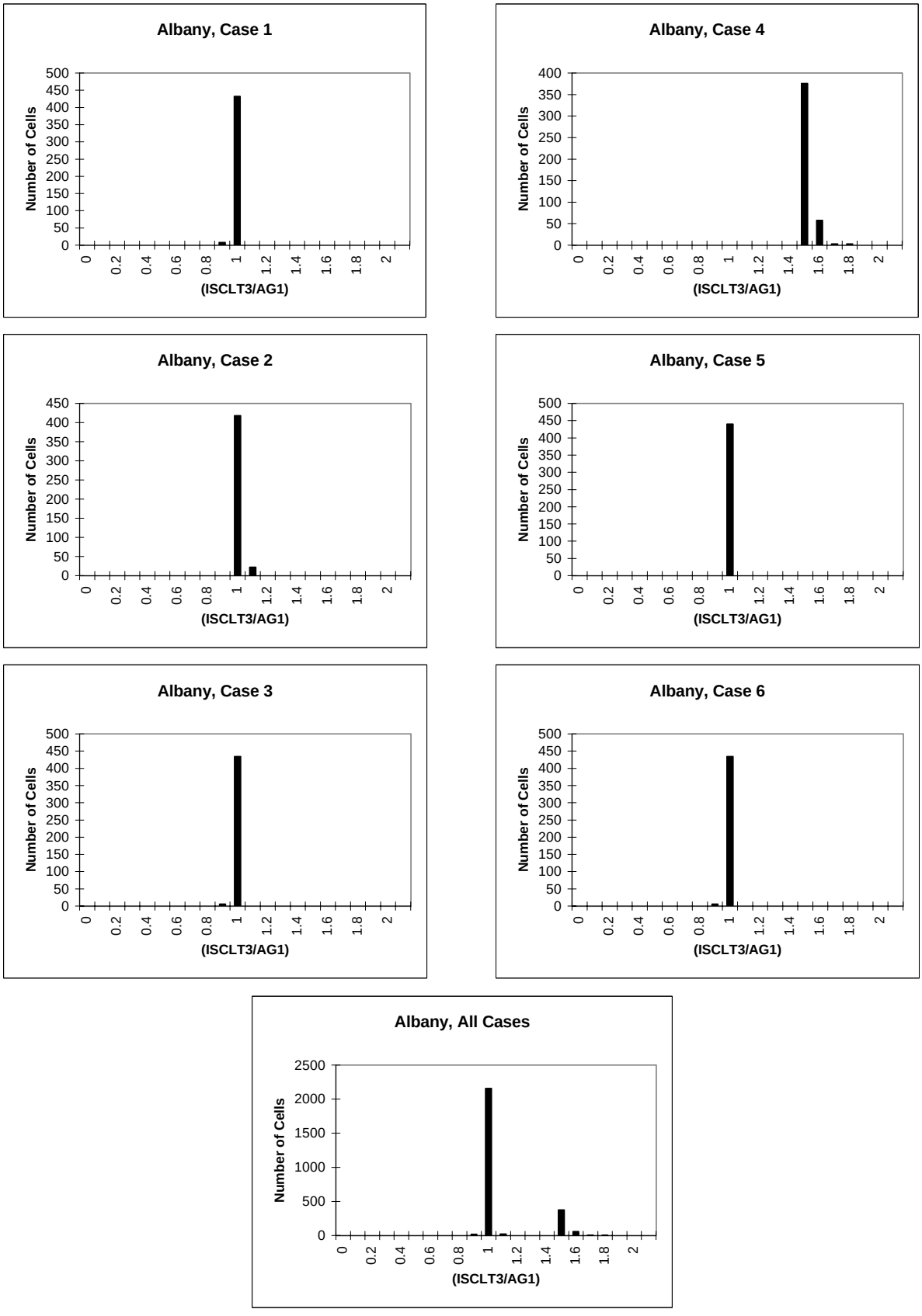


FIGURE 4
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Buffalo Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

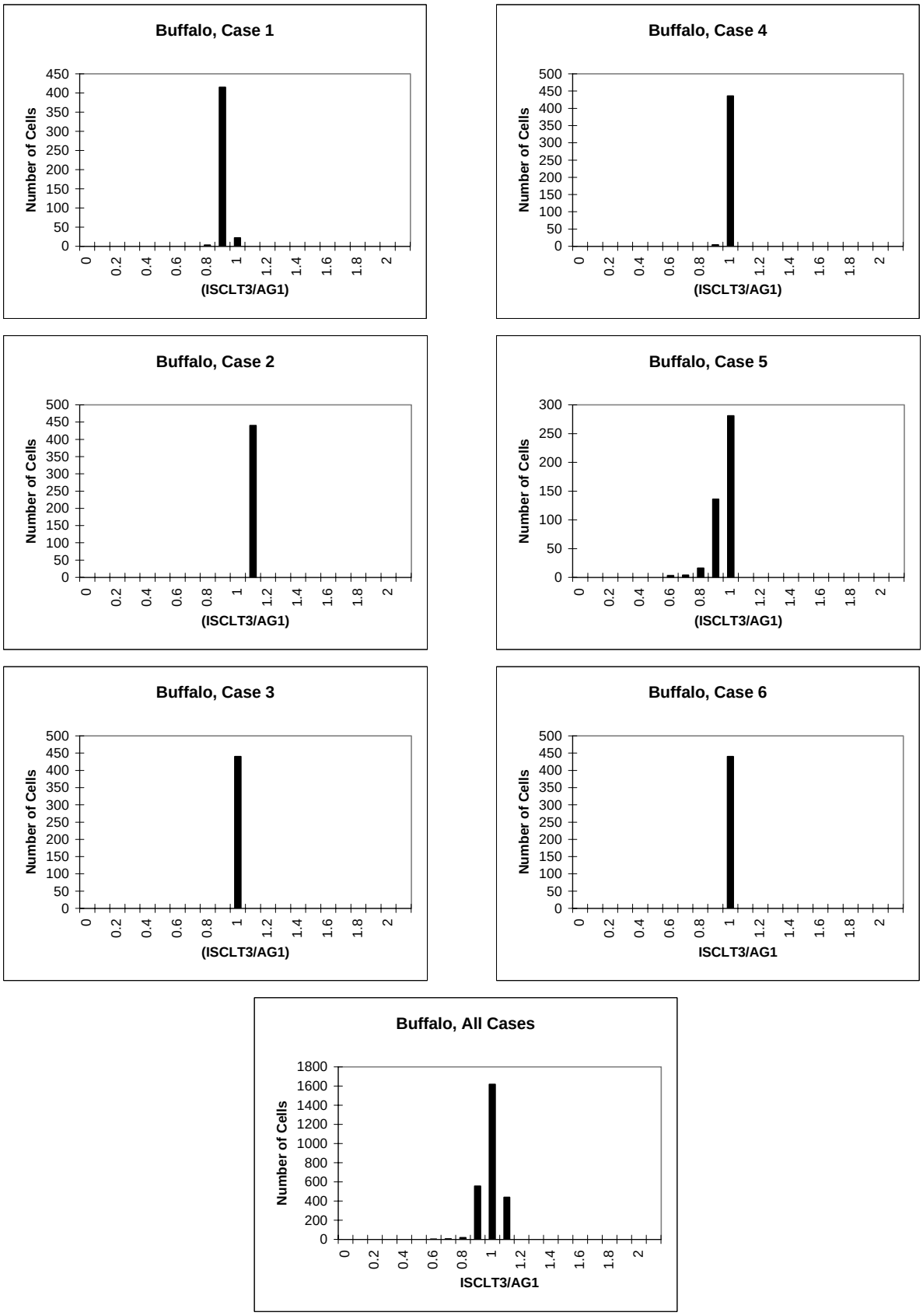
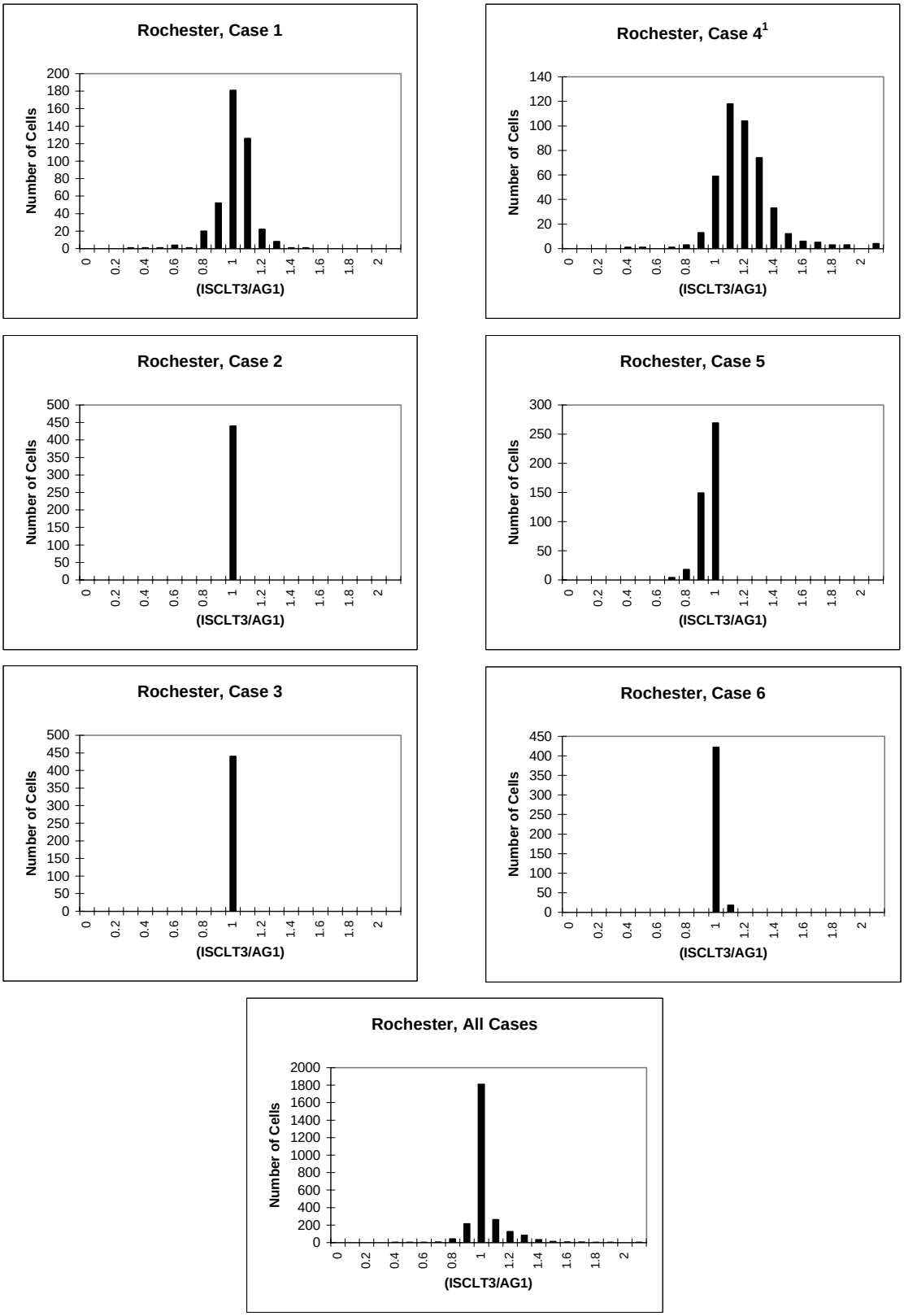
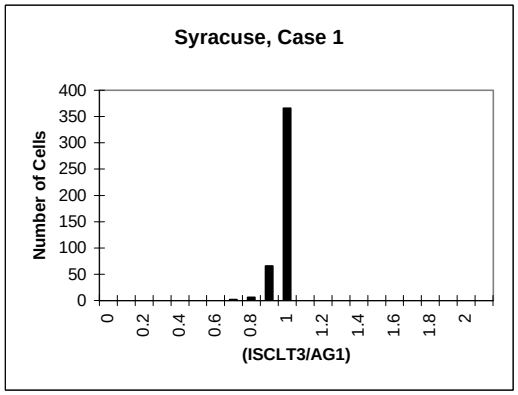


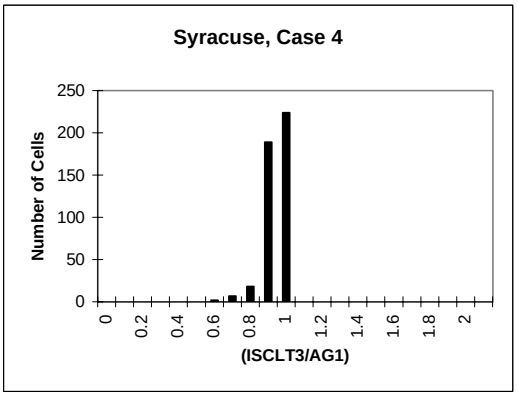
FIGURE 5
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Rochester
Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

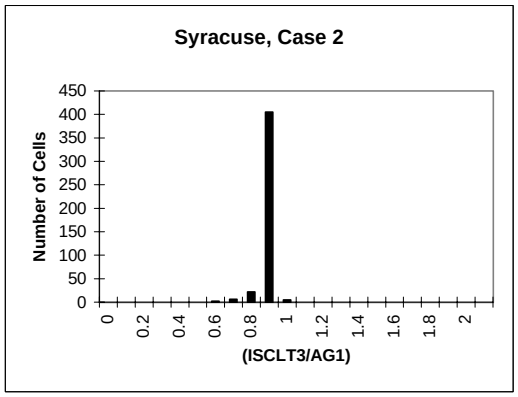


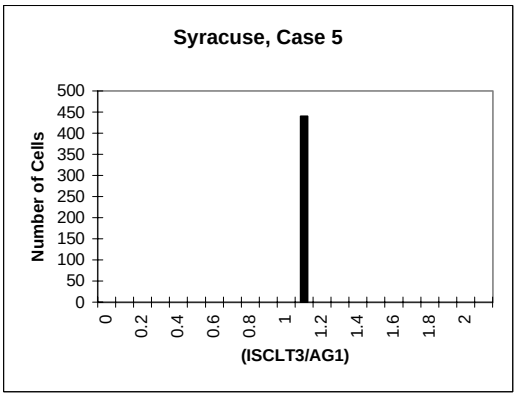
[1]All ratios greater than 2.1 are grouped in the last bar.

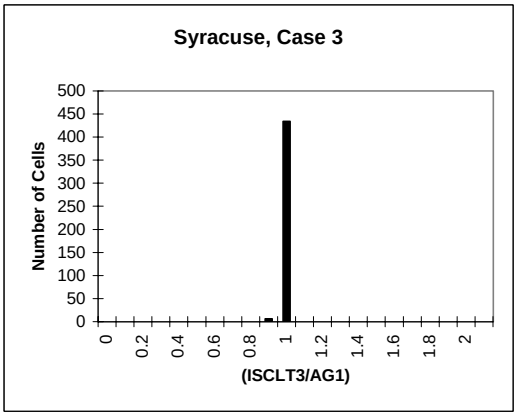
FIGURE 6
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Syracuse
Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

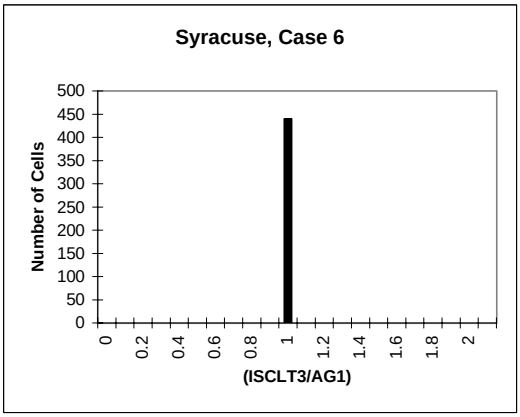












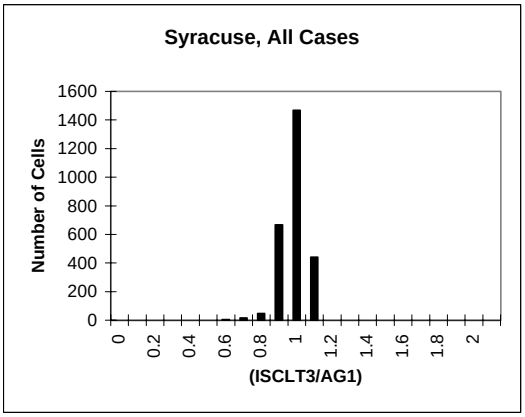


FIGURE 7

Average (ISCLT3/AG1) by Ring, Chemical, and Case: Albany

Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

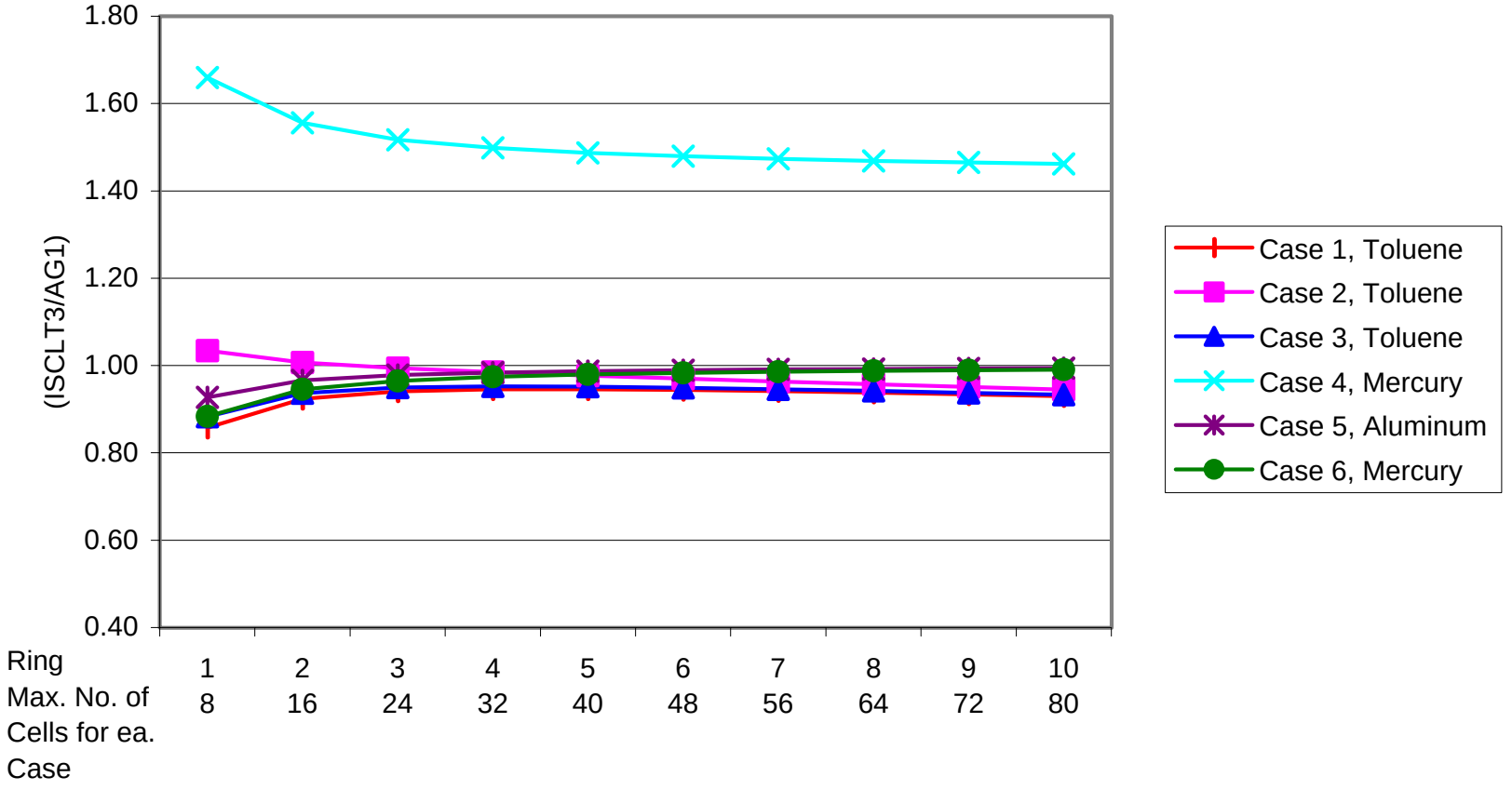


FIGURE 8

Average (ISCLT3/AG1) by Ring, Chemical, and Case: Buffalo

Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

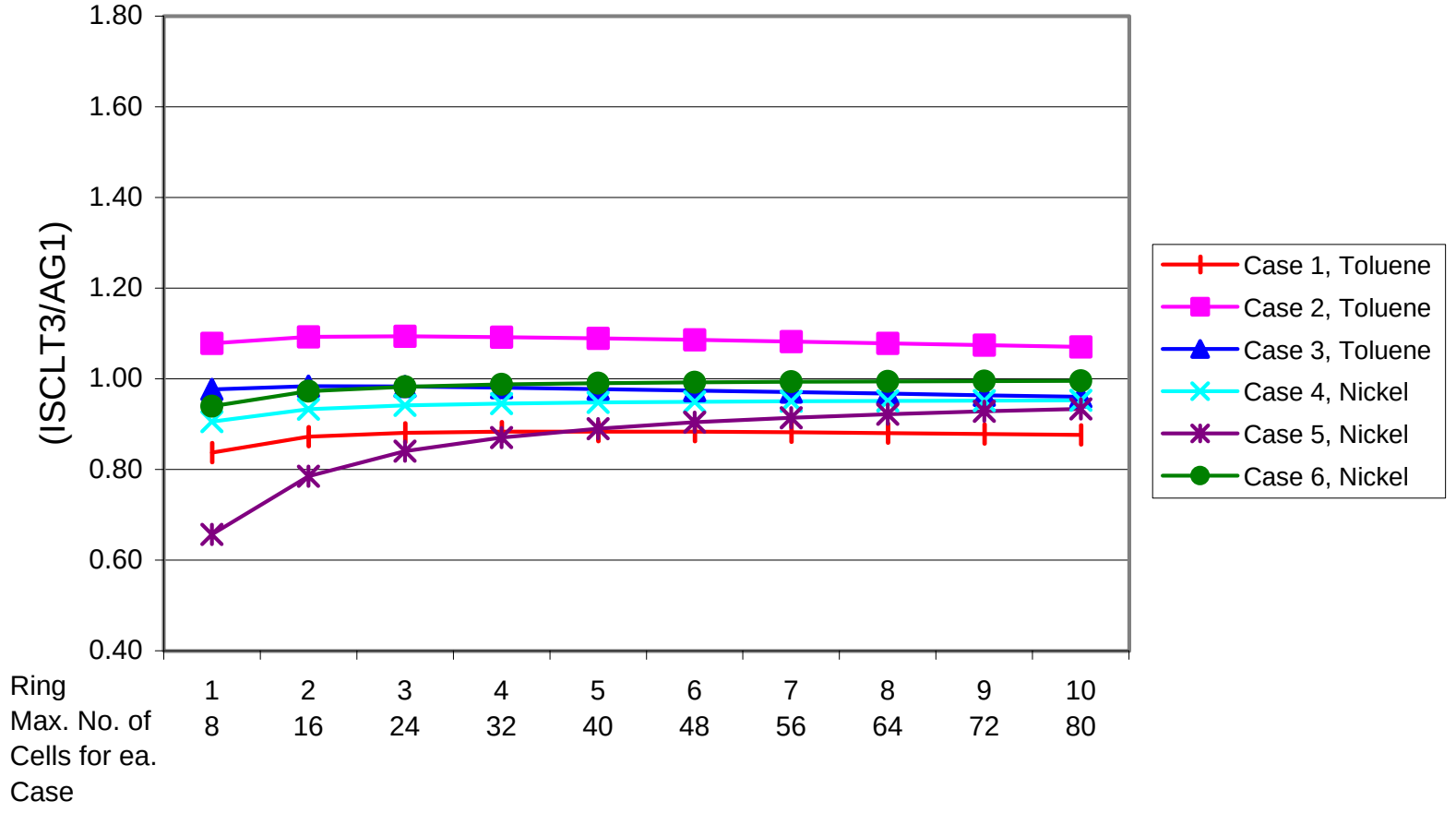


FIGURE 9

Average (ISCLT3/AG1) by Ring, Chemical, and Case: Rochester

Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

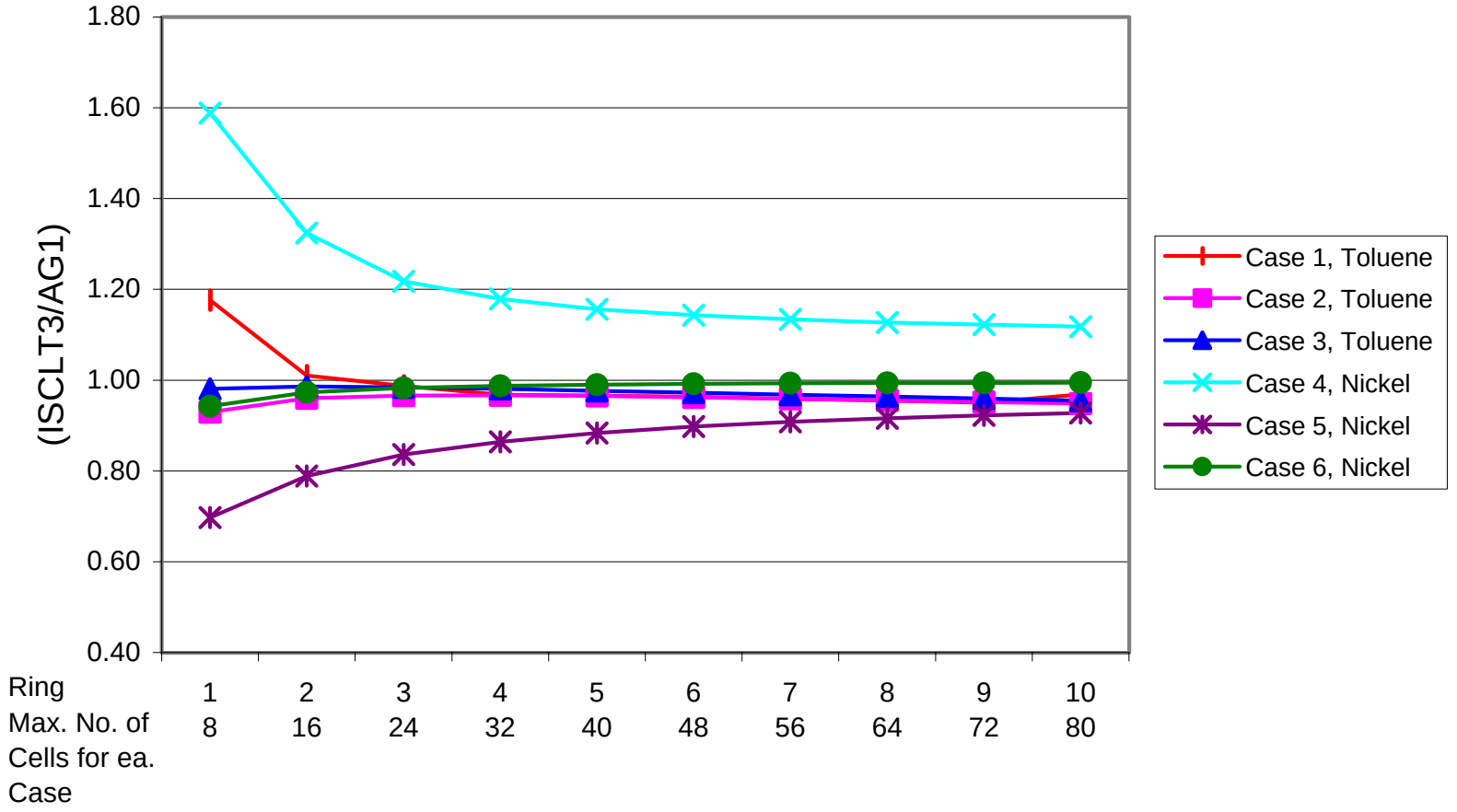


FIGURE 10
Average (ISCLT3/AG1) by Ring, Chemical, and Case: Syracuse
Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

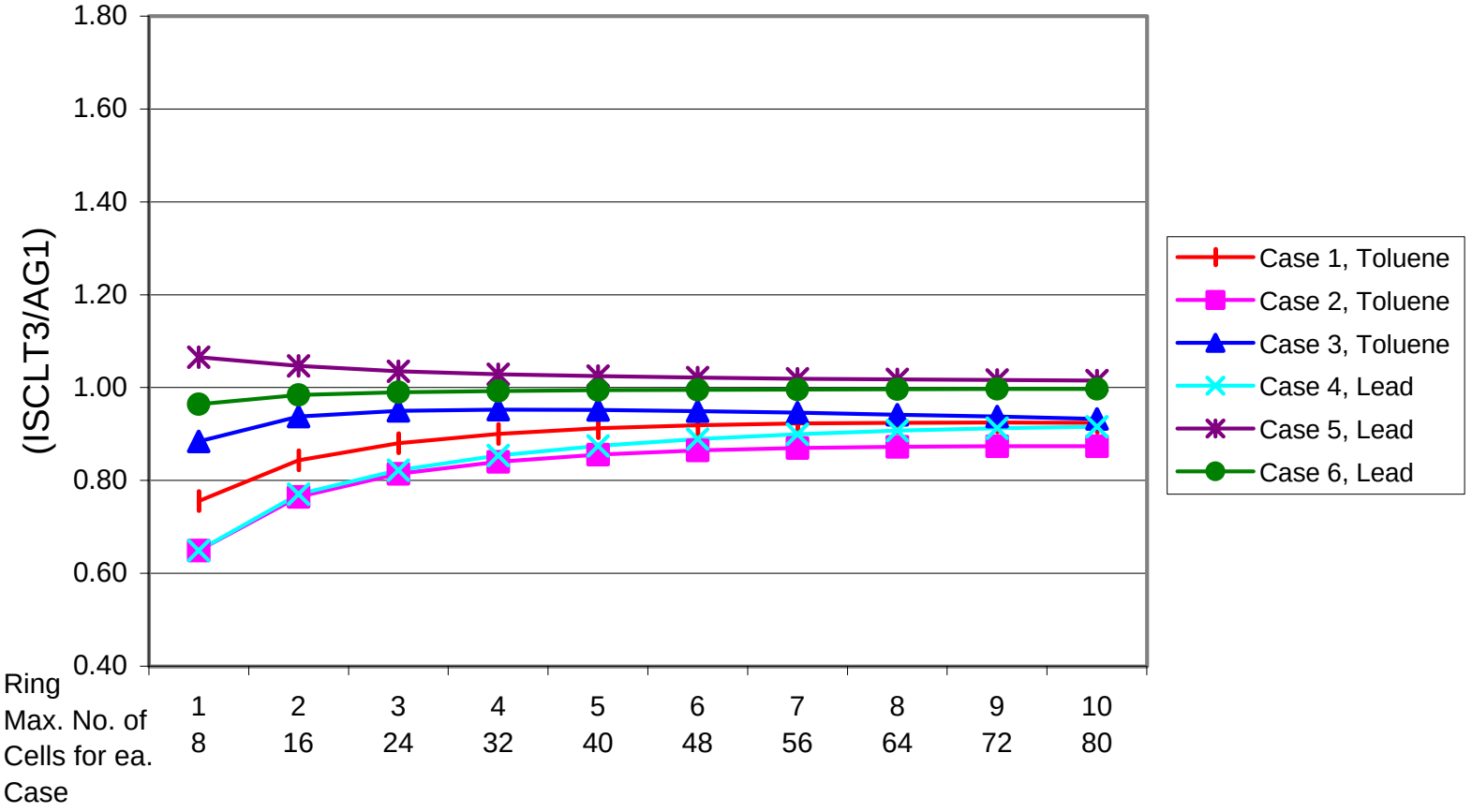


FIGURE 11
Average (ISCLT3/AG1) by Ring and Stack Height Bin
Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

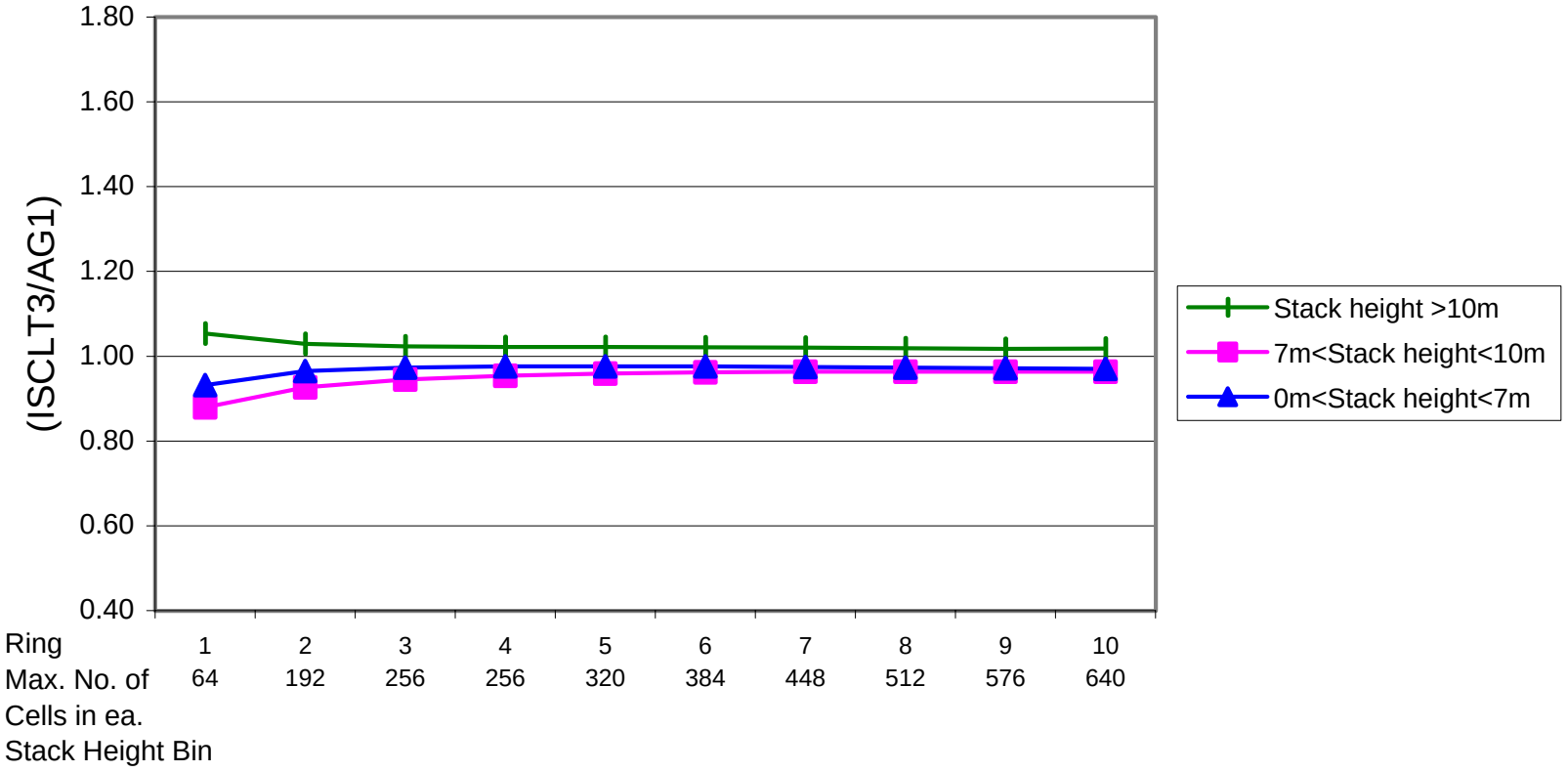


FIGURE 12
Average (ISCLT3/AG1) by Ring and Chemical Characteristic
Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity

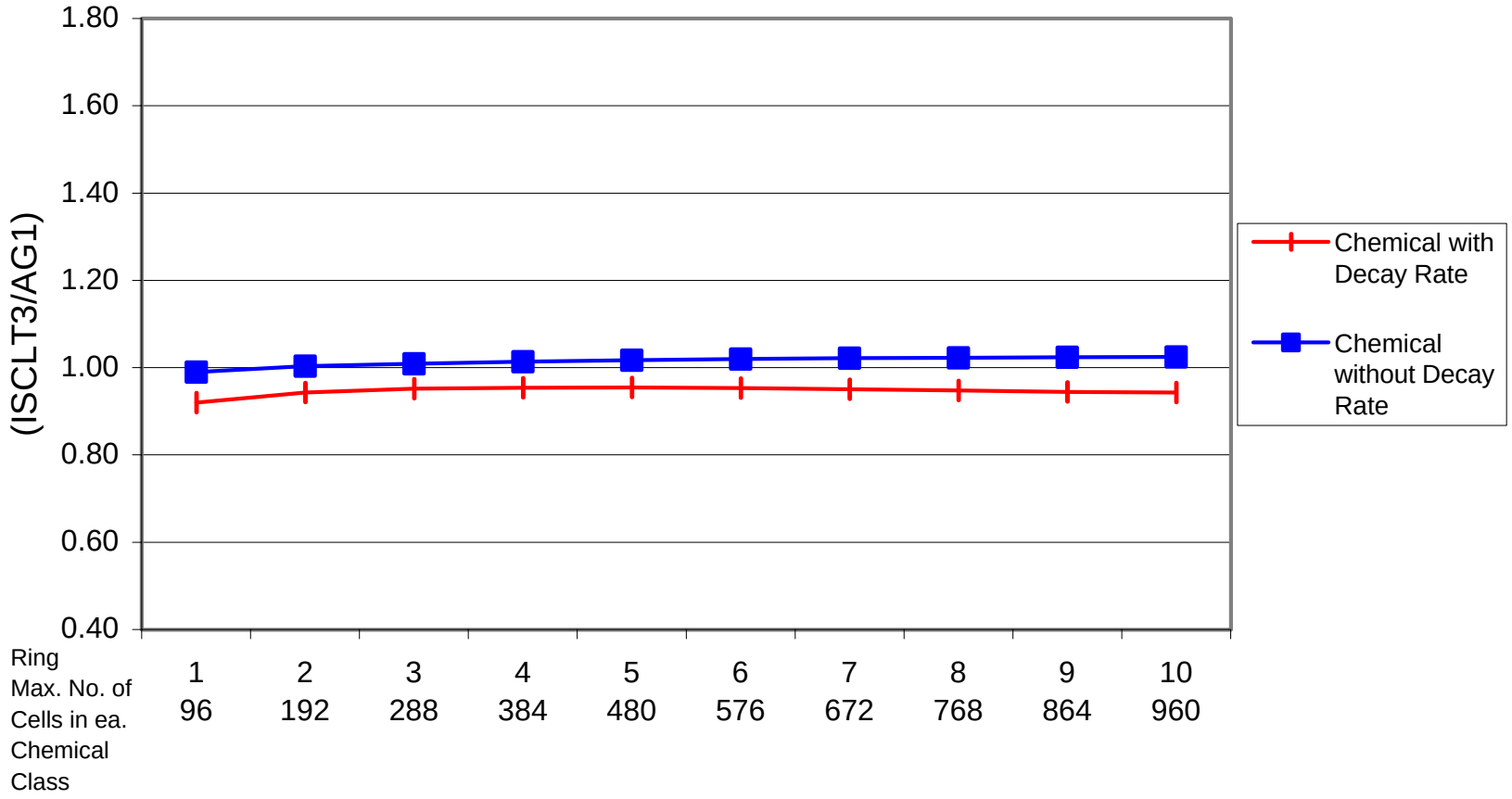
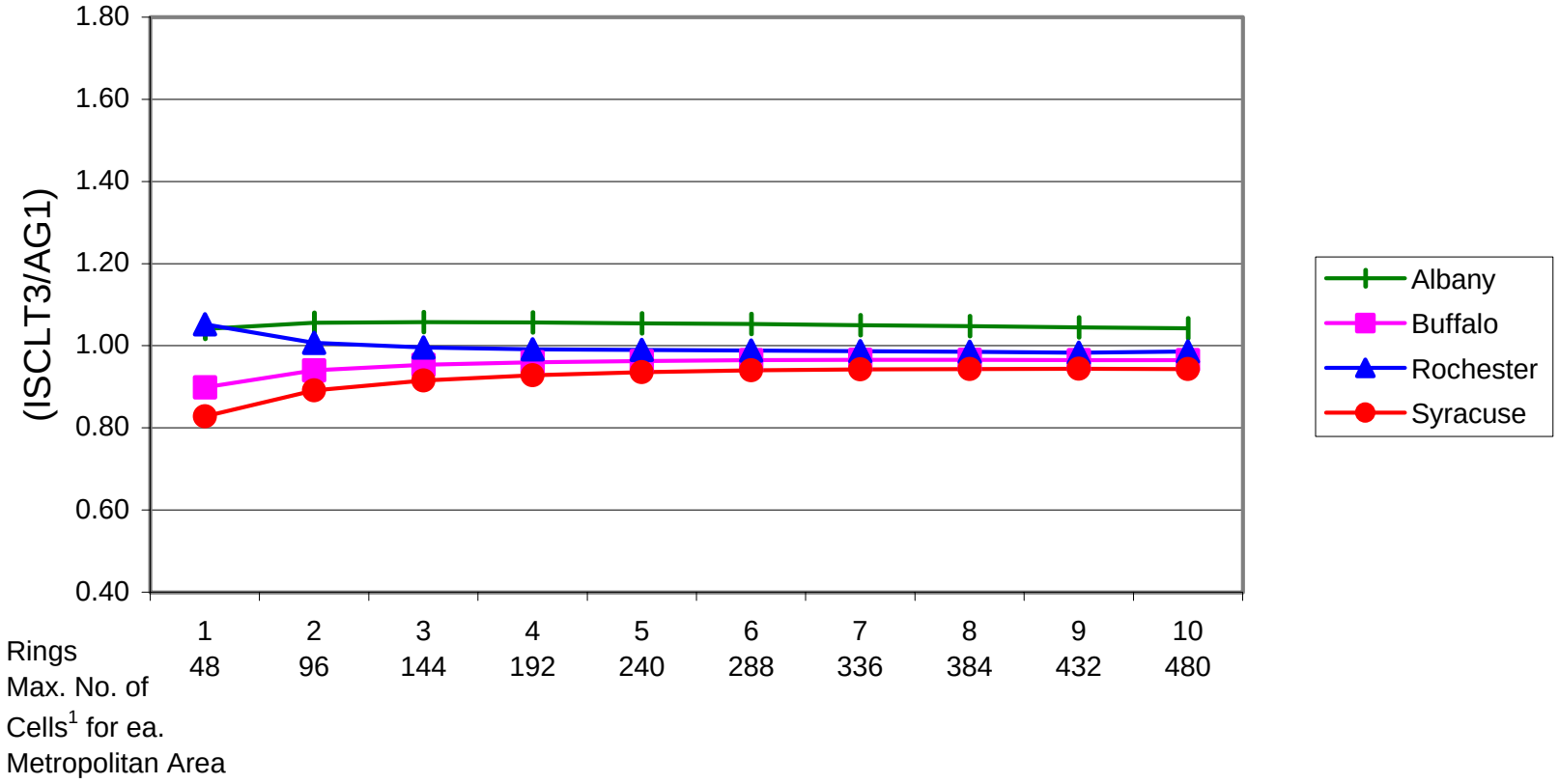


FIGURE 13

Average (ISCLT3/AG1) by Ring and Metropolitan Area

Scenario: Facility-Specific Median Stack Height and Median Exit Gas Velocity



[1] See Table 10 for actual number of cells per ring in each metropolitan area

FIGURE 14
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Albany
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

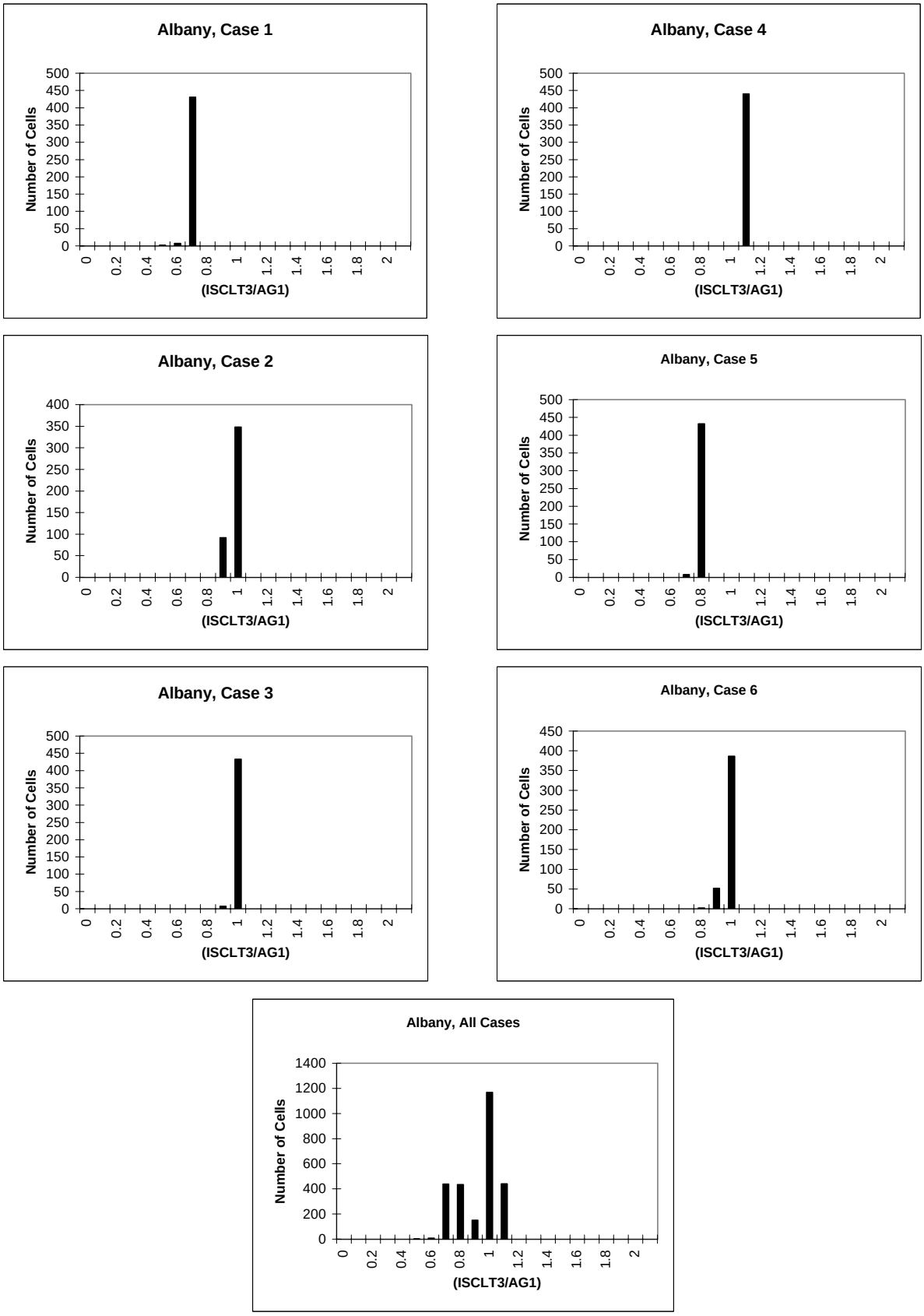


FIGURE 15
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Buffalo Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

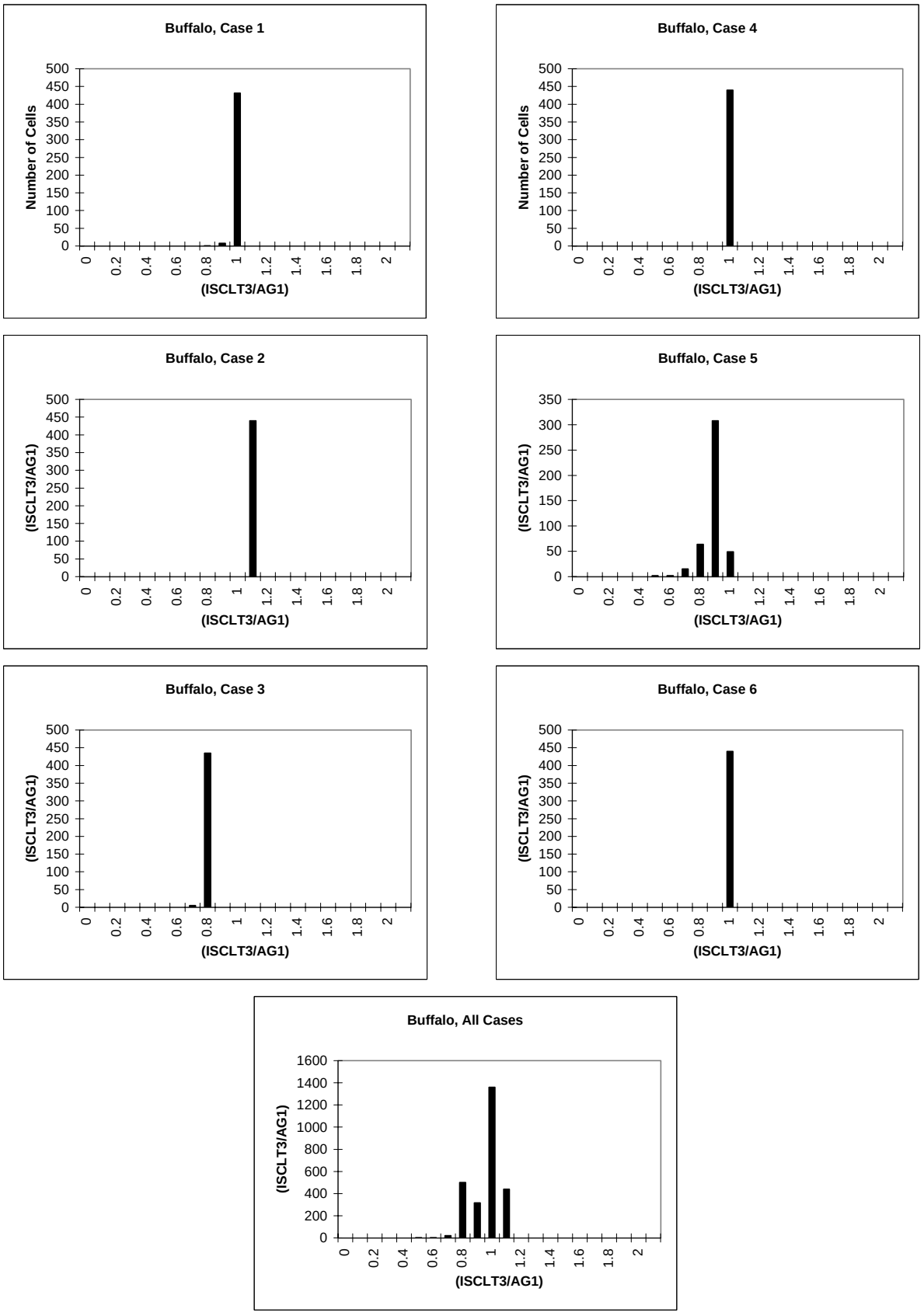
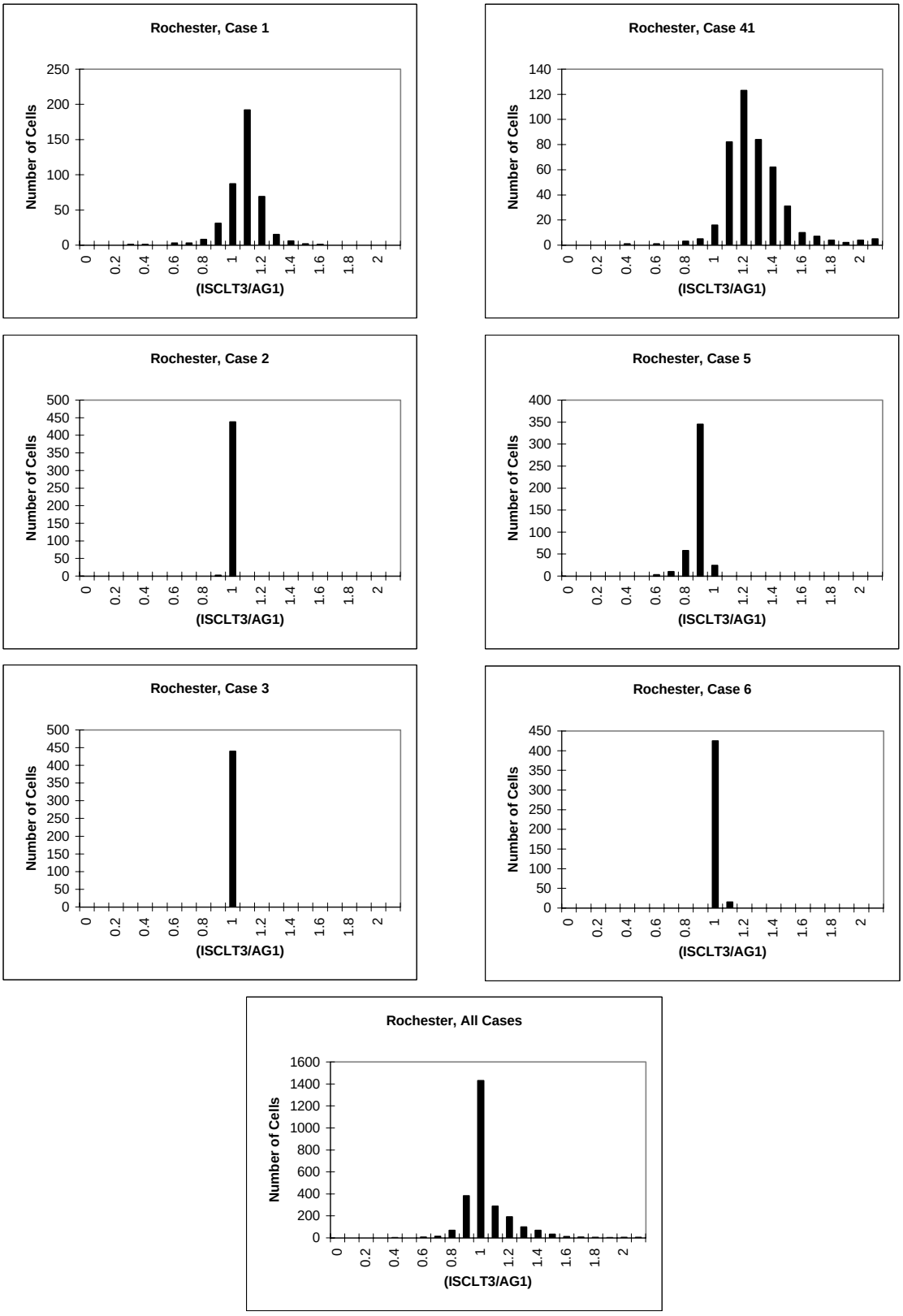
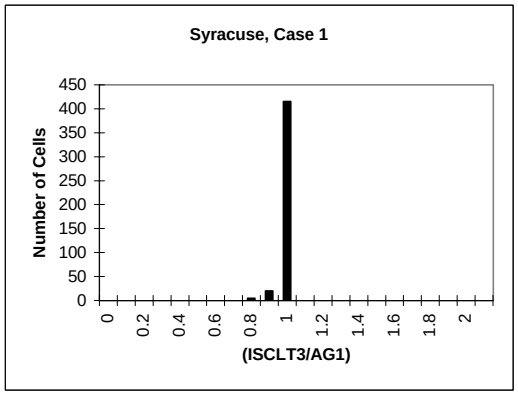


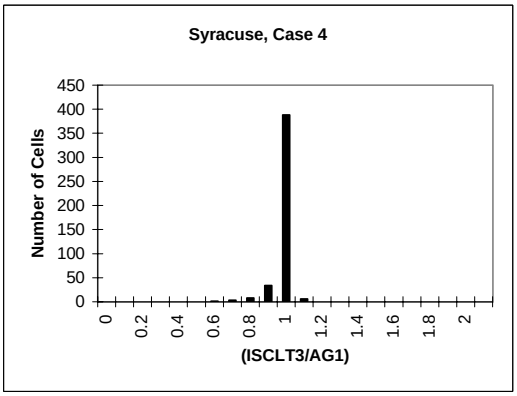
FIGURE 16
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Rochester
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

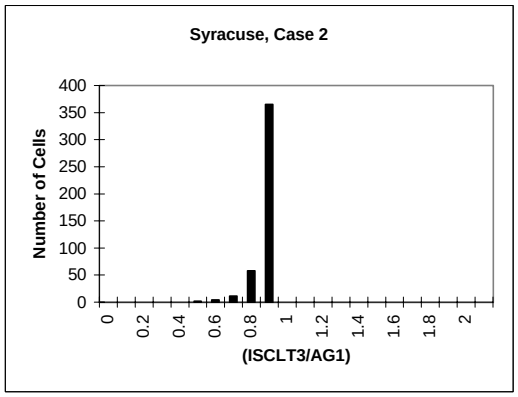


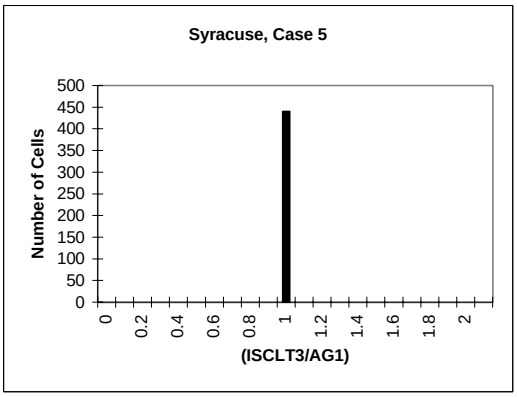
[1]All ratios greater than 2.1 are grouped in last bar.

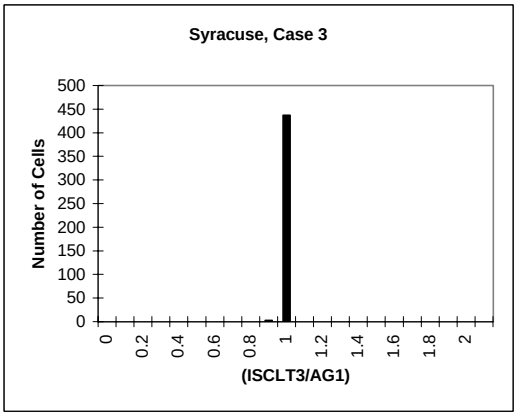
FIGURE 17
Frequency Distributions of Concentration Ratios (ISCLT3/AG1) by Case and For All Cases: Syracuse
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

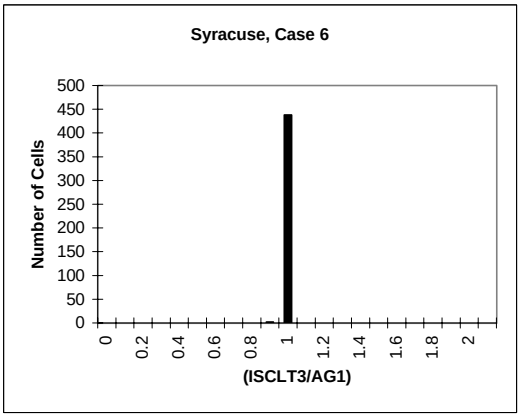












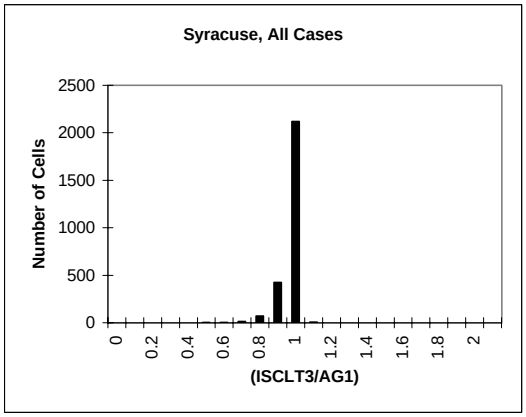


FIGURE 18

Average (ISCLT3/AG1) by Ring, Chemical, and Case: Albany

Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

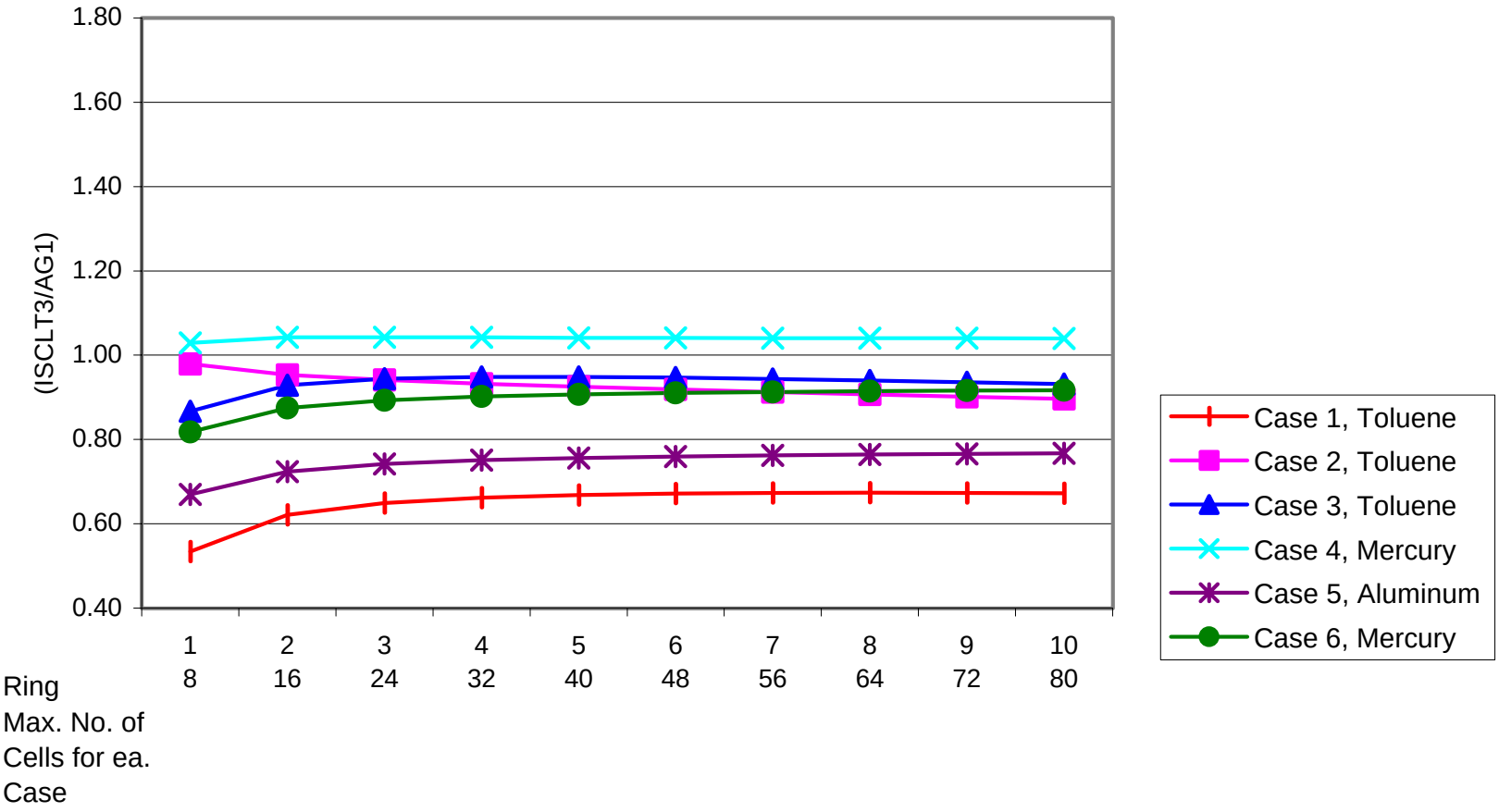


FIGURE 19
Average (ISCLT3/AG1) by Ring, Chemical, and Case: Buffalo
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

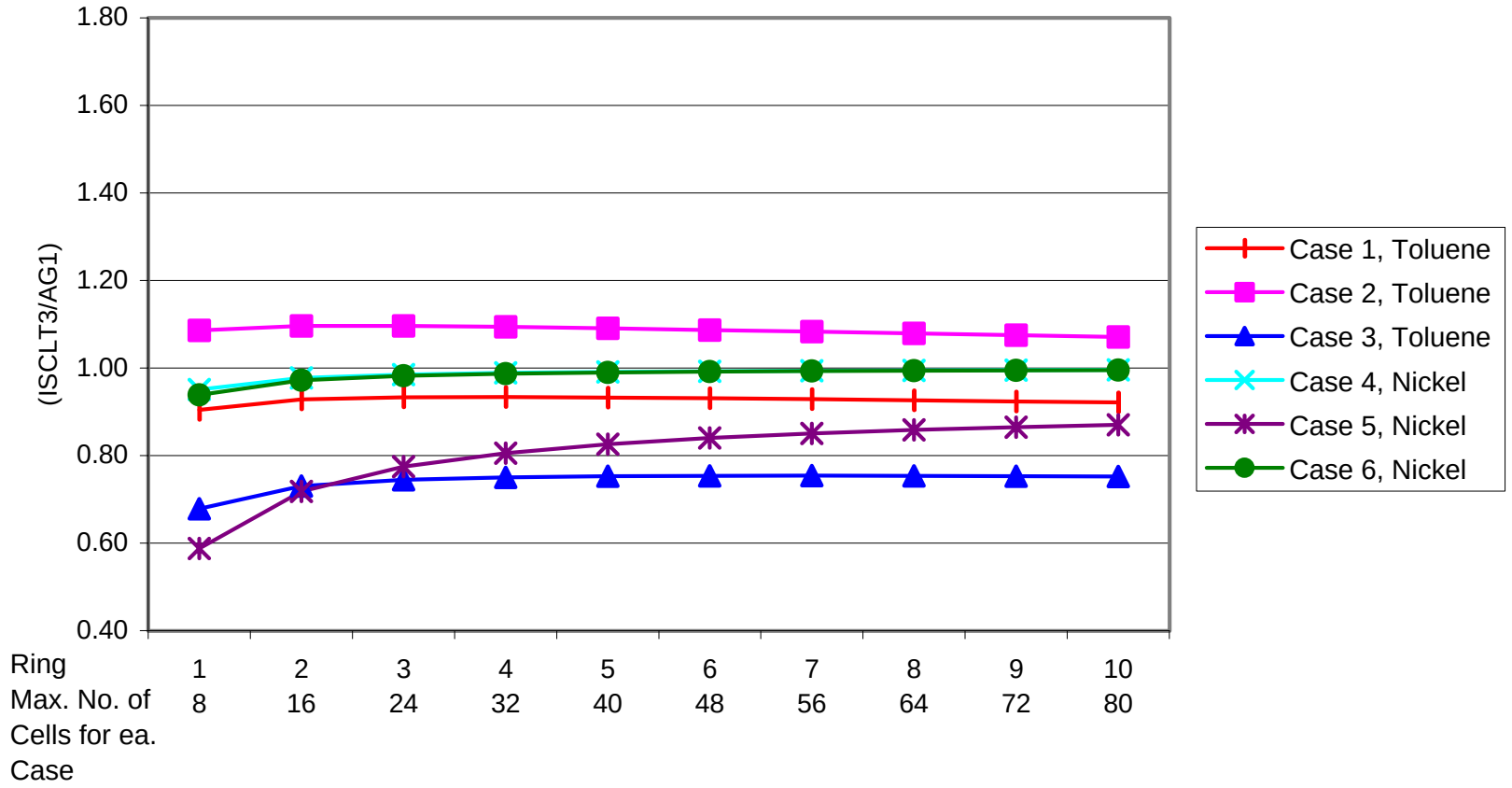


FIGURE 20
Average (ISCLT3/AG1) by Ring, Chemical, and Case: Rochester
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

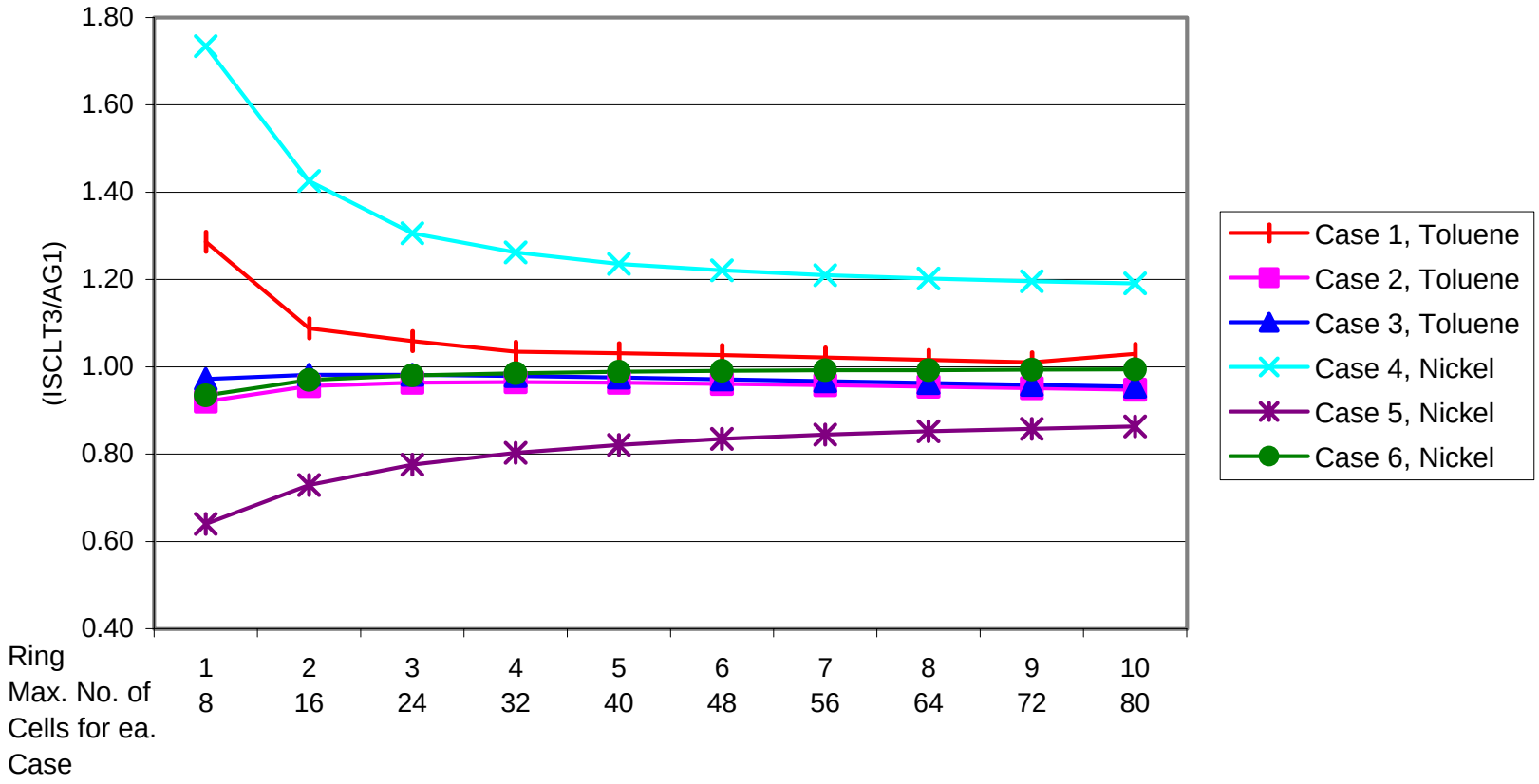


FIGURE 21
Average (ISCLT3/AG1) by Ring, Chemical, and Case: Syracuse
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

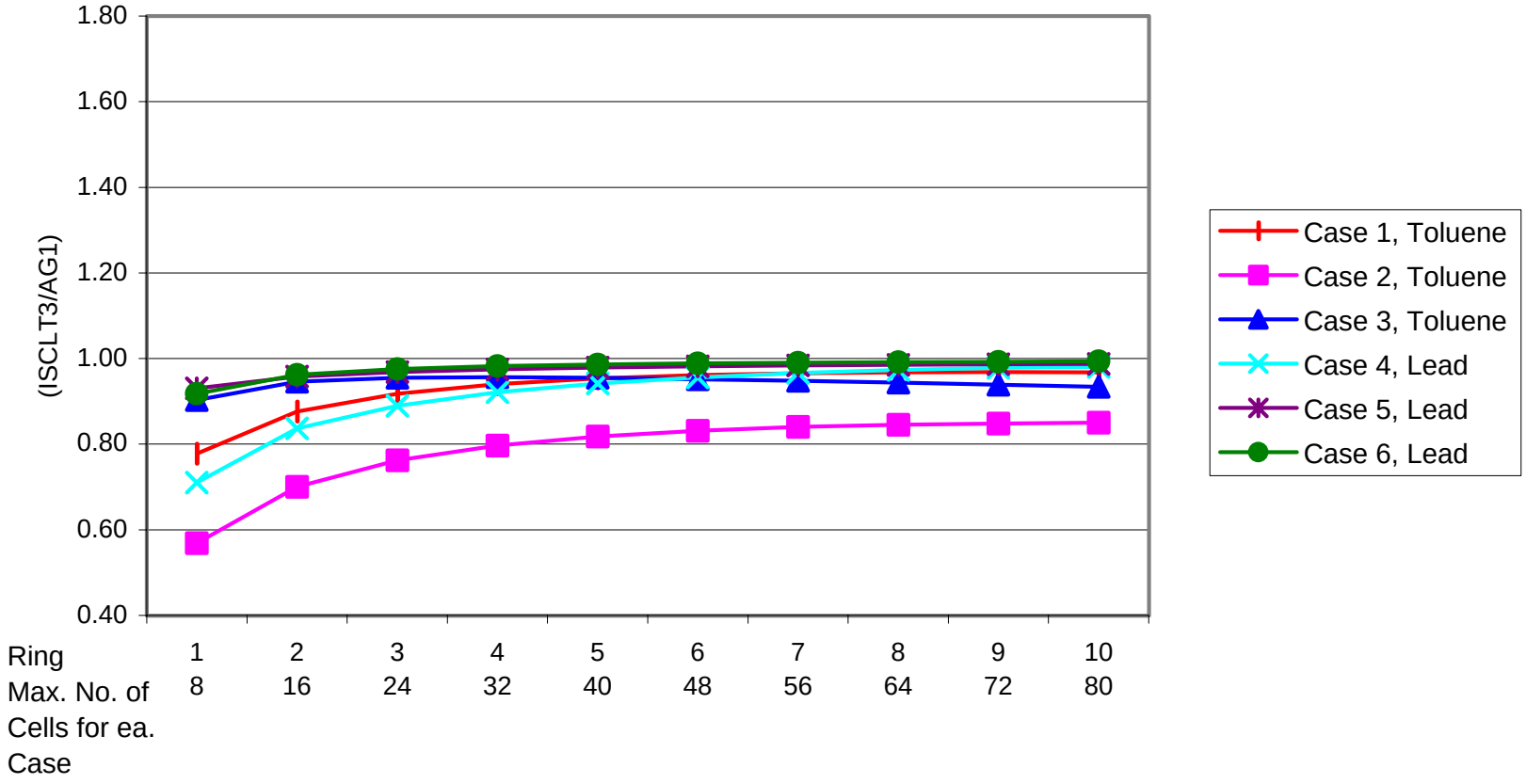


FIGURE 22
Average (ISCLT3/AG1) by Ring and Stack Height Bin
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

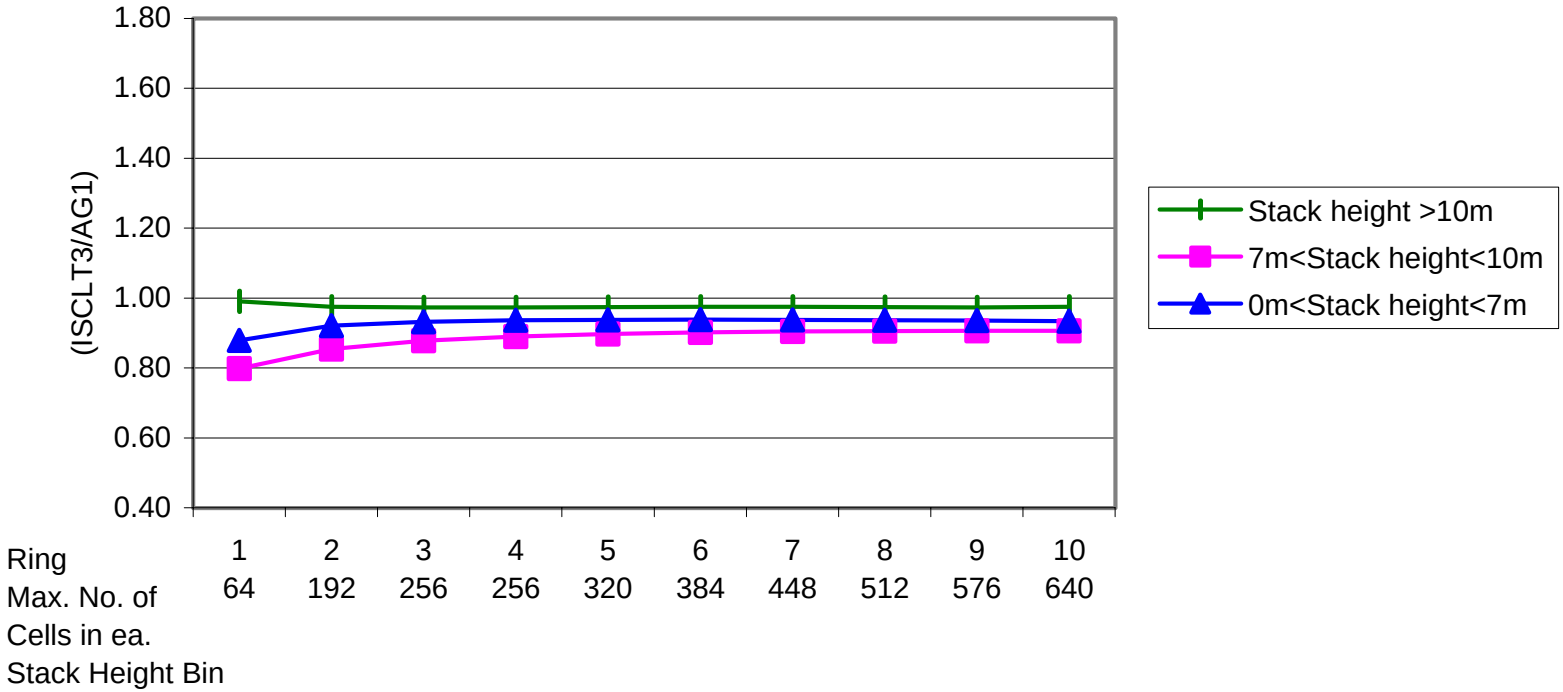


FIGURE 23
Average (ISCLT3/AG1) by Ring and Chemical Characteristic
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity

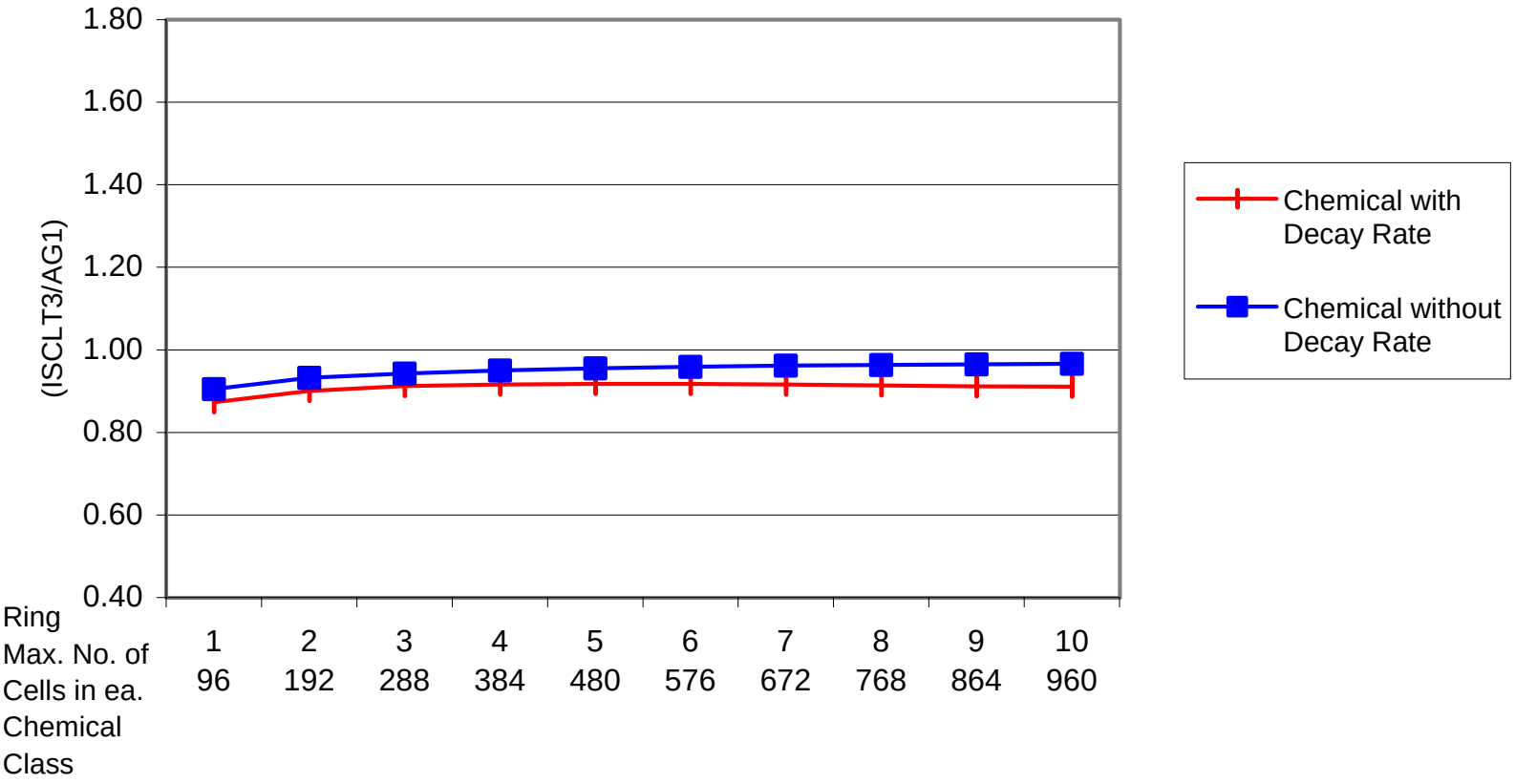
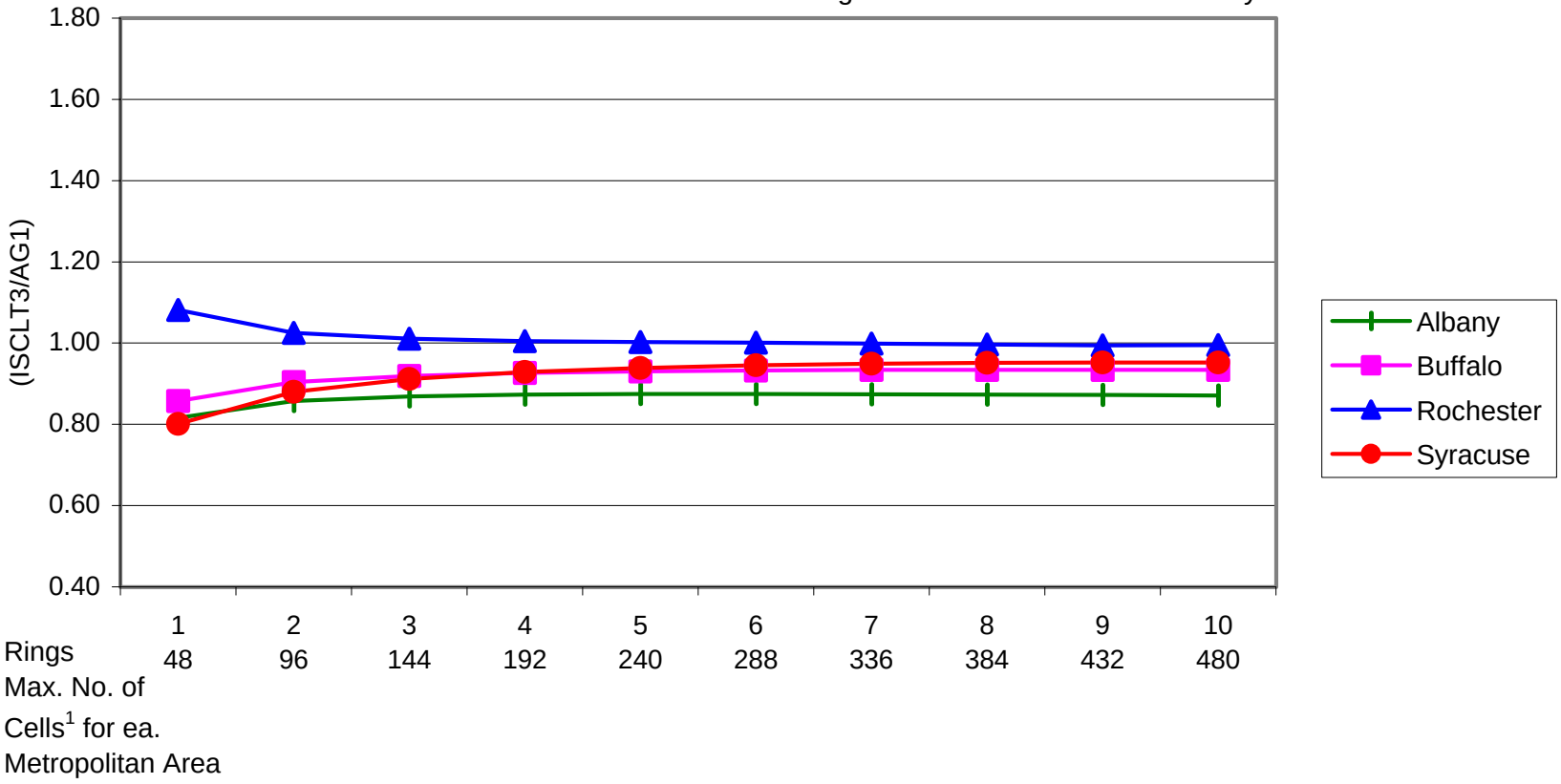


FIGURE 24
Average (ISCLT3/AG1) by Ring and Metropolitan Area
Scenario: SIC Code Based Median Stack Height and Median Exit Gas Velocity



[1] See Table 15 for actual number of cells per ring in each metropolitan area

FIGURE 25
Difference in Median Stack Height
(SIC Code Based Stack Height Minus Facility-Specific Stack Height)

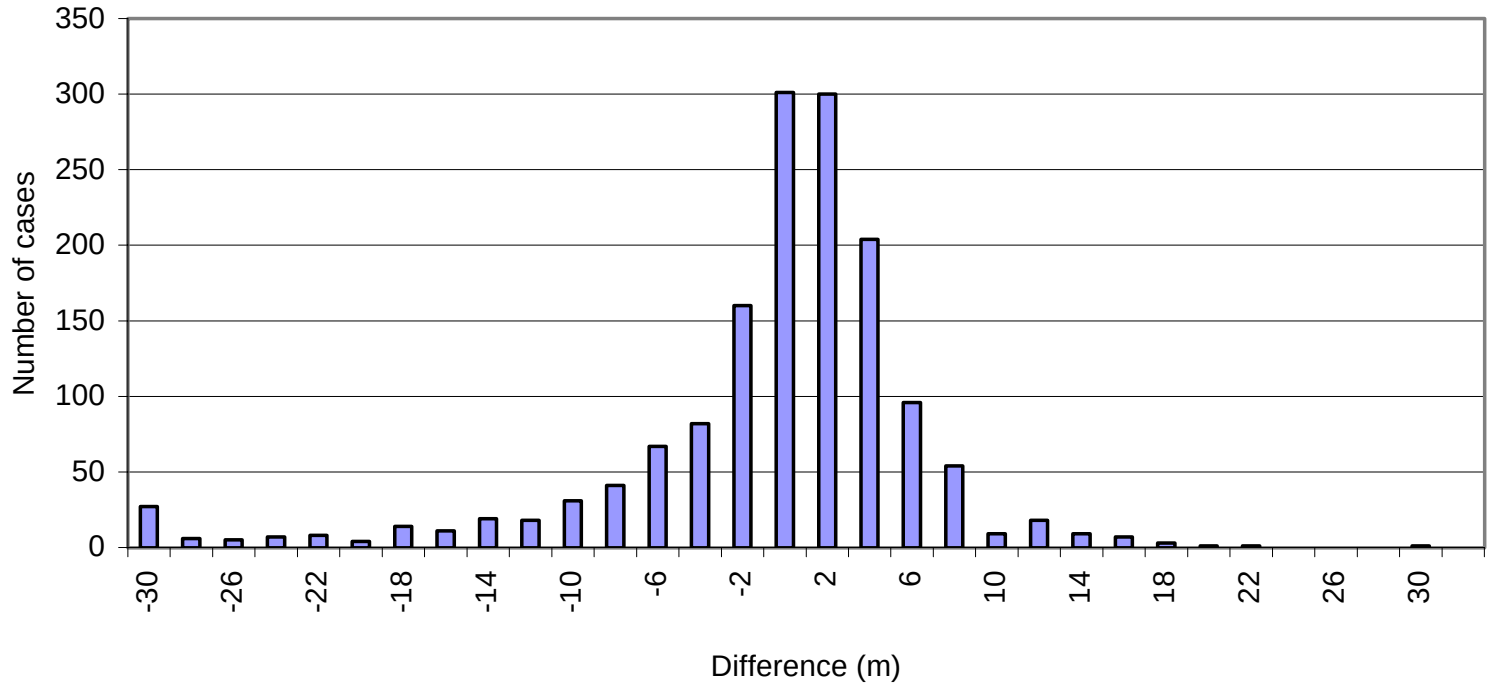


FIGURE 26
Difference in Median Exit Gas Velocity
(SIC Code Based Exit Gas Velocity Minus Facility-Specific Exit Gas Velocity)

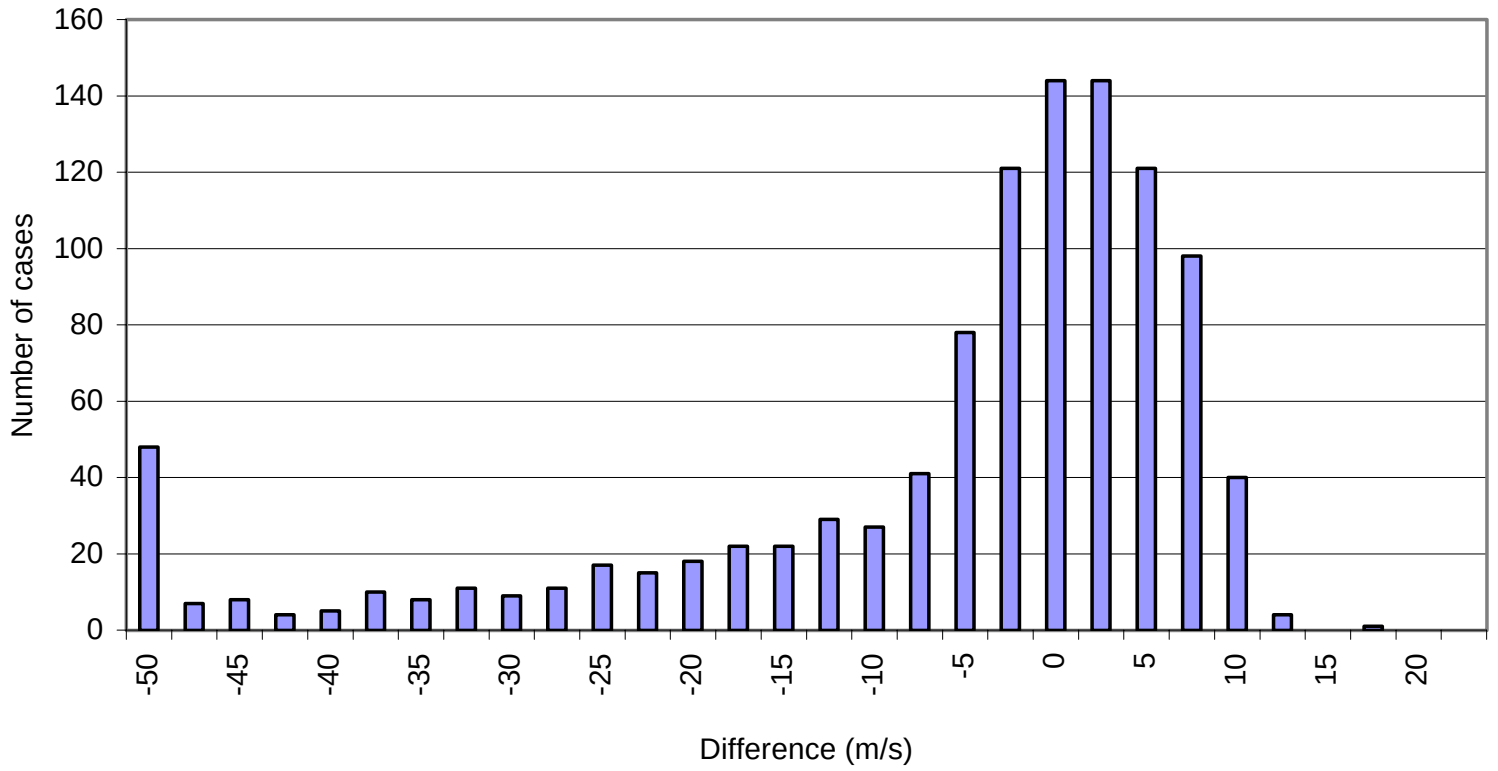
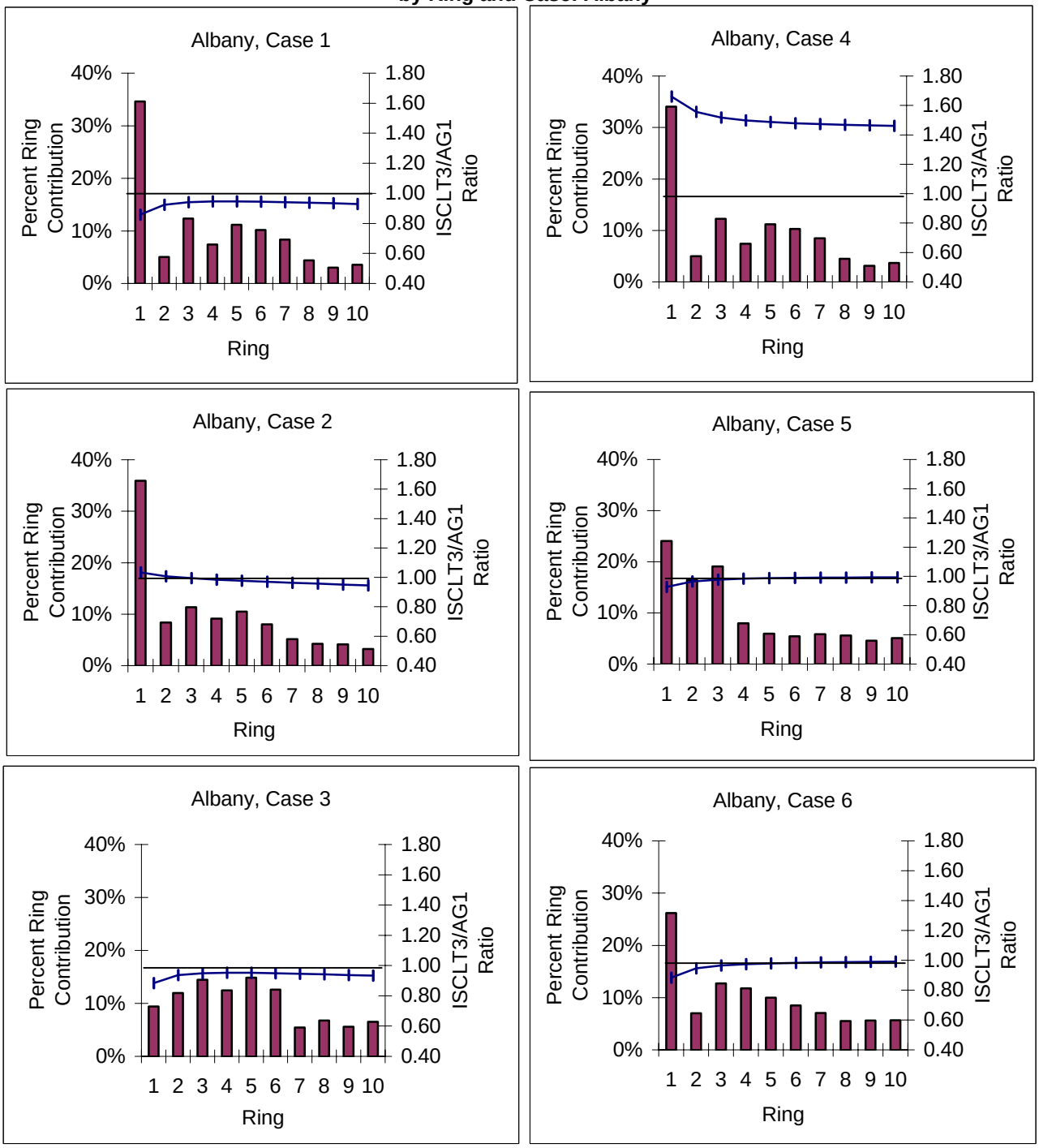


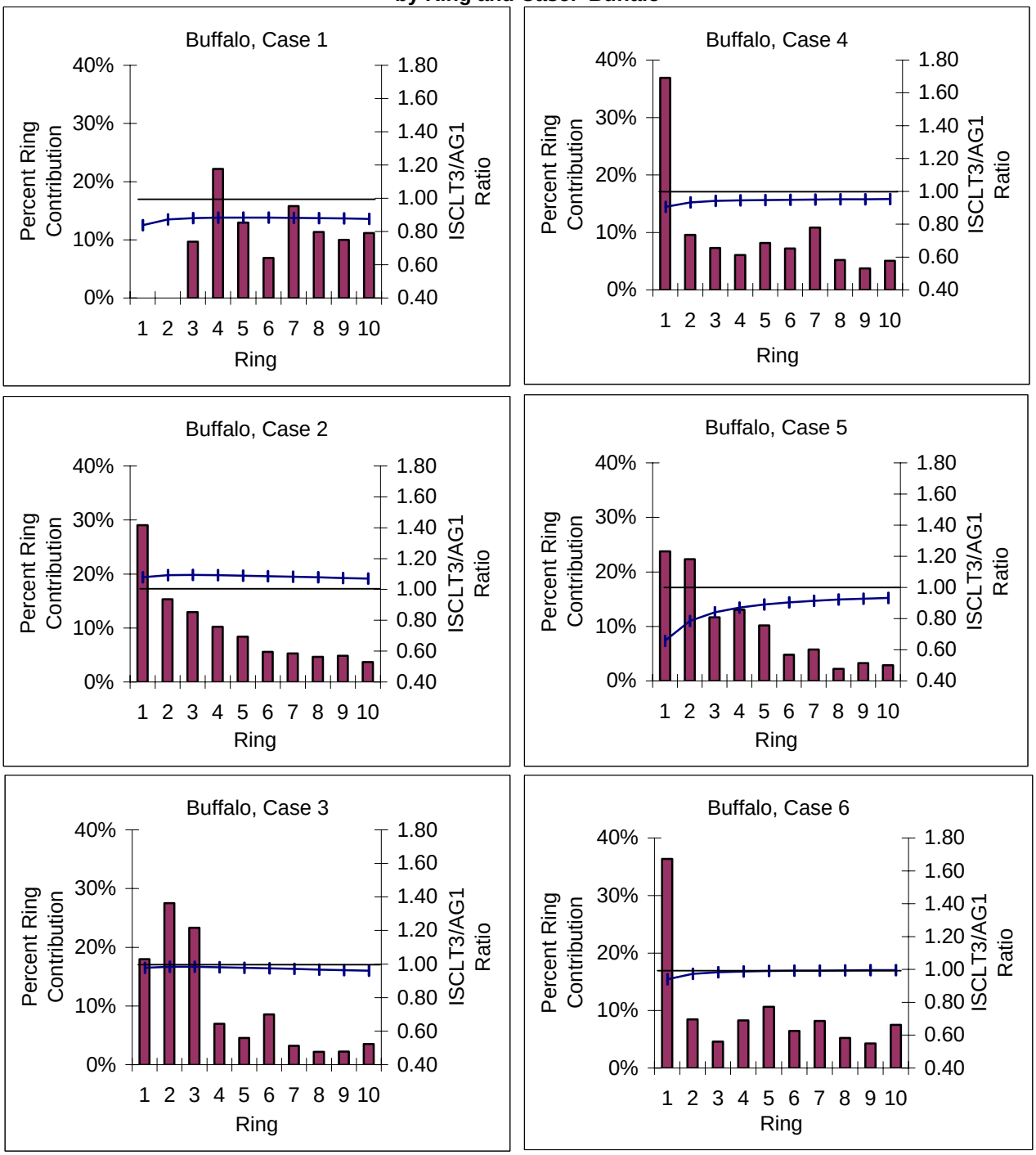
FIGURE 27
Indicator Sub-element[1] Contributions and Concentration Ratios (ISCLT3/AG1)[2] by Ring and Case: Albany



[1]Indicator Sub-elements (percent) shown as histogram and can be read on the left vertical axis. Indicator Sub-elements are the product of pollutant concentration and population in each cell, summed over all cells in a ring. They reflect percent contribution to Indicator Elements by ring (e.g., for case 1, ring 1 contributes 35% to the Indicator Element and ring 10 contributes 4%).

[2]Concentration ratios (ISCLT3/AG1) are shown as a line and can be read on the right vertical axis (e.g., for case 1, ring 1, the ratio is 0.86 and for ring 10, the ratio is 0.93).

FIGURE 28
Indicator Sub-element[1] Contributions and Concentration Ratios (ISCLT3/AG1)[2] by Ring and Case: Buffalo

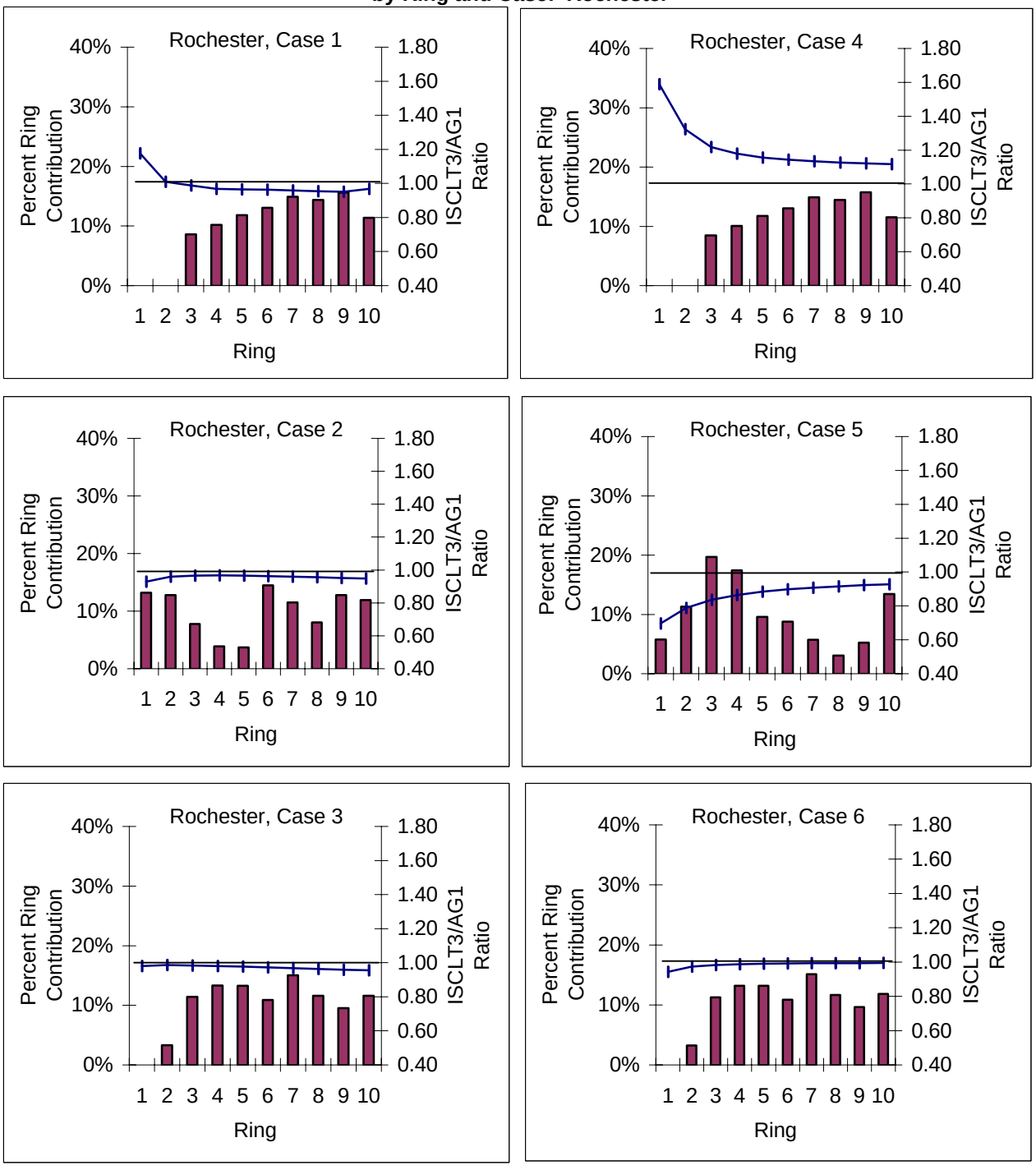


[1]Indicator Sub-elements (percent) shown as histogram and can be read on the left vertical axis. Indicator Sub-elements are the product of pollutant concentration and population in each cell, summed over all cells in a ring. They reflect percent contribution to Indicator Elements by ring (e.g., for case 1, ring 1 contributes 35% to the Indicator Element and ring 10 contributes 4%).

[2]Concentration ratios (ISCLT3/AG1) are shown as a line and can be read on the right vertical axis (e.g., for case 1, ring 1, the ratio is 0.84, and for ring 10, the ratio is 0.88).

FIGURE 29

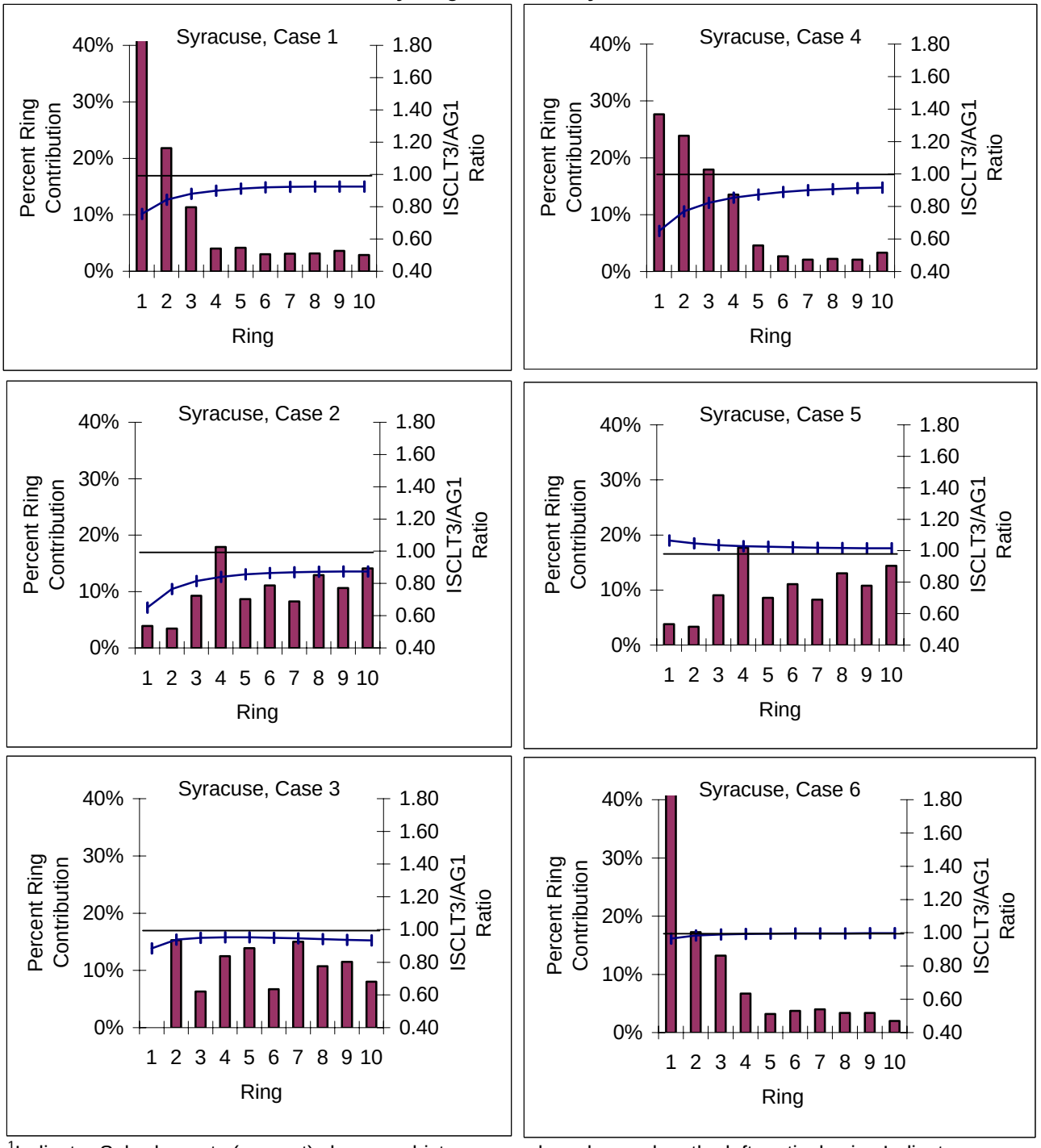
Indicator Sub-element[1] Contributions and Concentration Ratios (ISCLT3/AG1)[2] by Ring and Case: Rochester



[1]Indicator Sub-elements (percent) shown as histogram and can be read on the left vertical axis. Indicator Sub-elements are the product of pollutant concentration and population in each cell, summed over all cells in a ring. They reflect percent contribution to Indicator Elements by ring (e.g., for case 1, ring 1 contributes 35% to the Indicator Element and ring 10 contributes 4%).

[2]Concentration ratios (ISCLT3/AG1) are shown as a line and can be read on the right vertical axis (e.g., for case 1, ring 1, the ratio is 1.18, and for ring 10, the ratio is 0.97).

FIGURE 30
Indicator Sub-element[1] Contributions and Concentration Ratios (ISCLT3/AG1)[2] by Ring and Case: Syracuse



[1]Indicator Sub-elements (percent) shown as histogram and can be read on the left vertical axis. Indicator Sub-elements are the product of pollutant concentration and population in each cell, summed over all cells in a ring. They reflect percent contribution to Indicator Elements by ring (e.g., for case 1, ring 1 contributes 35% to the Indicator Element and ring 10 contributes 4%).

[2]Concentration ratios (ISCLT3/AG1) are shown as a line and can be read on the right vertical axis (e.g., for case 1, ring 1, the ration is 0.76, and for ring 10, the ratio is 0.92).