Draft Assessment of the Potential Environmental Impact of the Construction and Operation of a New Jersey Sports and Exposition Complex at a Site in East Rutherford, Bergen County, New Jersey

DEPOSITORY COPY
Do Not Remove From Library

9.14.90
R299
1972d

Prepared for The New Jersey Sports and
Exposition Authority
(Jack)
by Jack McCormick & Associates
860 Waterloo Road
Devon, Pennsylvania 19333

in cooperation with Ewing Cole Erdman & Eubank/Clauss & Nolan
Camden, Trenton, Princeton, Newark, N. J.

with the assistance of Environmental Research & Technology, Inc.
Lexington, Massachusetts

Bolt Beranek and Newman, Inc.
Arlington, Virginia

Contents

Overview, Summary Assessment, and Recommendations..... v

Part I. Environmental Impact Assessment

Enabling Legislation..... 1

The Hackensack Meadowlands Region..... 3

Description of the Proposed Sports Complex..... 5

Location of the Proposed Site..... 6

Alternative Sites Considered..... 8

Environmental Features of the Proposed Site..... 26

Land Form and Geology..... 26

Vegetation..... 27

Wildlife..... 29

Water Quality..... 31

Summary Evaluation..... 34

Preliminary Master Plan for the Complex..... 36

Environmental Assessment of the Master Plan..... 36

Recommendations to Minimize Impact and to Enhance the Environment..... 38

Details of the Proposed Plan..... 45

Football Stadium..... 45

Racing Facility..... 47

Proposed Site Work..... 50

Pest Control..... 51

Initial Pre-construction Clean-up..... 51

Pre-construction Termite Treatment..... 52

Maintenance Pest Control Operations..... 52

Temporary Pumping..... 53

Clearing and Demolition Work..... 53
Unclassified and Classified Excavation on the Site..... 54
Construction of Perimeter Dike..... 54
Borrow Fill..... 55
Impervious Fill..... 56
Cofferdam for Stadium and Grandstand..... 56
Pavements..... 57
Pump Stations..... 58
Electrical Facilities..... 60
Telephone Connections..... 61
Sanitary Work..... 61
Water Supply..... 62
Landscaping 62
Support Requirements..... 64
Electric Energy..... 64
Potable Water Supply..... 66
Sewage..... 67
Storm Water..... 69
Solid Wastes..... 70
Deposition of Unsuitable Materials..... 73
Volume and Source of Fill..... 76
Probable Environmental Impacts of Operation..... 77
Noise..... 77
Traffic..... 82
Air Quality..... 86

Part II. Environmental Inventory (Basis Papers)

The Hackensack Region

Physiography and Geology..... Section I

The Hackensack River..... Section II

Vegetation..... Section III

The Project Site

Vegetation..... Section IV

Wildlife Populations..... Section V

Geology..... Section VI

Water Quality..... Section VII

Project Operation Analysis

Noise..... Section VIII

Water Pollution..... Section IX

Solid Wastes..... Section X

Traffic Analysis..... Section XI

Air Pollution..... Section XII

Documents Inspected..... Section XIII

Maps (In Pocket)

Map 1. Hackensack Meadowlands District, Air Photo

Map 2. Weehawken Quadrangle (U. S. Geological Survey, 1967)

Map 3. Hackensack Meadowlands District, Tidal Marshes, 1925

Map 4. Hackensack Meadows Forests, 1896

Map 5. Hackensack Meadowlands District, Wetlands, 1972

Map 6. Hackensack Meadowlands District, Vegetation, 1972

Map 7. Hackensack Meadowlands District, Filled Areas

Map 8. Hackensack Meadowlands District, Site Alternatives

Map 9. Proposed Site, Wetlands and Historic Boundaries

Map 10. Proposed Site, Vegetation, 1972

Map 11. Preliminary Site Master Plan

Map 12. Preliminary Site Master Plan Showing Area of Berrys Creek Recommended for Preservation

Map 13. Landscape Details

Overview, Summary Environmental Assessment, and Recommendations for Minimization of Impact and Enhancement of the Environment

In 1971 the Legislature established a New Jersey Sports and Exposition Authority and directed the Authority to install, within the Hackensack meadowlands, a multiple-unit facility to provide for the recreation, amusement, and education of the public. Jack McCormick & Associates, with the cooperation and assistance of other firms, has overviewed the environmental conditions and resources of the Hackensack meadowlands region, the alternative sites which were proposed for the location of the Sports Complex, and the site in East Rutherford, Bergen County, which has been selected by the Authority. We also have examined the current plans for the Sports Complex and have assessed the resource requirements of the facilities and the probable on-site and off-site environmental impact of the construction and operation of the Sports Complex.

The Region

The Hackensack meadowlands encompass about 20,000 acres of wetlands and scattered inclusions of uplands. Less than a century ago, southern white cedar forests were prominent in the area, and tidal marshes covered by cordgrass, wildrice, and cattails anastamosed through them. Owing to a rising tide-level, to timber cutting, fires, diking, water pollution, air pollution, and other stresses, the native ecosystem collapsed and was replaced by the modern, low-quality, common reed grassland. While it is astounding to contemplate the rapidity and totality of this change, it is even more remarkable that the reed grass has been able to tolerate the severely polluted environment of the modern meadowlands.

Although much of the meadowlands area still is open space, the district is part of the most densely populated region in the United States. This concentration of people, of industry, and of supporting services greatly exceeds the carrying capacity of its immediate environment. To accommodate to this imbalance, resources are imported from, and wastes are exported to, less-intensively developed areas. Such import-export relationships are common to all centers of human population, but the degree of supplementation and the length of the lines of supply and discharge vary widely.

The condition of the Hackensack River estuary and of its tributary streams is witness to the overuse of the river and of the tidal waters below its mouth for the discharge of municipal and industrial wastes. The quality of the air, which presently does not meet Federal standards for the five pollutants monitored at regional surveillance stations, testifies to similar overuse of the atmosphere as a waste despository.

Potable water for the area now is supplied partly by interbasin transfers. Electric power is gathered from many sources which are expected to be supplemented within a few years by a new generating station near the head of Delaware Bay. From many points of view, therefore, the region is rooted deeply in the hinterlands and must draw heavily upon them for sustenance. Similarly, the urban complex depends heavily on its streams, estuaries, and the adjacent ocean to dilute and disintegrate its wastes.

The general quality of the region today, thus, is degraded through intensive use and the continuation of practices which were predicated decades ago on a smaller scale of use and on a less complete understanding of environmental systems. Various State, Federal, and local programs now underway already have instituted some improvements and promise to upgrade the region substantially in the years ahead.

The Site

Conclusions from our studies of the water quality of Berrys Creek concurred with those from more intensive studies made in 1964 and 1971. The water is heavily polluted by sewage, defiled by toxic effluents, and almost totally lacking in oxygen. Water quality standards established by the New Jersey Department of Environmental Protection should lead to substantial improvements in the next few years.

An inventory of the vegetation indicated that most of the site is covered by common reed grasslands, but parts of the Berrys Creek tidal marsh have scattered stands of cattail, salt reed grass, and water hemp. A dike was constructed before 1941 largely along the edge of a former cedar swamp. The dike was raised and brought more into conformity with the old forest limit recently. This dike now forms a clear demarcation between lands flowed by tides from Berrys Creek and those areas isolated from the tides.

Much of the area behind the dike has been covered by garbage and trash landfills. A small area of naturally elevated land is covered by less than an acre of oak forest and birch-aspen shrub vegetation that is a remnant of the oldgrowth forest of the region.

The eastern section of the site, between Route 20 and the New Jersey Turnpike western spur, largely is covered by landfills. On about 30 acres of this section, however, there is a tidal marsh area that is isolated from the Hackensack River by the Turnpike embankment. Tidal flows still reach the area through a culvert, but the marsh has been so thoroughly encroached upon that its potential is judged to be minimal.

The site master plan indicates that dikes would be constructed along the east bank of Berrys Creek and within the site between Route 20 and the Turnpike. All existing habitats, except for a narrow area adjacent to the Turnpike, would be excavated or filled. This would result in the elimination of the tidal wetlands and all other wildlife areas.

A number of recommendations are made to minimize the impact of site development and to enhance the environment of the area. The major recommendation is to revise the site plans to preserve approximately 130 acres of tidal marsh along Berrys Creek. This preserved area is suggested for use as an environmental education center, but it should be managed to restore its quality prior to such use.

It also is recommended that the roadway plan be revised slightly to permit the preservation of the small oak woodland in a median area. If landscaping plans for the complex are modified, attractive habitats for waterfowl and songbirds, as well as for small mammals, amphibians, and fish, can be created in developed parts of the site. It is recommended that woody plants native to the region be utilized insofar as possible in landscaping to increase wildlife values and to lend a distinctive regional identification to the site.

Owing to the present at-capacity operation of the sewage treatment plant which will serve the complex, it is recommended that the Authority should support and, if possible, expedite the expansion and upgrading of the plant. Should the expansion not be completed by 1975, it is recommended that completion of the hotel, which is predicted to be the major sewage source, be postponed until adequate facilities are available. Similarly, it is recommended that the arena, theme park, and baseball stadium be postponed.

Air quality will be a major problem owing to substandard existing conditions and the expectation of heavy vehicular use by attendees at the Complex. It is recommended that a concerted effort be made to expedite the development and use of mass-transit facilities. To reduce the concentration of pollutants generated by automobiles, methods to achieve a better spread of arrival and departure times are recommended.

Water requirements and electrical energy needs for the Complex will be supplied in part by importation from extra-regional sources. The demands for such imports, however, were not generated by the Complex but by projections of future industrial use of the site now proposed for the Complex. In point of fact, the demand for water by the Complex will be substantially less than that anticipated for industrialization. The same case apparently is true for electrical demand, but estimates of industrial use of electricity were not available in time to be included in this draft assessment.

The alternative use of this site, should the Sports Complex not be located here, would be for industrial development (local zoning). Part of the site currently is industrialized and will be cleared by the Authority. Under a superceded preliminary master plan drawn up by the Hackensack Meadowlands Development Commission, the northern half of the west section of the site would be an industrial research park; the southwestern quarter would be reserved for special use; the northeast quarter would be residential, and part of the area along Route 20 would be a hotel-office-highway commercial strip. A recreational park would border the special use area, and a highway would be constructed through Berrys Creek tidal marsh.

If the recommendations contained in this assessment are accepted, and if on-going environmental concerns are addressed by the Authority in the revision

of plans, methods of construction, and techniques of operation, the use of this site for the Sports Complex should not magnify, and in fact may help to ameliorate, the environmental problems of the region.

Should the master plan of the Hackensack Meadowlands Commission, or some modification of the proposed plan, be adopted, speculative development in areas surrounding the Sports Complex site can be controlled. Beyond the boundaries of the Meadowlands District, local zoning boards will be responsible for exercising suitable restraints in areas that will be less heavily impacted, but not immune from pressure.

Enabling Legislation

The New Jersey Legislature enacted legislation, signed into law by Governor William T. Cahill on 10 May 1971, which established the New Jersey Sports and Exposition Authority (Chapter 137, The New Jersey Sports and Exposition Authority Law). This was "An Act to provide stadiums and other buildings and facilities in the Hackensack meadowlands for athletic contests, horse racing, and other spectator sports and for trade shows and other expositions..."

The Authority was established in the Department of Community Affairs as an instrumentality of the State. The State Treasurer, the Attorney General, and a member of the Hackensack Meadowlands Commission appointed by the Governor are members ex officio. Four other members, one of whom is designated as chairman by the Governor, are appointed by the Governor with the advice and consent of the Senate.

The Legislature provided the Authority with the power of eminent domain over "any land and other property, including land under water, meadowlands, and riparian rights..." necessary for the project. It also invested the Authority with the right to relocate or reconstruct any highway or utility (Sections 5m, 8c). These powers, however, were tempered by the requirement that the Authority shall pay all costs of such condemnation or relocation from its own income (Sections 8a, 8c, 9a).

In regard to a site for the Sports Complex, the Legislature directed the Authority, "To determine the location, type and character of the project or any part thereof and all other matters in connection with all or any part of the project, notwithstanding any land use plan, zoning regulation, building code or similar regulation heretofore or hereafter adopted..., provided that

the authority shall consult with the Meadowlands Commission before making any determinations as to the location, type and character of the project" (Section 5x). It also was specified that the project is "to be located in the Hackensack meadowlands upon a site not to exceed 750 acres..." This section (6a) also enumerates a variety of principal and related structures and facilities which the authority may elect to construct on the site. The limitation of the area of the site to 750 acres is restated in Section 22 of the Act.

An Environmental Mandate

> *"It is the express intent of the Legislature that the authority in undertaking the meadowlands complex shall consult with the Meadowlands Commission and the Department of Environmental Protection with respect to the ecogolical [sic.] factors constituting the environment of the Hackensack meadowlands to the end that the delicate environmental balance of the Hackensack meadowlands may be maintained and preserved"* (Section 23).

The present environmental assessment represents an effort by the Authority to respond to this explicit declaration by the Legislature. In the same spirit, it is the desire of the Authority that the citizens of the State, their elected representatives, and the various agencies of the State, the Federal Government, and all local governments will join in an open exchange of information and ideas to the end that the New Jersey Sports and Exposition Complex truly will be a facility that will promote the welfare, health, and prosperity of the people of the State.

The Hackensack Meadowlands Region

At the turn of the century tidal marshes occupied 18,580 acres and fresh meadows covered 1,465 acres in an area commonly known as the Hackensack Meadowland (Maps 3, 4). The Hackensack Meadowlands Development Commission now has jurisdiction over much of the same area, including 20,000 acres, which is termed the Hackensack Meadowland District (Map 1).

The meadowlands occupy the lower valley of the Hackensack River. About 10 to 20 thousand years ago, this area was the bed of a large lake between the melting continental glacier and its abandoned moraine across Staten Island. Sediments accumulated in the irregular rock valley that had become the basin of the lake. Before the lake was drained, the sediments filled the valley bottom and formed a level floor through which only a few isolated hills projected. The natural elevation of the meadowland now ranges from slightly below mean sea level to about 3 feet above sea level. Scattered rock outcrops which mark the ancient hills, however, extend many feet above this general elevation.

After the lake was drained, sea level rose enough to bring tides into the basin, and it became a forested swamp, covered first by spruces and later by southern white cedars. But the sea continued to rise and, by 1800, the cedar forests were surrounded and encroached upon by fresh-water tidal marshes. The inexorable rise of the sea continued, and by 1922 it was abetted by the closing of the Oradell Dam across the Hackensack River near the head of tide. The dam reduced the flow of fresh water into the estuary and, particularly during the summer months or prolonged droughts, permitted

the saline waters of the sea to flow more freely into the Meadowlands. Because so many other activities of man intensified at about the same time -- timber cutting, withdrawal of fresh water, diking, filling, lumbering, purposefully and accidentally set fires, mechanical disturbance and soil compaction, releases of toxic gases, and the introduction of toxic, enriching, and oxygen-demanding substances to the water -- we may never be certain why the swamp forests of the Hackensack area died. Today their former luxuriance and abundance is witnessed by muck covered logs, buried stumps, and fibrous, brown peat.

As municipal sewage discharges increased and more and more industries discarded their toxic wastes into the lower Hackensack River and its tributaries, even the tidal marshes changed. Delicate wild rice, a favored waterfowl foodplant, was exterminated. By 1919 the common reed grass was established throughout most of the meadowland, and today it is ubiquitous.

Most of the human-generated stresses were believed to be desirable and necessary or harmless when they were initiated. As our knowledge of environmental systems grew, as the volume of our effluents increased, and as our technological capability to "conquer nature" magnified, however, many of the traditional practices were recognized to have been ill-conceived, grossly over-used, and generally reprehensible. Efforts toward the abatement of these practices are underway, but the stresses already imposed will continue for years, perhaps for decades or centuries, and some changes which have occurred are irreversible.

The ecosystem of the Hackensack Meadowlands is degraded to a point that must be near utter collapse. With prudent and wise management, this simplified and damaged system can be expected to recover, but only very slowly in

terms of the lifetimes of human beings. In an assessment of the environmental conditions of a segment of this crippled ecosystem, therefore, it is more important to identify potential, rather than to evaluate existing quality in relation to some standard based on the more pristine and less spoiled habitats which characterize many other riparian areas of New Jersey and neighboring states.

Description of the Proposed Sports Complex

As now envisioned, the New Jersey Sports and Exposition Complex will include a football stadium, a horse racing facility, a theme park, a hotel and exposition center, an indoor arena, a baseball stadium, and related service facilities. Preliminary plans for the football stadium and horse-racing facility have been drawn, but the other features of the complex still are defined only schematically. Owing to the lack of detail in planning at this time, no major effort is devoted in this analysis to descriptions of features which may not be initiated in the immediate future, if ever. The decision to adopt any one or more of these projects will depend upon studies not yet fully explored by the Authority.

Location of the Proposed Site

The Hackensack Meadowlands Development Commission (HMDC) contracted with the firm of Ewing Cole Erdman & Eubank on 15 June 1970 to evaluate alternative sites for the location of a proposed New Jersey sports and exposition center. The alternative sites had been designated as "Special Use" areas on a preliminary draft of the HMDC master plan for the Meadowlands District. After field studies and consultations with the Commission staff, under the direction of Clifford A. Goldman, various public agencies, and other firms, Ewing Cole Erdman & Eubank made final recommendations in 1970 at a meeting with HMDC chaired by Edward Hume, Commissioner of the Department of Community Affairs. The Commissioners selected alternate Site #6-6A as the most suitable location for the proposed sports complex (Map 8).

After the act to establish the New Jersey Sports and Exposition Authority was signed into law by Governor Cahill on 10 May 1971, alternative Site #6-6A officially was adopted by the Authority. The site subsequently was identified as the "Sports Complex Zone" on a proposed "Official Zoning Map, Hackensack Meadowlands District," published by the Hackensack Meadowlands Development Commission on 28 December 1971.

The proposed site is located in the municipality of East Rutherford, Bergen County, New Jersey. The western spur of the New Jersey Turnpike is its eastern boundary. Two other highways, New Jersey State Highway Route 3 and the Paterson Plank Road, enclose the tract on the south and north, respectively. Berrys Creek, a tributary of the Hackensack River, forms the western boundary of the site. New Jersey State Highway Route 20, which parallels the Turnpike, divides the site into a western section of about 580 acres and an eastern section of approximately 175 acres.

The northern half of this entire site was excluded as a planning area for the Phase II Master Plan of the Hackensack Meadowlands Development Commission (1969) and is zoned by the municipality of East Rutherford as "General Industrial." The southern half of the site, which is included as a planning area for the Phase II Master Plan, is under great pressure for continued industrial development (Real Estate Research Corporation, 1969).

Alternative Sites Considered for the New Jersey Sports Complex

The following is a review of the six sites that were considered as alternative locations for the proposed sports complex during 1970 by the Hackensack Meadowlands Development Commission (Map 8). Criteria employed for the evaluation and comparison of these sites were:

1. The site must contain a developable area of 600 acres or more.
2. To assure proper foundation conditions, bedrock must be no more than 70 to 80 feet below grade in sections of the site on which major buildings will be constructed.
3. The site should be as nearly as possible square in outline so that various component facilities can be placed in proper relationship to one another.
4. The site must be accessible to the major highway system of the region and to railroad facilities which could provide mass-transit services.
5. To avoid the accumulation of noxious or explosive gases beneath structures, any solid waste or sanitary land fills which contain garbage, inflamable substances, or other undesirable materials must be removed from the site and deposited elsewhere.
6. Utilization of the site should not threaten to upset the environmental balance of the wetlands of the Hackensack Meadowlands region.

In the paragraphs below, each alternative site is located, its approximate size and condition of occupancy is described, accessibility to transportation facilities is evaluated, and the site environment is characterized.

Locational data, acreages, land use analyses, subsurface conditions, and areal suitability for the proposed complex were summarized for this report by Ewing Cole Erdman & Eubank/Clauss & Nolan (1972). Subsurface conditions were determined from information supplied by the United States Army, Corps of Engineers, and published by the Hackensack Meadowlands Development Commission (1970:11). Additional data for some sites was obtained from the New Jersey Turnpike Authority, but no soil borings were made specifically for the site evaluation. The evaluations of transportation implications for the sites are quoted verbatim from a report made by the firm of Wilbur Smith & Associates, Inc., on 22 July 1970. Site environmental conditions were appraised for this report by Jack McCormick & Associates with the assistance of Drs. Robert Reimold and Eugene Odum (University of Georgia) and Dr. Edward MacNamara (Lehigh University).

Site #1

Location: This area is bordered by the western spur of the New Jersey Turnpike on the east, the boundary of the Borough of South Hackensack on the north, New Jersey State Highway 503 (Moonachie Road) on the west, and Paterson Plank Road Extended on the south.

Size and occupancy: The site contains 700 to 800 acres. Except for a few developments along Moonachie Road and Paterson Plank Road Extended where fill operations are permitting light industrial and commercial buildings to be constructed, this site is vacant. Gas storage facilities (TRANSCO) are located on an adjoining tract immediately southeast of the New Jersey Turnpike.

Subsurface conditions: Available subsurface information indicated that bedrock is within 20 feet of the surface along Moonachie Road, but that it slopes steeply to a depth of 60 feet near the Hackensack River.

Transportation implications: This site fronts on the New Jersey Turnpike approximately 1 mile north of the interchange with New Jersey Route 3. An interchange could be implemented to give direct access from this major facility to the site. The site is bounded on the south and the west by Routes 120 and 503, respectively. If these routes are not adequate at this time they could be upgraded to accommodate the anticipated traffic loads. Both of these secondary access roads connect to New Jersey Route 3 and Route 17 and in turn to all major freeways and parkways in the area. The mainline of the Erie-Lackawanna Railroad is approximately one mile away from the site. A connecting spur line for rapid transit could be implemented.

Site environment: Dikes equipped with gates on Bashes (Boetches) Creek and Moonachie Creek, as well as the embankment for the western spur of the New Jersey Turnpike, obstruct the flow of tides into this site. Most of the tract is covered by stands of common reed grass, but several small ponds provide heavily used waterfowl habitat. Waterweed (*Potamogeton* sp.) was abundant in the channel of Moonachie Creek near Moonachie Road.

With the exception of developed areas, Sipple (1971) mapped the vegetation of the entire tract as common reed grass. Renlund (1970), however, delineated two ponds near Moonachie Road and indicated three large stands of "marsh vegetation" on the site.

Site #1A (Combined)

Location: Site #1A (Combined) is composed of Site #1 with the land located between the western spur of the New Jersey Turnpike and Hackensack River.

Size and occupancy: The combined tract includes approximately 1100 to 1300 acres (Site #1 plus 400 to 500 acres to the east of the Turnpike). Occupancy of Site #1 was described above. The supplementary tract is vacant except for a small marina on the Hackensack River at the end of Patterson Plank Road Extended, a large gas storage facility (TRANSCO), and an underground gas pipeline that parallels the Turnpike through the site.

Subsurface conditions: Bedrock is in excess of 60 feet below the surface near the center of the site and is progressively deeper toward the Hackensack River.

Transportation implications: See description for Site #1.

Site environment: From ground inspections around the periphery of the supplementary tract east of the New Jersey Turnpike, the vegetation was observed to be principally a dense growth of common reed grass. Particularly near the Hackensack River at the TRANSCO pipeline, low-water cordgrass (*Spartina alterniflora*), bulrush (*Scirpus olneyi*), and other brackish marsh species were observed.

The supplementary tract is reported to be open to the flow of tides and is considered to be among the best tidal wetlands in the Hackensack Meadowland District (Personal communication, Donald Smith).

The vegetation of the supplementary tract was shown on a map by Sipple (1971) to be composed entirely of common reed grass. Renlund (1970) also mapped the vegetation on most of the site as common reed grass. He recognized a large part of the north-central section of the tract along Doctor Creek, however, as "marsh vegetation." Marsh vegetation also was shown along the bank of the Hackensack River. In a written statement (Anon., 1972), Renlund and Geller described the "Headwaters of Doctor Creek and along the TRANSCO Pipeline, Carlstadt and Moonachie" as follows:

> "West of the pipeline are numerous muskrat houses made of mounds of Phragmites stalks ... Eastwards, towards the Hackensack River were open areas with smart weed species, cocklebur, Indian grass, and goldenrods. Cecropia moth cocoons and praying mantis egg masses were found on Elder shrubs, which were growing in patches at the fringes of stands of Phragmites and along the road embankments.
>
> "The long strip of land between the pipeline and the new highway [Turnpike] roadbed is undergoing changes in drainage; the diking impounds water closing it off from tidal access and drainage. The dredging has exposed stumps and roots of old white cedar ... The Phragmites vigor is level one. The other plants present indicate moistness, and are species of smart weed, elderberry, Indian hemp and goldenrod."

Site #2

Location: Site #2 is bounded on the west by the eastern spur of the New Jersey Turnpike, on the north by State Highway 3, on the east by the Erie-Lackawanna Railroad, and on the south by the State Route 3-New Jersey Turnpike interchange complex. Cromakill Creek bisects the site.

Size and occupancy: Only about 250 acres are contained in this tract. Nearly all of the tract is vacant.

Subsurface conditions: The depth to bedrock beneath the site exceeds 100 feet.

Transportation implications: This site is very tight for achieving vehicular access. It is in the northeast quadrant of a major interchange between the New Jersey Turnpike, Interstate Route 495, New Jersey Route 3, and New Jersey Route 153. The easterly boundary is adjacent to the Erie Railroad which would make it difficult and expensive to achieve vehicular access from this side. The close proximity to the previously mentioned interchange complex would make it very difficult to get local access to this site. Rail access for rapid transit would be excellent from the Erie Railroad.

Site environment: The southern 70 percent (approximate) of this site is covered by a trash landfill that now is inactive. Ponds on Cromakill Creek along the east edge of the site allegedly receive raw sewage from developed upland areas. The creek drains into the tidal wetland in the northern 30 percent of the site and thence into the Hackensack River. The channel of Cromakill Creek was partially obstructed by fill materials in at least two places, but ebbing water was observed to flow over them.

Vegetation on the tidal wetland section of the site is composed largely of vigorous stands of common reed grass. Dense colonies of narrow-leaved cattail are scattered in the area. The filled land is covered by weedfields with scattered aspens, trees-of-heaven, and elderberries.

Analysis of the vegetation on the site by Sipple (1971) essentially is in accord with observations made during the present investigation. He mapped ruderal species (weedfield) on the filled section of the site and common reed grassland on the northern section. Renlund (1970) did not characterize the vegetation on the landfill, but concurred in typing the vegetation on the remainder of the site as common reed grassland. In text comments (Anon., 1972), Renlund and Geller apparently described the tidal section of this site:

> "Further south on the upper reaches of the Cromakill one large area of Typha angustifolia was sighted as well as patches of S. cynosuroides and Pluchea purpurascens. Occurring also were scattered specimens of Acnida cannabina and Hibiscus sp. Some access areas, however, had no salt marsh plants at all. This area is actually a continuation of a salt and brackish area lying between Cromakill and Mill Creeks. Here are found salt and brackish marsh conditions, again hidden from view in many cases because of Phragmites Communis. In 1948, Heusser did an analysis of the vegetation of this region in which he listed 117 species or varieties. Observation in this area showed that many of these salt and brackish marsh plants are still present."

Site #3

Location: The interchange complex for State Highway 3 and the New Jersey Turnpike borders Site #3 on the north. The site is bounded by the eastern spur of the New Jersey Turnpike on the west, the Penn-Central Railroad on the south and east, and also by Corporation Line Road on the

south. Penhorn Creek extends through the western third of the site.

Size and occupancy: The bulk of this ± 170 acre site is vacant, but there is a minor fringe development along the northern boundary. The tract is reported to be under consideration as the site for a major heliport to serve the New York City-North Jersey metropolitan area. Presently, there is a "Park-and-Lock" facility on the site.

Subsurface conditions: Bedrock depths vary from 20 feet below the surface in the southwest corner to 100 feet or more beneath the surface in the center of the site.

Transportation implications: This site is in the southeast quadrant of the interchange complex noted for Site #2 and for the same reasons vehicular access would be difficult. The southerly boundary of this site is adjacent to the Penn Central tracks. There is a local street along the southwesterly frontage. However, there would be major engineering problems in attempting to achieve access to the freeways that would bring the largest portions of the patrons to the site. Rapid transit access would be excellent from the adjacent Penn Central Railroad.

Site environment: Penhorn Creek, which flows through the western section of Site #3, is blocked from tidal action at the Erie-Lackawanna Railroad

near its mouth. A pumping facility has been installed to provide an outflow capability. The character of the site is that of a former tidal marshland. The marsh is severely polluted and crankcase oil was observed over a large area at the eastern margin of the tract.

Except on a small landfill near the northeastern corner, the vegetation can be characterized as a vigorous common reed grass marsh interspersed with large, robust stands of narrow-leaved cattail. Sipple (1971) characterized the site entirely as a common reed grass marsh. A large, centrally-located stand of cattail surrounded by common reed grass was delineated over the site by Renlund (1970). Renlund and Geller referred to the site as their "Penhorn Creek-Secaucus" area and described it as follows (Anon., 1972):

> "East of the inspection station are two drainage ditches cut through several acres of cattails. Associated with the cattails and Phragmites were tall knotweed species. It was reported that most of this region was burned out in 1968. Further east were thickets of elderberry, foxgrapes and curcurbit vines."

Site #4

Location: The long western and eastern limits of this site are bordered by the Erie-Lackawanna Railroad. The north boundary coincides with the Hackensack River and the south boundary is County Road.

Size and Occupancy: An aqueduct that carries potable water to Jersey City extends lengthwise through this ± 200 acre tract. The western third of the site is developed for warehousing and other industrial uses. A recent landfill covers a triangular area in the southeastern part of the undeveloped section of the tract.

Subsurface conditions: The depth to bedrock varies across the site, but generally ranges from 50 to 100 feet beneath the surface.

Transportation implications: This long narrow site has restrictions on three sides. The Hackensack River is along the northwesterly side. The mainline of the Erie-Lackawanna Railroad bounds the northeasterly side. The Secaucus Yard of the Erie-Lackawanna Railroad bounds the southwesterly portion of the site. The site has approximately 1,200 feet of frontage on a local road on the remaining southwesterly side. Major contact with the freeway system would be from a proposed new road running through the site parallel to the river. The New Jersey Turnpike is located approximately 600 feet southwesterly and parallel to the southwesterly property line. It appears that an interchange might be implemented with the Turnpike. However, with the close proximity of the many railroads an interchange would be costly. Rapid transit access to the site would be excellent due to the close proximity of the many railroad lines.

Site environment: The hydraulically placed landfill in the southeastern part of the site contains sandy material which is easily blown by the wind. It is barren. Weedfields occupy most of the older fill on the western third of the site, except for areas covered by buildings, roads, or parking lots. The section of the site between the hydrofill and the Hackensack River is open to the tides and is covered by a vigorous stand of common reed grass interspersed with colonies of low-water cordgrass (*Spartina alterniflora*).

Aerial photographs employed as base maps by Sipple (1971) and Renlund (1970) apparently did not show hydrofill on this site. Sipple categorized the vegetation in the southeastern corner and along the western edge of the tract as weedfield types. The remainder of the site was shown to be covered by common reed grass marsh. On the map by Renlund (1970), an effort apparently was made to sketch in the limits of the hydrofill. In applying symbols to the map, however, the area of common reed grassland was coded as a landfill. The landfill area, conversely, was coded as a common reed grassland. The remainder of the site was categorized as "transportation" except for a small area adjacent to County Road that was combined with developed lands.

Site #5

Location: The site is bordered on the north, south, and west by the Erie-Lackawanna Railroad and on the east by the western spur of the New Jersey Turnpike.

Size and occupancy: Most or all of the site is vacant. It contains approximately 500 to 600 acres.

Subsurface conditions: Bedrock ranges in depth from 50 to 70 feet along the western spur of the New Jersey Turnpike to the east of the site. The entire site, however, appears to be over a buried valley because bedrock is 100 feet or more beneath the surface throughout the tract.

Transportation implications: This site is bounded on three sides by the Erie-Lackawanna Railroads. The easterly side of the site fronts on the

the proposed Route 17 freeway. At the northeast corner of the site is proposed an interchange between Route 17 and Route 7. At the southeast corner of the site there is a proposed major interchange with the New Jersey Turnpike, Interstate Route 280, Route 17 and Route 506. With only 2,500 feet of frontage between the Route 17 and 7 interchange and the previously mentioned major interchange complex, access would be difficult to achieve for vehicles from this route. Major roadway connections would have to be constructed from upgraded local streets, over the railroad lines and to the site. Rapid transit implications would be excellent with the contiguous frontage with the Erie-Lackawanna Railroad.

Site environment: Railroad embankments and dikes enclose this site and isolate it from regular tidal flows. It was reported that the Hudson County Mosquito Commission formerly maintained a tide gate that regulated drainage from the site. The Commission currently is inoperative, however, and the tide gate has been blocked by debris. As a result, water from precipitation and seepage collects on the site and often is 1 foot or more in depth over the very level terrain. Only a trash landfill in the western part of the tract is not subject to this flooding. If the tide gate were removed, most of the site probably would be capable of supporting a brackish tidal marsh biota.

The landfill is covered by a weedfield vegetation. Except for a shallow central trough, which appears (on 5 April 1972 aerial photographs) to be flooded and barren, virtually all land at natural elevation in the tract is covered by common reed grassland. A large muskrat population

is present in this diked marsh and individual animals are said to be robust (Dr. Edward MacNamara and Mr. Donald Smith, oral communcations).

Common reed grass marsh was shown to occupy all but the extreme western edge of this site by Sipple (1971). The western margin was characterized as developed land.

The site was divided into four type areas by Renlund (1970). The vegetation on at least 80 percent of the tract was characterized as common reed grassland. A linear area that extended from southwest to northeast through the northern half of the tract was shown as open water. Oldfield vegetation covered the extreme southwestern corner of the site and a small landfill occupied the ground immediately to the east. In text comments, Renlund and Geller (Anon., 1972) referred to this area as the "Kearney Meadows" and described it as follows:

> "These meadows are covered by wet Phragmites areas. There is extensive industrial development, much recontouring due to the new turnpike spur, and active garbage fill. At the higher edges of the meadows near the roads are occasional milkweed and panicum grass."

Site #6-6A

Location: Berrys Creek is the western limit of this site. The tract is enclosed on the north and south, respectively, by the Paterson Plank Road and its extension and New Jersey Highway 3. The western spur of the New Jersey Turnpike is the eastern boundary. New Jersey Highway 20, which parallels the Turnpike, divides the tract into a western (site #6) and an eastern section (Site #6A).

Size and occupancy: The total site contains approximately 750 to 800 acres, including about 600 acres in Site #6 and 150 to 200 acres in Site #6A. The northern half of Site #6-6A was excluded from the planning areas for the Phase II Master Plan of the Hackensack Meadowlands Development Commission (1969) but was considered in the alternative site evaluation to provide an area adequate for the complex. Several developments are located on the north perimeter of the tract and preparations for additional industrial sites on fill have been initiated on Site #6. Much of the central area has been covered by trash landfills and several industries have located along Route 20.

Subsurface conditions: Bedrock is approximately 20 feet below grade at Route 20. It slopes toward Berrys Creek and toward the Hackensack River to depths as great as approximately 100 feet.

Transportation implications: This site is bounded on three sides by primary and secondary highways. Route 120 borders the northerly portion of the site. Route 20 is adjacent to the easterly side of the site. Route 3 and a major interchange complex with Route 20 and the New Jersey Turnpike is along the southerly portion of the site. It appears from the preliminary plans that there is a service road system proposed along Route 3 that would give ready access to the site. Access could also be achieved from Route 20 and Route 120. Berrys Creek is along the westerly boundary. Across the Creek from the southwest corner of the site is the mainline of the Erie-Lackawanna Railroad. Rapid transit access could be achieved from this line by constructing a bridge over the Creek.

Site environment: Trash landfills of various ages occupy approximately 40 percent of the tract. Most of the remainder is covered by common reed grassland. An upland oak grove (less than one acre) is located in the southeastern section of the site adjacent to Route 20.

Most of Site #6 is enclosed by a dike that extends from Route 3 to the Patterson Plank Road. An area of approximately 160 acres, located between the dike and Berrys Creek, still is flowed by the tides and is covered by a vigorous stand of common reed grass interspersed with small colonies of narrow-leaved cattail and salt reed-grass (*Spartina cynosuroides*). An unfilled section (approximately 30 acres) on Site #6A also is subject to tidal action, but the embankment for the western spur of the Turnpike separates the reed grass tidal marsh from natural flooding by the Hackensack River. The area is connected to the River through a culvert beneath the Turnpike.

Most of the unfilled and undeveloped sections of this site were characterized by Sipple (1971) as common reed grass marsh. He indicated one small stand of cattail adjacent to Berrys Creek. Renlund (1970) treated the area even more generally and categorized all areas of the site as common reed grassland except for developed lands and barren landfills. Renlund and Geller (Anon., 1972), who included Site #6 and a nearby area north of the Patterson Plank Road as their "Walden and Eight Day Swamps" site, pessimistically appraised the site as follows:

> "The coming of industry has changed the conditions here so the remaining vegetation visible is Phragmites of lowest vigor. There is no tree or bush; no other plant in the vast area. The enlargement of Paterson Plank Road and Route #17 is further changing the area, leaving an uncertain future for the sparse vegetation which persists."

Comparisons of the Alternative Sites

Area and configuration: Only three of the alternatives, Site #1 or #1-1A (combined), Site #5, and Site #6-6A, were considered individually to be large enough and of a proper configuration to accommodate the development of a complete sports facility.

Site #2 and Site #3 were judged to be too small for development devoted to more than one sport. Although the two sites are separated by less than 0.5 mile, an intervening highway interchange complex obviates their combined utilization. The combined site also would be deficient in total acreage.

Site #4 was judged to be too small for the development of a full sports complex. Furthermore, the long, rectangular shape of the tract was considered not to be readily adaptable to usage for a stadium or a racing facility.

Subsurface conditions: The requirement that bedrock be no more than 80 feet beneath the surface in a portion of the site large enough for the location of major structures was met only by Site #1-1A, Site #4, and Site #6-6A.

Transportation accessibility: In their report, the firm of Wilbur Smith and Associates, Inc., drew the following conclusions in regard to the relative accessibility of the sites to transportation facilities:

"After considering and reviewing the transportation implications for each of the sites, it became evident that Sites 1 and 6 would have the best vehicular access based on existing or committed roadway patterns. It is anticipated that a substantial portion of the patrons would arrive and depart by passenger car. Therefore, the access from the major arterial system should receive primary consideration with secondary consideration to the connections from the railroads. Sites 1 and 6 are bounded on at least three sides by highways which would connect into the major freeway and arterial system.

Site 1 would require a longer rail connection from the Erie-Lackawanna mainline for rapid transit. Site 6 would have a very short rail connection to achieve access into the site.

Site environment: Only two sites, Site #3 and Site #5, are fully blocked from normal tidal flows. Approximately 60% of the area within Site #4, which is adjacent to the Hackensack River in Secaucus, is tidal marshland with brackish-water species. Site #1-1A also is adjacent to the mainstem and supports brackish water species in at least part of the 30% that is flowed by the tides. No definitive brackish species were noticed on either Site #2 or Site #6-6A, of which approximately 30% and 25% are subject to regular tidal inundation.

Other considerations: A large gas storage facility of the Transcontinental Gas Pipeline Corporation is located on Site #1A near the New Jersey Turnpike western spur. Although the probability of an accidental explosion of a gas storage tank at this site is low, the potential hazard to thousands of spectators was considered to preclude the use of Site #1-1A.

Comparative summary of suitabilities of the alternative sites for the location of a sports complex. The symbol "x" indicates general suitability in regard to a specific condition.

	1-1A	2	3	4	5	6-6A
Size	X				X	X
Bedrock	X			X		X
Transportation	X					X
Tidal area	30%	30%	0%	60%	0%	25%
Low hazard		X	X	X	X	X

The Hackensack Meadowland Development Commission, on the basis of the information summarized above (excepting the estimation of the proportion of each site subject to regular tides), selected Site #6-6A as the most suitable for the location of the proposed Sports Complex. The Commission's recommendation was accepted by the New Jersey Sports and Exposition Authority after that body was authorized by the Legislature.

Environmental Review of Selection

Four of the alternative sites (1, 4, 5, 6) were inspected during a field meeting on 7 June 1972 by a group of professional ecologists (Dr. Jack McCormick and Roman Gankin of Jack McCormick & Associates, Dr. Robert Reimold, and Dr. Edward MacNamara). Dr. Eugene Odum, also a professional ecologist, subsequently reviewed the information with Dr. Reimold and concurred in the group opinion.

Sites #2 and #3 had been rejected by the Hackensack Commission on the basis of size, depth to bedrock, and difficult accessibility. Site #3 is

wholly a marsh area, although it now is blocked from tidal flow (Map 5). Approximately 30% of Site #2 is a tidal marsh and any expansion of the site would usurp more tidal wetland (Map 5). On the basis of this information, verified by helicopter inspections by Mr. Gankin on 6 June 1972 and examination of a 5 April 1972 infra-red aerial photograph (Map 1), these sites were considered to have high environmental potential.

With the exception of small areas of fill (Map 7), Site #1-1A is almost wholly a wetland area (Map 5), although about 60% is reported to be currently blocked from tidal action. The area is connected directly to the main stem of the Hackensack River and supports low water cordgrass, three square bulrush, and other brackish indicators.

Approximately 60% of Site #4 is a tidal marsh connected directly to the main stem of the Hackensack River (Map 5). This area also has substantial stands of low water cordgrass.

Site #5 is blocked from tidal flow by embankments, but approximately 85% of the tract is freshwater marshland. Subsurface information indicated that the depth to bedrock throughout this tract is greater than 100 feet.

On Site #6-6A, tidal wetlands occur along a tributary, Berrys Creek (20% of tract), and in connection with the Hackensack River (4%). Wetlands that have been blocked from tidal action by dikes and landfills occupy an additional 35% of the site (Map 5). About 45% of the site is covered by landfills (Maps 5, 7, 10).

On the basis of the extent and quality of the wetland habitats of alternative Sites #1, 4, 5, and 6, the group rejected Sites #1-1A and Site #4 as suitable for the location of the Sports Complex. Site #5 and Site #6 were judged to be of comparable quality, with Site #6 being less suitable for the Complex because of the inclusion of the Berrys Creek tidal area. Owing to the excessive depth of bedrock on Site #5, however, the group concurred in a recommendation that Site #6-6A be selected for the Sports Complex. This recommendation was conditioned on the exclusion of the Berrys Creek tidal area from any diking, filling, or other coverage.

Environmental Features of the Proposed Site

Land Form and Geology

Natural elevations on the proposed site range from slightly below mean sea level to 14 feet in a small oak woodland. Trash landfills, however, generally rise to 10 feet or more above sea level. Except for the filled sites, the low oak ridge, and a dike parallel to Berrys Creek, the virtually level topography is interrupted only by stream channels and drainage ditches.

Bedrock in the site area is a soft red shale with occasional interbeds of fine-grained sandstone (Brunswick Formation, Late Triassic). It ranges in depth from about 40 feet below mean sea level just south of the junction of Route 20 and the Paterson Plank Road to about 170 feet below sea level at Berrys Creek just north of Route 3. (A stratigraphic section is presented in Chapter VI of the inventory.)

Glacial till of Pleistocene age overlies the bedrock throughout the site and ranges from 5 to 20 feet in thickness. The till consists primarily of fragments derived from the Brunswick Formation which range in size from greater than 12 inches (boulder size) to less than .005 millimeters (clay size).

Water-saturated varved silts and clays of Pleistocene age overlie the glacial till throughout the site. This nearly impermeable bed is from 13 feet to 53 feet thick under the project site, and its upper surface is at a relatively uniform elevation of about 3 feet below sea level.

A thin layer (0 to 5.5 feet) of gray, medium to fine-grained sand (Recent) overlies the varved material throughout the site. The sand, in turn, is overlaid throughout the site by muck or peat of Recent age. This

is largely organic, water-saturated material, intermixed with small amounts of stream-deposited silt. The uppermost portion of the material, which is known as meadow mat, is a mixture of decomposed and partially decomposed rhizomes and leaves of common reed grass. The meadow mat grades downward into decomposed conifer forest material, or peat. The combined thickness of peat and meadow mat ranges from 0 to 8 feet.

Vegetation

The earliest published information on the vegetation of the proposed site is contained in a map of Hackensack Meadows prepared by Vermeule (1897). The modern dike near Berrys Creek approximates the western edge of a southern white cedar swamp forest which occupied the site in 1896 (Map 9). Virtually all of that section of the proposed site between the modern dike and modern Route 20 was covered by the swamp forest. Approximately at the location of the Woodland area (Figure IV-1), a ridge of upland without swamp forest is delineated. The cedar swamp forest extended east of Route 20 for a distance of approximately 100 feet in the central third of the site. Cedar swamp bottom, however, covered most of the western half of the tract between Route 20 and the New Jersey Turnpike.

Five vegetation types were recognized on the site during surveys from 18 May through 7 June 1972 (Map 10). The following table summarizes the acreage and relative proportion of the tract covered by each:

	Acres	% of Site
Vegetated Areas		
Common Reed Grassland	415	53
Vegetated Fill	98	13
Flooded Shrubland	8	1
Birch-Aspen Shrubland	0.5	<1
Oak Woodland	0.2	<1
Subtotal:	522	67
Areas Without Vegetation		
Barren Fill	230	29
Open Water	28	4
Subtotal:	258	33

A tidal marshland of approximately 160 acres adjacent to Berrys Creek is covered by dense stands of common reed grass in which water-hemp forms a sparse, discontinuous understory. Pure stands of water hemp, narrow-leaved cattail and salt reed-grass are scattered throughout the tidal marsh, particularly along the streams. The ground surface in the marsh has an average elevation of about 3.3 feet amsl and was flooded by 2 or more inches of water at high tide. It drained completely at low tide.

Another tidal marsh is located adjacent to the New Jersey Turnpike south of the Paterson Plank Road. The area is connected to the Hackensack River through a culvert (approximately 48 inches in diameter) located approximately 800 feet southwest of the Paterson Plank Road. This culvert limits tidal flow to the marsh and apparently has reduced tidal flushing.

The former cedar swamp area between the dike and Route 20 is covered predominantly by a common reed grassland in which oldfield herbs, such as

goldenrod, are abundant. The level of the peat in this diked marsh area apparently has receded, for it now averages only about 2.4 feet amsl. If the area were not diked, it apparently now would be flowed regularly by the tides.

North of Route 3 and immediately west of Route 20 the drainage of an area of former cedar swamp has been obstructed by the road embankments and nearby landfills. Water in this area was as deep as 2.5 feet during early June 1972. The site is covered by common reed grass, but dead blackberry plants protrude above the water throughout the area. Dead birch and aspen sprouts also are conspicuous in the north-central section of this tract and in a small area near Route 20.

Perhaps the most unique vegetation feature of the site is a small woodland (0.2 acre) along Route 20. The canopy of this grove is composed of approximately fifteen white oaks, the largest stem of which is 12 inches in diameter, and several red oaks and chestnut oaks. The woodland is bordered on the west and south by a birch-aspen shrubland.

Wildlife

Sixty-five kinds of birds, including 26 nesting species, ten kinds of mammals, one amphibian, and three reptiles are known to inhabit or visit the proposed site (Tables V-1 and 2). No nationally or regionally rare or endangered species, however, is known to occur on the tract.

The most common breeding birds in the diked marsh area are mallard, black duck, blue-winged teal, common gallinule, and ring-necked pheasant. Numerous gallinules, including several young, were observed in ditches near the intersection of Routes 3 and 20. One green heron and one black-crowned

night heron also were noted in the area. A king rail was heard calling in the north-central section of the tract; this very uncommon species may still breed in the area. Spotted sandpipers breed near mudflats along ditches, and numerous kinds of songbirds are uncommon to abundant breeders throughout the area.

Twenty-eight kinds of birds were observed in the tidal marshes. Ten species are known to nest, and two others are believed to nest in this habitat.

Garbage dumps in the New York area generally attract many thousands of gulls, especially in winter, and represent some of the best sites for the observation of the rarer arctic and European gull species. Smoke from persistent garbage fires on the site (Maislin Fill), however, apparently discourages most gulls from feeding or roosting in the proposed Sports Complex site.

Several species of breeding songbirds, particularly the robin and yellow warbler, primarily are associated with the small woodland area adjacent to Route 20. Many other species undoubtedly visit this woodland during migration.

Abundant mammals include the house mouse, muskrat, and Norway rat. The last two and the long-tailed weasel are the only mammals in the tidal marsh habitat. Only one cottontail was seen, but the rabbits are reported to be common in diked marsh and landfill habitats. Several species which seldom are common in highly polluted areas still are represented on the site by occasional individuals. These include the opossum, striped skunk, raccoon, gray fox, red fox, and long-tailed weasel. Wild dogs and feral house cats also are reported to visit the site, but none was observed during field investigations.

Northern leopard frogs and painted turtles inhabit the diked marsh area, and snapping turtles are common in the diked and tidal marshes. The eastern garter snake is the only other reptile known from the site.

Water Quality

A study made by the Federal Water Pollution Control Administration (FWPCA) during the summer of 1964 (Public Health Service, 1966) included a special investigation of phenols in the Berrys Creek Canal and upper Berrys Creek in June. Results indicated that phenols were present in concentrations ranging from 20 to 340 parts per billion whereas the desired standard listed by FWPCA was 5.0 parts per billion or less.

Results of analyses at a station on the mainstem of the Hackensack River about 0.8 mile above the mouth of the Berrys Creek Canal probably are representative of the quality of water that enters Berrys Creek on flooding tides. In the FWPCA study, the concentration of chlorides was 5,500 mg/l, or strongly brackish.

Concentrations of organic nitrogen and organic phosphate (PO_4) were 4.65 and 4.7 mg/l, respectively. These values reflect a severely upset condition that can be attributed to heavy discharges of poorly treated sewage and probably to some industrial effluents as well.

Chemical oxygen demand (COD) at high tide slack in June 1964 was 115 ppm. This value was the highest COD measured on the mainstem. At high slack in June 1964, BOD was 3.7 mg/l. These concentrations indicate that significant loads of chemical and organic pollution were being received by the river.

Correlated with the high concentration of oxygen demanding substances, the concentration of dissolved oxygen was only 2 mg/l, or approximately 22.5%

as great as the saturation concentration. This low concentration probably enforces a lethal stress on most aquatic organisms. Most species of fish, for example, are unable to live in water with a concentration of less than about 4 mg/l of dissolved oxygen.

Results of a monitoring program by the Newark College of Engineering during the summer of 1971 indicate that dissolved oxygen virtually was absent from the water of Berrys Creek. Total phosphate and nitrate concentrations were very high and indicate substantial degradation of water quality by sewage and industrial discharges. As expected, the concentration of chlorides was highest at the downstream station (Route 3, 4670 ppm) and least at the upstream station (1770 ppm), but the influence of saline water is demonstrated throughout the reach.

The Hackensack Meadowlands Development Commission also supplied information concerning several industries which allegedly discharge pollutants into Berrys Creek or its tributaries. These include two firms on the proposed site. A trucking company allegedly permits crankcase oil to flow into a ditch in the diked marsh. A metal processing company allegedly discharges chromium and possibly other heavy metals, as well as substances with high COD into the diked marsh. Ditches in this marsh drain through a tide gate into the Berrys Creek tidal marsh and thence to the stream.

Measurements made on 31 May and 5 June 1972 during this investigation confirmed the findings of the two previous studies.

Dissolved oxygen (DO) virtually is absent from the water in Berrys Creek and in the tidal marsh channels. Although the two marsh areas did inject oxygen into the water during the tidal excursion samples, the increase in DO was not sufficient to render the water suitable as an environment for aquatic animals.

Apparently, there was a relative lack of circulation and longer residence time in the Turnpike tidal marsh than in the Berrys Creek tidal marsh. Nutrient concentrations, which increased in the Berrys Creek marsh and generally decreased in the Turnpike marsh, may indicate a substantial load of mobile organic sediments in the Berrys Creek marsh. These sediments presumably originate principally from the two sewage plants that discharge to the creek. Significant increases in specific conductance of water during its residence in the Turnpike tidal marsh may indicate a local source of chemical pollution from an industrial discharge.

Water temperature and dissolved oxygen both increased during the afternoon in the Diked Marsh (Figure VII-1; Station 6). Turbidity and the concentrations of nitrate- and nitrite-nitrogen also increased and may indicate the influence of the diurnal patterns of industries which are alleged to discharge wastes into the area.

Only killifish and snails of the genus *Physa*, both of which are known to be resistant to water pollution, were found in water on the proposed site. Blue-green algae (*Oscillatoria* and *Anabaena*) that are present on the site also are characteristic of areas with heavy loads of organic pollution. Tests indicated that the Berrys Creek tidal marsh and the adjacent diked marsh are contaminated with coliform bacteria. These probably originate from local sewage treatment plants.

Chromium, arsenic, and mercury are present in unusually high concentrations in the muck beneath the surface and in the channels of the Berrys Creek tidal marsh (Table VII-2). These persistent, toxic pollutants appear to be contained principally in the upper 2 to 4 inches of the substrate.

Summary Evaluation of Existing Conditions at the Site

The vegetation of the site proposed for the location of the New Jersey Sports and Exposition Complex has changed during the past 76 years from a dense forest of southern white cedars edged by fresh-water tidal marshes and oak forests to a common reed grassland interrupted by dikes and trash-, mineral-, and peat-landfills that are partly covered by industrial buildings, stored equipment, parking lots, roads, and highways. The vegetation changes apparently were initiated by natural processes, particularly by a fluctuating, nearly imperceptible, but cumulative, rise in sea level. The rate of these changes was accelerated, and the nature of the changes was modified, by human intervention.

The central section of the Berrys Creek tidal marsh exhibits the greatest potential for recovery (Figure IV-1). This area is flowed daily by the tides and is protected from accelerated erosion by dense stands of common reed grass. In contrast, the southern section of the tidal area was diked (Map 9) until relatively recently. It is pocked by many, small, depressed mudflats which probably reflect a lowering of the surface of the organic soil by fires and decomposition while the area was blocked from the tides. Landfills adjacent to Route 3 on the south and to Paterson Plank Road on the north have covered several acres of former tidal wetland.

The Turnpike tidal marsh at the eastern edge of the proposed site has been altered by uncontained landfills and tidal flow into the area is restricted by the Turnpike embankment. The area now serves principally as a sump for drainage from adjacent artificial high ground.

At present, Berrys Creek essentially is an open sewer serving inadequate and loosely regulated public facilities and private enterprises. There is an urgent need for major improvements in the methods of treating sanitary sewage and for stringent control of industrial discharges. These conditions, left unchanged, could make an unhealthful and unaesthetic environment for the tens of thousands of visitors anticipated a few years hence at the proposed Sports Complex.

Other sections of the site serve as useful breeding areas for waterfowl, several native mammals, and several amphibians and reptiles. The obvious pressures for industrial and commercial development, however, seem likely to erase these habitats in the near future. One of the most heavily used areas is an accidental impoundment. Should the landowner excavate a small channel through one of the adjacent landfills, the area probably would drain rapidly. Although no tests of organisms were conducted, observation of high concentrations of heavy metals in their immediate surroundings make it probable that the resident animals are carrying heavy body loads.

Garbage landfills on the site were poorly constructed, and one was burning at least for three weeks during May and June 1972. These dumps provide excellent breeding areas for Norway rats, and two specimens trapped during this study were robust.

To summarize, the proposed site apparently was in a state of naturally-induced change, from forest to marsh, at about the time that human intervention became excessive. Efforts now underway should result in substantial improvement in the quality of the water entering Berrys Creek. If the Complex is constructed in a manner that will preserve the tidal marsh along the Creek and recreate attractive habitats on the site, existing detractions of the area can be overcome.

Preliminary Master Plan for the Complex

The preliminary site master plan (Map 11) illustrates the proposed positioning of the stadium, grandstand and racing facilities, and parking areas. Three drainage lagoons and related pump stations will evacuate water from the site. The possible site for a hotel, pavilion (exposition hall), and arena and for a baseball stadium are shown by dashed lines. A theme park could be established in the north section of the site near Paterson Plank Road. In this preliminary plan, the perimeter dike is aligned parallel to the east bank of Berrys Creek.

Environmental Assessment of the Master Plan

The preliminary master plan envisions the erection of a new dike from the Paterson Plank Road to Route 3. This dike would be located at or near the east bank of Berrys Creek. All of the area within this dike and the existing embankments on which the Paterson Plank Road, Route 20, and Route 3 are situated would be excavated or filled. Similarly, between Route 20 and the New Jersey Turnpike, virtually all land that remains at a natural grade would be diked and covered with spoil removed from the western section of the site.

Should the preliminary site plan be implemented, all existing vegetation and animal habitats on the proposed site would be destroyed and all drainage would be artificialized. Primary productivity (not measured) in the estuarine sections (Berrys Creek and Turnpike tidal marshes) would be reduced by more than 95 percent, and any biological actions that

presently result in water quality improvement or detritus releases would be eliminated. Similarly, the flood storage volume afforded by the tidal areas would be removed and adjacent areas can be expected to be subject to an undetermined increase in flood hazard.

No rare or endangered species of plant was observed on the proposed site. The small oak woodland and birch-aspen shrubland, however, do represent a locally scarce vegetation resource and are remnants that illustrate the historic vegetation of the area.

No nationally or regionally rare or endangered species of vertebrate is known to inhabit the proposed Sports Complex site. The elimination of 700 acres or more of habitats, however, will reduce slightly the regional populations of all species known to breed on the site. Migrating and wintering hawks, waterfowl, and songbirds will be forced to utilize other nearby areas, most of which also are under substantial pressure for development.

Marked changes in the kinds of birds that utilize the site doubtlessly will occur when the planned complex is constructed. Buildings with abundant ledges or openings will permit increases in the populations of rock doves, starlings, house sparrows, barn swallows, and house finches. Replacement of the weed fields and upland reed grass stands by paved areas will eliminate the breeding populations of ring-necked pheasant, killdeer, and mourning doves. There also will be substantial reductions in numbers of migrating and resident hawks and songbirds that now utilize the weed-covered fill areas. Lack of cover doubtlessly will allow fewer eastern cottontails, raccoons, opossums, and striped skunks to utilize the site. The gray fox, red fox, muskrat, and long-tailed weasel

probably will be eliminated from the site. Removal of waste land fills should also result in a substantial reduction of the Norway rat population by limiting the food supply. The changes in wildlife populations and in the character of the land will eliminate hunting from the area and also will reduce slightly the availability of muskrats for commercial trappers.

Recommendations to Minimize Impact and to Enhance the Environment

It is recommended that the proposed dike along Berrys Creek be relocated to an alignment coincident with, or as near as possible to, the existing dike between the subareas identified as the Berrys Creek Tidal Marsh and the Diked Marsh (Figure IV-1). At the north end, the proposed dike could be aligned to enclose the nearby Paterson Plank Fill, but to avoid alteration of the northernmost natural drainage channel. At the south end, it could be aligned to enclose the Sportland Fill. Owing to the irregular configuration of that fill, to the altered condition of the adjacent marsh area, and in the interest of reasonable economies, an alignment coincident with an old, breached dike should be considered (Map 9).

Implementation of this alternative will require substantial changes in the preliminary master plan, but it will spare the only estuarine area (approximately 130 acres) on the proposed site that is considered to retain a high potential for recovery. To assure and expedite this recovery, the Authority or other State agency with jurisdiction may seek to obtain title to any lands considered to be owned privately but contained in the area situated between the proposed dike and the channel of Berrys Creek. If

State riparian lands exist in the area, the Authority may seek a commitment from the Agency with jurisdiction to establish those lands as a wetland preserve.

As mitigation for the loss of other tidally flowed lands that may result from implementation of an alternative site plan, the Authority might devise and implement compatible methods to enhance the quality of the preserved Berrys Creek Tidal Marsh and to make it available for the education and enjoyment of the public.

It is doubtful that the tidal marsh can recover any significant biological integrity for many decades if it were merely set aside as a preserve. Without management, the marsh would serve principally as an example of a thoroughly degraded section of an "urban estuary." Furthermore, if concommitant off-site improvements in municipal and industrial waste treatment facilities are not made, an education program that might encourage mass visitation to the Berrys Creek tidal marsh, and possibly could result in water contact, would endanger the health of the public.

Management of the marsh area must be addressed to three principal aspects: immobilization of accumulated toxic metallic substances, improvement of water quality, and re-establishment of pre-1900 vegetation. Should these priorities be achieved, repopulation of the tidal marsh by a diverse flora and fauna characteristic of such habitats will occur by natural dispersal or can be expedited by transplantation.

Immobilization of the toxic sediments probably can be accomplished best by skimming the upper 4 to 6 inches of muck from the area and depositing them with fixing agents within the construction spoil basin. The

contaminated sediments could be placed in a way that will prohibit them from leaching into ground or surface waters. (Advice from hydraulic engineers should be sought in regard to this matter.) It also will be determined by additional sampling and analysis whether or not other areas on the site are similarly contaminated. In particular, areas receiving drainage from a metal products firm adjacent to the Diked Marsh will be investigated. If other contaminated soils are discovered, plans for proper placement of them in the spoil basin also should be devised.

To avoid the release of metal-laden sediments into Berrys Creek and the Hackensack River, skimming of sediments from the tidal marsh would best be conducted only during periods of low tide. Excavations could be staged to complete a particular area during a single tidal cycle. Further studies may indicate that such excavations should be made only during the spring season. It will be critical to determine the depth of common reed rhizomes in the tidal flats. If the rhizomes are concentrated at depths greater than 6 inches, sprouting might revegetate the stripped area rapidly. If the rhizomes are shallower, the removal of contaminated substrate materials may also serve to eradicate the reed grass so that more desirable vegetation can be introduced. The stripped areas immediately might be sown with native wild rice and perhaps, should be protected temporarily with netting or other material.

Improvement of water quality can be achieved in several ways. By eliminating several sources of industrial pollution from the proposed site, while assuring the quality of its own releases, the Sports Complex will reduce the volume of pollutants reaching Berrys Creek. Until water quality throughout the region is improved substantially, mechanical aera-

tors could be placed in the bottoms of existing channels and ditches to replenish the oxygen content of the water in and near the marsh.

In cooperation with other agencies, the Authority also may wish to seek to establish regulations that will prohibit obstruction of tidal flow in Berrys Creek, restrict to a minimum necessary for essential public benefit any facilities which might encroach on the marsh area (such as walkways or observation platforms, a roadway connection with Union Avenue, or a mass transit line) and require that such essential facilities be constructed on pilings or other open structures where they cross the tidal area, and prohibit the use in Berrys Creek or its tributaries above Route 3 of any amphibious or aquatic vehicle powered by an internal combustion engine. The intent of the last recommendation is to minimize mechanical erosion of the marsh edges as a result of the wakes created by rapidly moving water vehicles.

Should the Berrys Creek tidal marsh become suitable for use as an environmental center, a pathway constructed on the perimeter dike would afford many excellent vantage points for observations of wildlife. The educational value of the area could be enhanced by providing an observation building and interpretative center at a place easily accessible to pedestrians from neighboring areas and to the extensive parking lots planned for the Complex. Many thousands of city dwellers could be introduced to the ecology of tidal marshes, the importance of tidal marshes in an estuarine system, and the adverse effects of pollution on marsh vegetation, wildlife, and man.

Drainage lagoons proposed in the preliminary plan may be developed as useful wildlife habitats to mitigate, at least in part, the loss of existing habitats. To serve in this way, a section of each lagoon could be planned as a shallow edge, with areas of exposed mudflats and emergent plants attractive to shorebirds, waders, and songbirds. Cattails, which are excellent food for muskrats but of limited value to most other wildlife, could be planted in part of one lagoon. Thickets of blackberry, blueberry, and similar shrubs that support dense songbird populations might be planted in slightly higher areas around the lagoons. It may be possible to plant white cedars, red maples, sweetbay magnolias, and other native swamp forest trees around one or more of the lagoons to simulate the cedar swamps that formerly covered much of the Hackensack region. Such an area would provide a pleasing aesthetic amenity to the Sports Complex site, would be attractive to wildlife, and would have substantial value in educational programs. (Before initiating such a plan, methods of winter ice control on parking areas should be evaluated as should the possible requirement to supplement lagoon water levels during periods of drought by pumping from local streams. Any significant concentration of chlorides introduced into the lagoons by these activities could be detrimental to the cedar and other species.)

Provision will be made in the site plan to preserve the historically and educationally valuable remnant of oak woodland and birch-aspen shrubland adjacent to Route 20. It is recommended that the present owner of the land be requested to permit the erection of a protective barrier and warning signs to avoid any unnecessary interim damage to the vegetation. Specimens of trees, shrubs, or ferns that cannot be preserved *in situ*

could be protected and transplanted individually to suitable locations where landscaping is desired.

It is recommended, in addition, that native upland shrubs and trees valuable to wildlife as food sources, nest sites, and cover be considered for planting throughout the site. This will lend a distinctive, regional appeal to the site. If opportunities to cluster plantings are utilized, habitats attractive to migratory songbirds and small mammals also will be created. Small ponds might be placed in or near such plantings to maximize attractiveness of the areas to a wide variety of birds. In this way, many of the terrestrial bird species characteristic of the Hackensack Meadowlands would continue to live on and visit the site.

An area intensively utilized by man cannot be a pristine wildlife preserve as well. The Sports Complex site, however, can bring hundreds of thousands of people each year into a closer association with nature and can provide a valuable facility in which important environmental information can be conveyed in an easily assimilated and stimulating manner. The recommendations outlined above seek to satisfy the legislative mandate to maintain and protect the environment of the Meadowlands in a way that will be compatible with the further mandate to develop a major new facility for the enjoyment of the public. Should the Authority accept and implement any of these construction alternatives, it also would be appropriate to institute operational methods that will provide continuing respect and care for the amenities thus established.

The water quality studies indicate another potential source of problems during the operational life of the Sports Complex. Should the drainage lagoons be developed for aesthetic amenities and as wildlife habitats,

there doubtless will be periods of drought during which water levels cannot be maintained by runoff within the diked site. If water of the quality that now exists in Berrys Creek were pumped into the lagoons to maintain their levels, nutrient enrichment would be rapid and eutrophic conditions could be expected to develop. It may be necessary, therefore, to provide a small treatment facility to remove nutrients from water drawn from Berrys Creek, the Hackensack River, or any tributaries.

Potable water is in short supply in the intensively developed metropolitan area of northeastern New Jersey. Particularly during periods of drought, it would be desirable to utilize water from Berrys Creek or the Hackensack River to irrigate extensive lawns, the turf racing track, and widespread landscape plantings. Because local surface waters are heavily contaminated with bacteria, and probably with viruses as well, it will be necessary to treat any water drawn from them for irrigation or lagoon stabilization.

Details of the Proposed Plan

Football Stadium

The stadium will accommodate 75,000 or more spectators for football games or other appropriate events. The New York Football Giants team is expected to play its home games in this facility.

The following outline description was excerpted from preliminary specifications written by the coordinating architects, engineers, and planners (Ewing Cole Erdman & Eubank/Clauss & Nolan, 1972; Kivett and Meyers and Ewing Cole Cole Erdman & Eubank, 1971):

There will be a minimum of 75,000 spectator seats arranged in three levels (Field Level, Club Level, and Upper Level). Each level will be served by concession stands, vendors' commissaries, restrooms, and first-aid facilities. Food service also will be provided in a stadium club, a public cafeteria, private club rooms that may be developed by leases, and a Press Club. In addition to pedestrian ramps to and from all concourse levels, there also will be eight escalators and four elevators. A public address system will serve the entire stadium.

Press facilities at the Club Level will provide stations for approximately 200 writers, with auxiliary seating for approximately 120 writers at the Field Level. There also will be TV and radio broadcasting booths, TV camera platforms, spaces for home and visiting coaches, space for photographers, scoreboard operator's booth, public address announcer's booth, teletype room, statistician and document reproduction room, player interview room, storage rooms, mechanical and electrical equipment rooms, and two photographic darkrooms.

Administrative space for the New York Football Giants, Inc., will include a reception area, general offices, executive office, ticket office, counting rooms, a vault, meeting rooms, coaching staff rooms, switchboard room, and space for equipment and storage.

Team facilities will be located at the level of the playing field. The New York Giants' area will include a locker room and related facilities for 60 players, a trainer, a doctor, head coach, assistant coaches, and manager. Each of two visiting team locker rooms will have facilities for 45 players and their coaches. There also will be a locker room for 15 game officials.

Stadium service facilities will include concession storage space, concession locker rooms, locker rooms for stadium personnel, a maintenance office, shop, and locker room, a field maintenance office and storage area, general storage space, mechanical equipment space, a TV van parking area, and a trash compactor.

No final decision has been made, but the playing field either will be a natural or synthetic turf. The field and all exposed areas of the stadium will be drained into the storm-water system. Toilets, concessions, and all other enclosed facilities will be drained into the sanitary sewer system.

The foundation of the stadium will be supported on steel piles driven to bedrock. The stadium will be constructed of rolled structural steel, precast, pre-stressed concrete, and other suitable materials.

[This description of the proposed football stadium was written by Jack McCormick & Associates. It is drawn from the preliminary specifications cited in the second paragraph of the description and is not intended to be, nor should it be interpreted as, complete and inclusive.]

Racing Facility

The racing facility has been designed for thoroughbred and harness racing. The grandstand will have seats for 6,750 persons and an outdoor ramp for standees. Anticipated large crowds will number approximately 25,220 persons.

Specifications for the physical components of the racing facility are presented in a document by Ewing Cole Erdman & Eubank/Clauss & Nolan (1972). The following is a descriptive summary considered to be sufficient for the purposes of the present assessment of the impact of the facilities on the environment of the proposed site:

1. 1-mile oval track of compacted limestone for harness racing with an overlay of sandy loam for thoroughbred racing;
2. 7/8-mile oval track of turf for thoroughbred racing, which will be nested within the 1-mile track;
3. 5/8-mile oval track of compacted limestone for training;
4. Six-level grandstand, which will be electrically heated and air-conditioned, equipped with passenger elevators, freight elevators, and six escalator units, with an outdoor ramp for standees, and a trackside thoroughbred paddock. The grandstand will have a steel frame, concrete floor slabs, a glass track-side wall, insulated metal-panel walls on three sides, and a shed roof of insulated corrugated steel. The building will include several restrooms, concessions, a cafeteria, a kitchen to serve the clubhouse, a kitchen and bar to serve the super box level, and a kitchen to

serve a Board Room. The paddock stalls will have earth floors and will be drained into the sanitary sewer system;

5. One-story harness paddock building with a floor of compacted earth, a steel frame, concrete walls, and an insulated steel deck roof. Stalls for 80 horses in this building will have concrete slab floors which drain into the sanitary sewer system;

6. One-story administration and cafeteria building with a concrete slab floor on grade, steel frame, concrete walls, and an insulated metal deck roof. The cafeteria section will include a kitchen, food storage area, and diswashing room. The building also will house a barber shop and will be provided with rest rooms;

7. Six two-story dormitory buildings (not air conditioned) with concrete slab first floors on grade, concrete walls, and cellular concrete plank roofing. The dormitories will accomodate a maximum of 672 persons, and each building will be equipped with toilet and shower facilities;

8. Fourteen one-story horse barns to accomodate a total of 1540 horses. These buildings will have compacted earth floors. The walls and roof will be of a suitable material. Urine, wash water, and other liquids released within the barns will be drained into the sanitary sewer system;

9. Twenty-two manure storage bins (2,000 cubic feet each) with crushed stone floors, concrete walls, and no roofs. These bins will be drained into the sanitary sewer system;

10. Three horse unloading ramps with compacted earth floors, concrete walls, and no roofs. The ramps will be drained into the storm drainage system;
11. Two blacksmith shops with concrete slab-on-grade floors, concrete walls, and insulated concrete deck roofs. Eight blacksmiths will be employed. The type of forge to be used has not been determined;
12. Feed storage building constructed from materials similar to those used in blacksmith shops;
13. Two security station structures constructed from materials similar to those used in blacksmith shops;
14. Track appurtenances, including infield tote board, track rail, TV tower, and judges tower.

Proposed Site Work

During the period of construction of the stadium and grandstand, work will proceed concurrently on the installation of a perimeter dike to the east of Berrys Creek. Until this dike is completed, an existing dike will be maintained to assure the containment of sediments and debris from excavations.

The new perimeter dike, which will be impermeable to water, will afford an even greater degree of control over sediments and debris generated on the site west of Route 20. If a tide gate that is specified for insertion through this dike adjacent to the racing facility is bolted shut during the construction period, all water from the site can be directed to sediment basins, raised by pumps through a series of screens or filters, passed over the dike, and discharged through aerating nozzles into one or more channels in the tidal marsh, or if that is determined to be environmentally unsuitable, into the main channel of Berrys Creek. Water from the southeastern part of the west section of the site (Pump Station 1) is to be discharged through a 96-inch force main (jacked under the New Jersey Turnpike and a gas pipeline) to the Hackensack River after screening and aeration. The force main will be equippped with a tide gate at the Hackensack River.

The project site is entirely within dikes and the positions of all materials to be excavated are near or below sea-level. Owing to these conditions, the water-related impacts of all site-preparation activities can be contained and focused at the pump-discharge points. In the following environmental impact assessments, therefore, individual activities described in specifications by Ewing Cole Erdman & Eubank/Clauss & Nolan (n.d.) are

combined into general categories. [Details of site preparation plans are shown on the various sheets listed in the "Documents Examined" section of this report under Site Plan (1972).] This analysis presumes that a tide gate planned for insertion in the proposed perimeter dike will not be constructed or will be bolted shut throughout the entire period of site preparation. It further presumes that all water and debris from the construction site will be collected in sediment ponds. Before discharge to natural streams, the water will be screened and aerated. If oil spills from operating equipment, stored fuel, or trash landfills are predicted, suitable skimming devices or separators must be installed between the sediment ponds and the discharge points.

Pest Control

Initial Pre-construction Clean-up

Norway rats and house mice are present on the site, particularly in areas with trash fills. To avoid mass movement of these animals to developed areas adjacent to the site as their habitats are disturbed and removed, an intensive eradication program will be instituted. The methods to be used have not been determined, but the Authority will require the exterminating contractor to employ mechanical methods insofar as practical, to refrain from the use of persistent poisons, and to utilize measures that will protect human beings, native mammals, waterfowl, wading birds, songbirds, fish, amphibians, and other wildlife from unnecessary exposure to toxic materials. All State, Federal, and local laws, regulations, and ordinances, relating to the use of pesticides or traps will be followed.

Pre-construction Termite Treatment

The potential for termite problems on the proposed site is considered to be minimal. Where it is deemed necessary, however, preventative measures will be taken to protect structures against termite damage. The Authority will require any contractor to use mechanical methods insofar as possible, to refrain from the use of persistent pesticides, and to exercise all reasonable care to protect human beings, native mammals, waterfowl, wading birds, songbirds, fish, amphibians, and other wildlife. All State, Federal, and local laws, regulations, and ordinances relating to the use of pesticides will be followed.

Maintenance Pest Control Operations

During the operation of the facilities in the Sports Complex, litter, refuse, and garbage will be policed regularly, deposited in rodent- and insect-proof containers, and removed from the site each day. Containers for rubbish will be placed in convenient locations throughout the Complex site.

In addition to good housekeeping, and only if it is proven necessary by experience, programs will be established to control the populations of Norway rats and other pest species. It probably will be necessary to institute a program for roach control. The methods to be used have not been determined, but the Authority will require the extermination contractor to employ mechanical methods insofar as practical, to refrain from the use of persistent poisons, and to utilize measures that will protect human beings, native mammals, waterfowl, wading birds, songbirds,

fish, amphibians, and other wildlife from unnecessary exposure to toxic materials. All State, Federal, and local laws, regulations, and ordinances relating to the use of pesticides or traps will be followed.

Temporary Pumping

As soon as the stadium-grandstand site is enclosed by a cofferdam, dewatering equipment will be used to keep the area suitably dry until a perimeter dike is erected and permanent pumping facilities are constructed and operational. All water from within the cofferdammed area will be discharged to a settling basin before it is allowed to flow through the tide gate into channels in the Berrys Creek Tidal Marsh. Any water pumped from the site will be discharged through an aerating nozzle into a marsh channel or, should that prove to be undesirable, directly to the main channel of Berrys Creek. (Specifications for the cofferdam are given in Division 2 of Ewing Cole Erdman & Eubank [n.d.].)

Clearing and Demolition Work

Vegetation on the proposed site consists almost entirely of the common reed grass *(Phragmites communis = P. australis)*. This plant material and any unsaleable debris resulting from the demolition of buildings or other structures to be removed will be deposited in a basin to be constructed on the east section of the site. No vegetation, rubbish, or other materials will be burned on the building site or in the disposal area, and no vegetation, rubbish, or other solid material will be allowed to enter streams.

The Contractor will arrange for proper and complete disconnection and termination of all water, sewer, gas, electrical, and telephone facilities serving any building or structure to be removed. All work will be in conformance with requirements of municipalities and utility companies owning or controlling such facilities.

Unclassified and Classified Excavation on the Site

All meadow mat, peat, muck, mud, rocks, soil, solid wastes, and other material designated for removal will be excavated by the Contractor in a safe and prudent way to avoid damage to private property or utilities and to minimize the introduction of any sediments and pollutants into waterways adjacent to the site.

Suitable materials from excavations will be used as fill on the construction site, to form dikes, berms, or other embankments, or will be stockpiled at a place within the diked area to be designated by the Engineer. Unsuitable materials will be deposited in a diked basin to be constructed on the east site between New Jersey Highway 20 and the New Jersey Turnpike north of exit 16W.

Construction of Perimeter Dike

The perimeter dike will have a top elevation of + 10 feet amsl and will be constructed of suitable fill material imported to the site. An impervious cutoff wall within the dike, formed of bentonite, will

extend from a trench in the clay layer to the crest of the dike. The dike will be penetrated at a point opposite the racing facility by one 84-inch (outside diameter) storm drain equipped with an automatic steel tide gate. An environmental assessment of the off-site borrowing operation is presented separately (page 76). The environmental impact of the proposed dike is included in the Assessment of the master plan (page 36).

The preliminary specifications (Ewing and others, n.d.) require the installation of a durable rock rip-rap for erosion control around pumping station outfalls, lagoons, and on the outside face of the perimeter dike. A filter blanket, consisting of a porous sheet woven of polypropylene monofilament yarn, is to be installed on finished slopes before the rip-rap is placed.

Owing to the decision of the Authority to preserve a large proportion of the Berrys Creek Tidal Marsh, planning efforts will consider designs which will maximize compatible use of the outer banks of the dike for muskrat burrows. Comments directed to suitable design provisions will be appreciated.

Borrow Fill

Fill materials will be secured from an off-site upland or hydraulic source to supplement suitable materials acquired on the project site. The materials will be used to establish design grades in areas of dikes, embankments, and level elevated sites shown on

the preliminary site plans. (The environmental assessment of borrowing activities is presented separately).

Impervious Fill

Clay excavated within the project site will be employed as impervious fill. The material will be used to form the tops of dikes, embankments, and other raised areas.

Cofferdam for Stadium and Grandstand

The proposed location of the cofferdam is shown on the preliminary site master plan (Map 11) and in greater detail on Drawings S/SK-115 and 116 (Site Plans, 1972). Material will be excavated from the site of proposed Lagoon #3 to construct this cofferdam. (The Lagoon is shown on Map 11; its site is labeled "Sportland Fill" on Figure IV-1.) This area is not enclosed by the existing dike, although it is filled to an average elevation of 10 feet amsl. Care will be exercised during excavation to assure that a sufficiently wide embankment is left between Berrys Creek and the borrow pit to prevent the erosion or breaching of the residual berm. No spoil will be placed in the area between the borrow pit and Berrys Creek. No operation will be permitted to enroach on the Berrys Creek Tidal marshland or to generate sediments or flows of water that will enter the tidal area without first draining into sediment basins enclosed by the existing dike parallel to Berrys Creek.

Pavements

Paved parking areas associated with the footbal stadium, racing facility, and future facilities proposed on sites west of Route 20 will be situated at elevations of -3 and +4 feet msl. They will drain to lagoons, from which the water will be pumped to Berrys Creek or to the Hackensack River. The surfaces will be formed of asphalt slurry or hot bituminous binder.

Because the parking areas will be installed on varying thickness of ballast or granular fill above the varved clay stratum, the surface of which is below sea level, infiltration is not considered to be possible. The natural subsoil is impermeable and the hydraulic pressure gradient will be reversed. The major environmental concerns will be directed to: (1) the quality of run-off from the paved areas, (2) treatment necessary to assure water discharged to natural streams will meet or exceed all pertinent regional, state, and federal standards, and (3) the timing of discharges from the site in relation to peak flood flows and storm high tides in Berrys Creek and the Hackensack River. These are assessed separately.

Pump Stations

Three pump stations will have reinforced concrete or steel frames, reinforced concrete walls, and will be founded upon concrete-capped steel piles. They will be designed so as to present a satisfactory external appearance.

Pump station number 1 will have six vertical mixed low pumps. Two of these will have a capacity of 45,000 GPM each at 440 RPM. The remaining four will have a capacity of 27,000 GPM each at 705 RPM. The pumps will be capable of operation in parallel, and together will have a total dynamic head of 30 ft. Pump materials will be suitable for handling dirty sea water. The pumps will be capable of actuation by automatic float valves located in the sumps from which the pumps draw water. The pumps will be powered by electric motors. Discharge pipes will be 30 and 48 inches in diameter. Valves will be made of materials resistant to sea water corrosion. A standby diesel 900 kW generator will be installed with the pumps.

The pump station also will have 4-inch spaced, rectangular bar trash racks to prevent the entrance of troublesome solids into the pumps. The racks will be designed to withstand seawater corrosion and will be equipped with motor-operated raking combs. Waste water sump pumps, stop logs, and a 10 ton traveling bridge crane will be provided.

Pump station number 2 will have two Archimedes Endless Screw pumps. Each pump will have a capacity of 11,250 GPM, a diameter of 72 inches, a lift of 17 feet, and will turn at 45 RPM. The pumps will be driven by electric motors. The pumps will be capable of actuation by automatic float

valves located in the sumps from which the pumps draw water. Heating and ventilating equipment will be installed in the pump station.

Ten-inch spaced, rectangular bar trash racks will be installed to prevent the entrance of troublesome solids into the pumps. The bars will be designed to withstand seawater corrosion and will be equipped with cleaning mechanisms. Stop logs, screw pump troughs and cover gratings, and a 5-ton traveling bridge crane will be provided.

The pump screw operates in an open trough and will be covered with sturdy gratings to prevent people, vehicles, etc., from entering the pumping area and suffering injury or harm. Suitable handrails or barriers will separate the pumping trough and service stairs. The pumps will be designed so that the screws will not operate accidentally.

Pump station number 3 will be designed similarly to station number 2, with the exceptions listed below. The station will have two Archimedes Endless Screw Pumps, each with a capacity of 45,000 GPM, a diameter of 120 inches, a lift of 26 feet, and an RPM rating of 21.5. It will have one Endless Screw Pump with a capacity of 22,500 GPM, a diameter of 84 inches, a lift of 26 feet, and an RPM rating of 30.8.

Electricity will be supplied to the pump buildings by a 5 kv feeder line. Motors at Stations 1 and 3 will utilize 4160 V power. All other motors and apparatus will be supplied at 480 V from an air-cooled stepdown transformer. A smaller transformer will supply lighting and other equipment.

Electrical Facilties

A 26.4 kV pole line which runs through the site from East Union Avenue to Route 20 will be removed by the Public Service Electric and Gas Company. Removal operations will be conducted so as to minimize damage to Berrys Creek Tidal Marsh. Temporary electrical service to construction facilities on site will be provided by this pole line.

Two new underground lines will bring power to the site. One 26.4 kv line will run from East Union Avenue to the east side of Berrys Creek. Further study will be given to routing for this line so that damage to the tidal marsh will be minimized. A second 26.4 kv line will run from the Paterson Plank Road service line to the substation.

A primary substation will receive power from the two feeder lines. The substation will be constructed near the east bank of Berrys Creek at the termination of the East Union Avenue 26 kv service line. (Revision of the preliminary plan to preserve the Berrys Creek Tidal Marsh will require relocation of the proposed site for this substation.)

The substation will contain all facilities for transforming, relaying, and metering power to be distributed throughout the site. Equipment will be provided to allow complete automatic sectionalizing of the two 26.4 kv lines. Transformers will step voltage down from 26.4 to 4.16 kv.

Switchgear will be provided to transfer power automatically between two main breakers and a tie breaker in the event of failure of one of the power lines or transformers. The station will be grounded in bare earth at a depth not less than 12 inches.

Subsurface lines will connect the primary substation and the various 4.16 kv substations throughout the site. Duct banks and manholes will be provided along the subsurface lines.

Roadway lights will be single 400 Watt Metal Halide lights on 30 foot poles. Parking lot lights will be single 1000 Watt Metal Halide lights on 60 foot masts.

Telephone connections

The New Jersey Bell Telephone Company will install a subsurface duct bank and manhole system from Union Avenue through the site to existing facilities on the east side of the Sports Complex. Additional study will be devoted to alignment of this facility to minimize damage to the Berrys Creek Tidal Marsh.

Sanitary Work

The existing sewerage system will be raised or lowered to design elevations, and a new sewerage system will be installed to service the stadium, race track grandstand, paddock dormitories, security buildings, administrative offices, and cafeteria building. The system will employ gravity flow. Trenches for the system will be constructed with borrowed material whenever unsuitable material is encountered during construction. Tests for exfiltration and infiltration will be made. Materials, construction, and performance will conform to standards set forth by the New Jersey Department of Transportation, New Jersey Department of Health, East Rutherford Sewer Authority, New Jersey Department of Labor and Industry,

United States Army, Corps of Engineers, and the New Jersey Department of Environmental Protection and will conform with any standards established by the Hackensack Meadowlands Development Commission.

Water Supply

A water main will be constructed across the site from East Union Avenue to Route 20 by the Hackensack Water Company. Unsuitable material encountered during construction will be replaced with borrowed material. Work will follow standards set forth by the New Jersey Department of Transportation and the Hackensack Water Company. Additional study will be devoted to the alignment of this main to minimize damage to the Berrys Creek Tidal Marsh.

A fire water supply system will be constructed to provide water from the meter pits to the football stadium, racetrack grandstand, and hydrants at various locations throughout the site. Unsuitable material encountered during construction will be replaced with borrowed material. Work and materials will be performed and supplied in accordance with standards set forth by the American Water Works Association, American Society for Testing and Materials, the Cast Iron Pipe Research Association, and the Fire Underwriters.

Landscaping

Plans for landscaping of the Sports Complex are described as follows in the specifications prepared by Ewing Cole Erdman & Eubank/Clauss & Nolan (n.d., Division 8):

Soil Surface Treatment

a. Granular fills, used to shape mounds and slopes will be surface mixed with clay and organic material from the Site, to improve its capability of supporting plant life.

b. A topsoil mixture will be used for surface backfill around shade trees. Topsoil will be brought into all planting areas at a minimum 4" depth.

Slope Stabilization

Slope boards will be staked upon slopes greater than 3 to 1 to preclude erosion prior to stability provided by plant cover.

Ground Cover

Grass and/or crown vetch will be hydroseeded and mulched onto all slopes, berms and dikes to hold soil in place.

Shrubs

Shrubs will be used as definition and accents along the pedestrian malls and in a single row along the West Loop Road. Shrubs are to be planted at four (4) foot centers with bare root.

Ornamental Trees

Ornamental trees will be selected for special effects and variety accents at particular places along the pedestrian malls, grandstand and stadium entries. They will be balled and burlapped. Ornamental trees will be staked, their trunks wrapped, pruned and mulched.

Evergreen Trees

Three (3) year Japanese Black Pine trees will be planted at 8-foot centers in three (3) rows on the central berms along the pedestrian malls and crosswalks. Only two (2) rows of pines will be used inside the perimeter West Loop Road. Pines will be balled and burlapped.

Shade Trees

Shade trees will be planted in 4' x 6' openings along the walkways at 30-foot centers. They will be 2-1/2 inches caliper and their lowest branch 6 foot high. Trees will be balled. A three (3) row bosquet will be planted around the stadium. Shade trees will be staked, their trunks wrapped, pruned and mulched.

Large Trees

Large specimens will be planted adjacent to the grandstand and stadium. They will require winter moving with frozen earth balls. A top-soil planting mixture will be used for backfill.

Planting Maintenance

The contractor will be required to maintain planting for a season until final acceptance. He shall water, weed, fertilize and remove trash along and within landscaped areas until final acceptance. All dead plants will be replaced before final inspection and acceptance.

Landscape Hardware

a. Trash receptacles, benches and directional signs will be located on the plaza around the stadium and along the pedestrian malls. Benches are to be 6' long wood slats on concrete bases. Signs are to be metal post and plate material.

b. Kiosks will provide rental display surfaces on the plaza and at intersections of walks; kiosks will be 3 feet in diameter and 8 feet tall.

c. A flag pole will be located at the front ceremonial entrance.

d. Special signs will be located at each of the main entrances to the Site for identification and direction.

On Site Plan S/SK-132 (Landscape Master Plan), areas to be landscaped are designated by shading. Most of these areas are linear strips along roads and dividing strips between the 200 to 250 acres of parking lots, and average about 30 feet in width (from 10 feet to 50 feet in different sections). The approximate total length is 36,900 feet, so the combined area would be about 26 acres. Around the stadium the three row bosquet of shade trees is shown to be from 20 to 60 feet in width, with an average width of about 50 feet, and a total length of 4,080 feet (4.8 acres). A note on this plan states that the "slope inside Berrys Creek Dike and the race track dike "also are to be landscaped." Site Plan S/SK-133 (Landscape Details; Map 13) presents renderings of cross-sections and plan views of typical planting plans.

The following is a rough calculation of the number of shrubs and trees to be planted along roads, in parking areas, and around the stadium:

Shrubs (kind not specified):

West Loop Road (13,860 feet)		3465
As accents on malls (25,200 feet)		250
	Total	3715

Shade trees (kind not specified):

Along walkways (25,200 feet)		800
Stadium bosquet (4,080 feet)		400
	Total	1200

Japanese black pines:

Malls and crosswalks (25,200 feet)		9450
West Loop Road (13,860 feet)		1730
	Total	11,180

Large trees (not shown on plan)

Support Requirements

Electric Energy

(Bolt Beranek and Newman, Inc.)

Current plans specify that all heating, cooling, and cooking on the Complex site will utilize electricity. From records of consumption and demand experience in similar facilities, the following electrical characteristics were estimated for the Sports Complex:

Activity	Peak Demand (mW) Winter	Summer	Energy Use (Millions of kWh/yr.)
Football/Racetrack	12	7	25
Hotel*	8	8	30
Theme Park/Arena*	5	3	10
Baseball stadium*	2	3	10
TOTAL	27	21	75

*Very rough estimates

The current installed capacity of the Public Service Electric and Gas Company, the utility which serves the Complex site, is 8,000 megawatts. The demand expected in the summer of 1972 is 6,000 megawatts. The electrical needs of the Sports Complex, therefore, could be met this year.

The Public Service Company anticipates a load growth of 10% per year. Its current reserve of 2,000 mW, therefore, will be usurped by 1975. To service the Sports Complex and, concurrently, to retain capacity sufficient for required reserves and scheduled outages, the utility will require access

to generating capacity not now active or it could purchase electricity through interconnections with other utilities in the Pennsylvania-New Jersey-Maryland region. The company envisions, however, that turbine plants soon will be added to its generating capacity and that it will have 400 mW available by 1975 from the Salem Nuclear Generating Station. These additions would meet the electrical needs of the Complex.

The Public Service Company apparently will be able to meet the needs of the Sports Complex. The required reserve to satisfy a new 21 mW summertime demand, however, will reduce the ability of the Company to respond to power sharing with interconnected utilities (such as Consolidated Edison of New York). Although this diminution in reserve is relatively small, it deserves to be recognized.

The relatively high energy consumption predicted for the Complex is a consequence of a preliminary decision to use electricity for all heating and air conditioning (HAC), hot water, and cooking needs. The presumed economy of this approach reflects an assumed low load factor on the HAC system when only the racing activity is considered. Inclusion of the baseball and football stadiums, the indoor arena, the hotel, and the theme park activities, however, adds substantially to the diversity and the balance of the load.

The economic analysis employed in the decision to utilize all-electric power will be reviewed. Environmental factors, including the growing national need for energy conservation and system optimization, also will be considered to re-evaluate the advisability of using fossil-fueled steam and air conditioning systems. The use of Public Service Electric and Gas Company turbines in a total energy system also will be reviewed.

Potable Water Supply

(Bolt Beranek and Newman, Inc.)

Estimates of the peak demand and the annual use of water by the Sports Complex were derived from varied experiences in similar facilities. Unit consumption rates (gallons per person per event) were calculated for those facilities, averaged, and multiplied by anticipated attendance figures.

Event	Av. Consumption on event day (MGal)	Day/year	MGal/year
Football Game (pro)	0.40	10	4
Baseball Game	0.21	80	17
Football Game (college)	0.21	10	2
Track - racing day	0.18	160	29
Track - non-racing day	0.10	200	20
Hockey Game	0.06	40	2
Basketball Game	0.06	40	2
Misc. Arena Events	0.06	10	1
Theme Park	0.03	200	6
Facility Operation	0.10	365	37
Hotel	0.44	365	161
		Total:	281

The average daily water use will be approximately 0.8 million gallons, but a peak daily water use of about 1.07 million gallons is expected on the days of professional football games (total of professional football, track--non-racing day, theme park, facility operation, and hotel usages). The short-term peak demands probably will occur during the half-times of professional football games and should exceed 5,000 gallons per minute (gpm).

The proposed site for the Sports Complex is located in the service area of the Hackensack Water Company. Based on the installation of a 20- or 24-inch main to the Complex, the utility has reported that no new water supply development or water purchases will be required to supply the needs of the facilities. Because the average flow in the Hackensack Water Company exceeds 90 million gallons per day (gpd), it is probable that the water needs of the Complex can be met without disturbing or depleting the quality or reliability of service in the area.

Sewage

(Bolt Beranek & Newman, Inc.)

On the basis of the water usage projected for the Sports Complex, a sanitary sewage flow of approximately 0.8 million gallons per day (mgd), with peaks of more than 1 mgd, is estimated. This flow will pass through gravity lines to an existing collector which extends from a point approximately 2,300 feet west of Route 20 northward approximately 4,800 feet to an existing pumping station near Paterson Plank Road. The sewage then would be pumped to the Bergen County Sewer Authority (BCSA) treatment plant at Little Ferry.

The design capacity of the BCSA plant is 50 mgd, and it currently is operating at capacity. Although planning now is underway for an expansion to 62.5 mgd, the facility is reported to be fourteenth in State-wide priorities. It is unlikely, therefore, that the expansion will be initiated in less than two years, and possibly not until later. At the design capacity of 80% BOD removal, effluent from an average flow of 0.77 mgd from the full Complex is

expected to add 320 lb/day BOD to the Hackensack River. Should the plant be operating above capacity, the treatment is likely to be less effective and the BOD discharge correspondingly greater.

The Authority should seek to expedite the expansion of the Bergen County Sewer Authority treatment plant at Little Ferry, New Jersey. If the plant expansion is not completed by 1 January 1975, the earliest possible date, the Sports Authority should postpone completion of the proposed hotel, arena, theme park, and baseball facility until an expanded plant is available. Although football games may be played only on about seven days of each year, the peak flows at such times might seriously overload treatment facilities. To avoid such overloads, an equalizing tank might be installed on the site if State or Federal agencies with jurisdiction determine that such a tank is necessary or desirable.

Storm Water

The area within the perimeter dike west of Route 20 will include about 580 acres. The normal annual precipitation in the vicinity (Newark AP) is approximately 42 inches. The total volume of water that is expected to occur on the site, therefore, is 646.3 million gallons per year, or an average of 1.77 mgd.

Part of the storm water will evaporate, but at least 85% is expected to run off into the storm drainage system (1.51 mgd). This system currently is designed to terminate in three lagoon sumps from which the water will be pumped to Berrys Creek and the Hackensack River. The runoff from the track and stable area may be heavily enriched by manure and urine from horses. That from parking areas will contain toxic petroleum products, rubber particles, food scraps, and possibly lead and other heavy metals.

To avoid contaminating the local streams and to establish a model for other occupants of the meadowlands region, the Authority may wish to elect one of the following alternatives. At minimum, each lagoon could be enlarged and divided into a receiving basin and a polishing pond. On a somewhat larger scale, the three proposed lagoons could be joined in series, with one acting as a receiving basin and the other two as polishing ponds. A still more effective method would utilize treatment facilities through which the water would pass before it is flushed to the streams.

The parking areas that will be constructed at or below sea level might also be considered for the storage of excessive runoff during periods of unusually heavy rainfall. Each acre of such lots could hold slightly more than 0.32 million gallons of water if it were covered only to the depth of 1 foot. The water could be pumped out after the flood crest has passed the site and at a period of low tide.

Solid Wastes

(Bolt Beranek & Newman, Inc.)

Solid wastes will be generated within the Sports Complex site by several types of activities in the following estimated annual amounts:

Source	Quantity (Tons/Yr.)	%	Probable Disposition
Sporting Events	1,125	7.8	HMDC Landfill (recycle?)
Offices/Residences	650	4.5	HMDC Landfill
Theme Park	750	5.2	HMDC Landfill (recycle?)
Hotel	1,850	12.9	HMDC Landfill
Horse Stables	10,000	69.6	C & C Composting Company
Total:	14,375	100.0	

[Sources of these estimates are described in Section X of the appended Inventory.]

Nearly 70% of the 14,375 tons of solid waste expected each year will be composed of manure and bedding straw from the stables. All of this material will be collected and removed from the site for use as a commercial mushroom culture media (detailed in Section X of the appended Inventory). Most of the remaining 30% (4,375 tons/year), however, will be a variable mixture that probably will have to be deposited in one of the regulated landfills in the Hackensack Meadowlands District (Map 7). If landfills under the authority of the Hackensack Meadowlands Development Commission are utilized, environmental performance standards applicable to their operation should minimize any adverse environmental impact.

Some unknown proportion of the total represents wastes that usually are deposited at the visitors' homes. It is even possible that less persistent trash will be generated by the attendees at the Sports Complex than would have been produced had they remained at home. Fewer cans may be opened for meals; less garbage is produced by mass-served foods; and the uniformity of service makes recycling more feasible.

The composition of the wastes generated at sporting events and amusement parks is highly variable, and, to a large extent, reflects the methodology selected by the Concessionnaire in the food services activity. The quantity of waste may be reduced by the use of paper containers for beverages instead of glass bottles or cans. If cans or bottles are used, however, they should be recyclable or returnable. Returnables may be particularly desirable if vendors retain the bottles and serve the drinks in paper cups. These alternatives might be evaluated more completely and, if appropriate, the requirement for the use of one or more of them could be made a part of the contract with the food service concessionnaires.

The use of plastic should be minimized in favor of paper or other biodegradable food service materials. This will ease compaction both on-site and in a landfill disposal system and will promote rapid decomposition in landfills. In the future event that wastes are to be incinerated, the use of chlorinated polymeric materials (e.g. PVC) should be minimized or eliminated to reduce the generation of hydrochloric acid.

In all areas of the Sports Complex, good "house cleaning" should be practiced to prohibit the attraction of rats, sea gulls, roaches, and other scavenging pests. Visitors should be educated and encouraged to place wastes in conveniently located and abundant receptacles. These receptacles should be rodent proof, covered, and emptied frequently. Collected wastes should be removed from the site after each event or, at facilities in daily use, at least once every 24 hours.

In collaboration with the Hackensack Meadowlands Development Commission, the New Jersey Department of Environmental Protection, and manufacturers' groups, the Authority might explore the possibility of establishing demonstration-scale or full-scale recycling plants on or near the site. These plants could be linked with the suggested environmental education center to provide both for waste recycling and public instruction.

Deposition of Unsuitable Materials

Information now available in regard to the geology of the site, in combination with the preliminary plans for the Sports Complex layout, indicate that approximately 3.4 million cubic yards of material unsuitable for foundations will be excavated from the area surrounded by Berrys Creek, the Patterson Plank Road, Route 20, and Route 3. The preliminary site plans indicate that this material will be deposited in a spoil basin between Route 20 and the western spur of the New Jersey Turnpike.

The spoil basin will be constructed by enclosing an area of approximately 59.07 acres with a dike to an elevation of + 20 feet amsl. The capacity of the proposed basin, however, would be about 1.9 million cubic yards. Allowing for compaction of the spoil of approximately 7 feet (0.90 million cubic yards) the capacity would be 2.8 million cubic yards. Part or all of the 0.6 million cubic yards of spoil not accounted for on the site is garbage and other wastes that will be transferred to a sanitary landfill.

Because much of the natural materials on the site are conifer forest peats, it is possible that they can be utilized as landscape dressings and soil conditioners. According to Dr. Edward MacNamara (personal communication), the fibrous content of the peat probably will not meet minimum Federal standards for sale as a commercial landscape material. This would not preclude the use of the material for landscaping on the Sports Complex, for intrastate sales, or for free distribution to interested citizens. Tests will be conducted to evaluate the suitability of this peat for horticultural use. Chemical

analyses also will be conducted to determine if any heavy metals or other toxic materials are present in the peat.

The major environmental impact of spoil deposition will result from the elimination of all or most of the Turnpike Tidal Marsh (30 acres). This marsh is known to be polluted by sewage and probably by industrial effluents. It is connected to the Hackensack River by a 4-foot culvert which appears to restrict tidal flushing. The marsh is surrounded by trash and mineral landfills, including the embankment for the western spur of the New Jersey Turnpike. These landfills, of course, were placed over other sections of marsh and have so isolated this small area that its viability and potential are judged to be minimal. Particularly if its loss is mitigated by the preservation and enhancement of the Berrys Creek Tidal Marsh, the destruction of the Turnpike Tidal Marsh, per se, should not jeopardize the ecological system of the Hackensack Meadowland region.

The proposed dike will minimize the release of sediments or materials from the spoil site. Definitive plans for the drainage of the site have not been formulated. The situation of a large volume of material that will include organic soils (muck, peat) and building debris, and which may be contaminated with heavy metals and other toxic substances, may result in the release directly to the Hackensack River of leachates with high BOD and COD and with an unknown concentration of toxic substances. At present, the organic soils are in their places of natural deposition, are at or below sea level, and thus, are immobile and not subjected to accelerated leaching or decomposition. Solid waste materials that have been placed on the west section of the site drain

into the diked marsh. The water in this area is shallow and probably has a long residence time. Leachates, therefore, are subject to prolonged biological activity and to alteration by physical actions at the extensive water-air interface. The relatively low elevation (generally + 10 feet or less) of the landfills creates less head for leaching rainwater and places a substantial proportion of the material beneath the water table where the head would be zero and circulation of water would be extremely slow.

A more thorough study of the potential leachate problems associated with the proposed spoil disposal method will be conducted. Final plans for the placement of unsuitable materials will include provisions to minimize the release of toxic substances or materials with high BOD or COD.

Volume and Source of Fill

The exact requirement for fill from sources external to the site cannot be established until information from additional borings is available and the design of the proposed Sports Complex is more nearly finalized. Data available now suggest that little suitable fill will be gained on-site and that approximately 2.3 million cubic yards will be required by the preliminary site plan. The necessary granular fill may be available from the maintenance dredging operations in the region, by dredging from the Hackensack River, or by dredging at some more remote site where materials of suitable quantity and quality are available. To minimize the environmental impact of the excavation of the required materials, the Sports Authority will seek the cooperation of the United States Army, Corps of Engineers, and will utilize spoils derived from normal maintenance dredging if possible.

Data used to calculate required volume of fill material

Design elevation	Required Thickness of Fill (feet)	Acreage Planned	Fill Required (cubic yards)*
-3.0	0	206.7	0
+4.0	1	112.0	216,832
+5.0	2	20.5	79,376
+6.0	3	215.9	1,253,945
+10.0	7	30.8	417,401
Perimeter dike	-	-	300,000
		Total	2,267,554

*Calculated by multiplying 1613.33 cubic yards (fill on 1 acre to a thickness of 1 foot) x feet of required thickness x acreage planned x 1.20 to allow for compaction.

Noise

(Bolt Beranek & Newman, Inc.)

One of the prime impacts on the community due to the Sports Complex will be the increase in the noise levels due to spectator automobile traffic before and after events. Table VIII-1 shows the most frequent serious case, a weekday baseball game with all spectators leaving within one hour of the 11:00 p.m. game finish and the less frequent but worse case, a night football game departure period. For evaluation purposes, the acoustic environment in a residence 200 feet from each highway listed is considered, and the traffic speed is assumed to be 60 mph.

An initial test for residence suitability relates to sleep interference. The maxium interior noise level for no sleep interference was established as 40 dBA. To this value, an assumed 15 dBA reduction in noise levels due to passage from outside through partly opened windows was added. This yields an outdoor criteria of 55 dBA at the residence. At 200 feet from the roadway, this is equated to a traffic flow of about 200 automobiles per hour (at 60 mph). Every location in the survey equals or exceeds this criterion. The entire local area, therefore, appears to be marginal with regard to sleep interference.

The Noise Assessment Guidelines of the Department of Housing and Urban Development (Schultz and McMahon, 1971) describe four levels of site acceptability based on noise: Clearly Acceptable (CA), Normally Acceptable (NA), Normally Unacceptable (NU), and Clearly Unacceptable (CU). The NA and NU categories also may be combined as "Discretionary." The HUD Guidelines recognize that individual annoyance with noise varies and define bands of noise level ranging from low values where many people would agree to a lesser category

of acceptability through a range where opinions would differ to an upper limit where again a decision as to category may be reached unanimously.

The four HUD categories are used in Table VIII-1 to assess the impact of spectator automobile traffic. For the assumed case, the traffic flow at the boundaries of the categories are:

CA to NA : 0 to 130 vehicles per hour (vph)

NA to NU : 130 to 1,200 vph

NU to CU : 1,200 to 50,000 vph

In no case is the change due to the increased traffic flow more than one catrgory (in fact, there is never more than an 8 dB increase in noise levels), and the levels are always in the "Discretionary" category, never reaching Clearly Unacceptable levels. At worst, the increase in local automobile traffic due to the Sports Complex will be moderate and will never cause clearly unacceptable living conditions in existing residential areas.

Public address systems will represent a major source of noise from the site. Predictions of the impact due to these systems is difficult owing to their variable sound output.

The peak output of a good public address speaker system produces a level of about 95 dBA at the most distant spectator. Because the nearest off-site residences are at 6,000 feet and there is some barrier effect due to the stadium structure, the levels at the residences would be about 63 dBA (assuming installation of a 10-foot-high sound barrier around the upper rim of the stadium). Evening traffic on Route 17 might be expected to result in

levels between 70 and 80 dBA at 100 feet. At 1,000 feet beyond Route 17, these levels might decrease to from 50 to 60 dBA. The speaker system peak levels will decrease to about 60 dBA. If a peak in public address system sound level were to coincide with a lull in traffic noise levels, the public address system might be identified, but it will be a problem of marginal importance to existing residences. If residences were built nearer to the stadium, however, the acoustic problems would be more significant.

Other noise problems to neighbors of the site probably will be slight in comparison to the roadway and stadium noise. The arena and racetrack grandstands, for example, are to be enclosed, and the Theme Park, while out-of-doors, is susceptible to noise control (as through the use of rubber tires on any ride vehicles).

The impact on wildlife due to noise at the site cannot be forecast precisely. Animals have not shown any observable reactions to the relatively low noise levels (below 90 dBA) that will occur at the site. Construction noise levels, especially any blasting, will be higher, but wild animals probably will avoid areas where construction is in progress.

Impact of Existing Noise Sources on Site

Teterboro Airport

Teterboro Airport is about 2 miles north of the site. It has no scheduled air traffic, but is used extensively by jet-powered business aircraft. The extension of the primary jet-use runway passes about 1,000 to 1,500 feet east of the

Sports Complex site. According to predictions of noise levels using Composite Noise Ratings (CNR) and HUD Guidelines, the eastern part of the site should be placed in a Normally Unacceptable category for normal residences. Because the hotel planned on the east site will have air conditioning and fixed windows, the noise intrusion will be much less than in normal dwellings. These characteristics will produce a change of one category to a Normally Acceptable rating. In the design of the hotel, attention should be given to the abatement of aircraft noise.

Newark Airport

Newark Airport is located about 8 miles southwest of the site. Air traffic is expected to rise substantially when a new terminal area is completed. The western portion of the site is close to a line projected from Runways 4-22 (dual). For IFR landings, in which the flight path closely follows the runway extension, aircraft will pass near to the site, and the western section of the site will be in the Normally Unacceptable category. In all other operations aircraft probably will turn between the airport and the site and will not pass as close to the site. The design of dormitories planned near Berrys Creek should incorporate noise abatement features.

Highway Traffic

Dormitories are proposed on a site near Berrys Creek. The controlling noise source for this location (other than aircraft noise) is truck traffic on the Paterson Plank Road. A dormitory planned for a site 1,500 feet from the road would be in the Normally Acceptable category. Another site, 800 feet

from the road, would be Normally Unacceptable. Both of these locations are within the HUD "Discretionary" category and, as such, would require adequate noise control features to be incorporated in the design of a residential building.

The controlling traffic noise source for the hotel site is truck traffic on Route 20. Noise from the New Jersey Turnpike, particularly post-toll station acceleration, also is important. The strict application of the HUD Guidelines evaluates the hotel site as a Normally Unacceptable location. Owing to the intention to air condition the building, the category can be raised to Normally Acceptable. This site is in HUD's "Discretionary" category and will require adequate noise control treatment in the building to provide a satisfactory interior noise environment.

Highway noise levels within the open stadiums, tracks, etc., will be well within desirable limits for sporting events. Normal crowd noise usually is much louder than highway noise. A well-designed public address system will be heard easily over highway noises. With possible brief (a few seconds) interruptions from aircraft over flights, the spectator environment should be fully acceptable. The use of stadium or other outdoor facilities for musical presentations or fine arts performances probably will not be acceptable and should be evaluated more carefully.

PROPERTY OF
NEW JERSEY STATE LIBRARY
186 W. STATE ST. PO BOX 520
TRENTON, NJ 08625-0520

Traffic

Reports by Wilbur Smith and Associates (1971, 1972), which are summarized in Section XI of the appended Inventory, were the source documents for all traffic impact analyses. Assumptions concerning travel modes, attendee points of origin, traffic volumes, and descriptions of local highway facilities are included in Section XI.

Large scale events which occur at times that would conflict with normal traffic will produce the most significant congestion. These are football games on autumn Sundays, thoroughbred racing on weekday afternoons, and baseball games on weekend afternoons.

Football Traffic

Traffic departing from football games on autumn Sundays between 4 and 5 p.m. will coincide with relatively heavy normal traffic flows. Approximately 18,000 cars and 400 buses will attempt to leave the site in one hour, and these volumes, even though distributed by direction to several facilities, will overload available capacities. For example, the projected peak hour departure volume north on the west branch of the New Jersey Turnpike is 5,900, or 500 more than the maximum capacity under optimum conditions (Figure XI-2). Other links also are overloaded, but to a lesser extent. Because the estimated capacities are for optimum conditions, either bad weather or accidents on the road could reduce capacities 10 to 20% and produce more strained conditions. These peak congestion periods occur so infrequently (only 10 per year) that major temporary operational modifications will produce a tolerable traffic situation.

Such modifications could include the conversion of several highways to one-way operation for short periods of time; the closure of certain access ramps to give preference to traffic departing the site; the completion of certain already-programmed highway improvements by 1975; and the construction of specific internal roadways and ramps for better connection to existing highways. To the extent to which more than 27% of the attendees can be induced to use special bus transportation or the Erie-Lackawanna Railroad, automobile congestion can be reduced. Further reductions could be achieved by inducing motorists to arrive early or remain on the site after a major sports event. Special prices might be offered in the Theme Park at these times, for example, or the exhibition center might provide a program related to the special interest of the patrons. Phased-release parking also could be used to distribute departure times.

Racing Traffic

Thoroughbred racing scheduled for January through March and in August will create a demand for attendee departures on weekdays between 4:30 and 6:30 p.m. (Figure XI-3). Although the number of departing cars (4-5,000) is only about one-third as many as predicted at football games, the departure time will coincide with evening peak commuter traffic. The racing traffic peak also will be daily and, therefore, will not be conducive to the special traffic operation modifications.

The coincident loading of the site demand on the normal peak demand in 1975 approaches estimated facility capacity under optimum conditions. This will mean daily delays and inconvenience for normal road users; in bad weather

or with accidents, longer delays can be expected. Reduction of congestion can best be obtained by more extensive use of public transportation with park and ride programs either by bus or by rail.

Baseball Traffic

Baseball games will occur approximately 80 times on weekday nights and weekend afternoons. Weekend afternoon games during August will cause the most serious problems when 15,000 cars and 200 buses attempt to reach the baseball game between 12:30 and 1:30 p.m. at the same time that 6,500 cars approach the horse racing event. This traffic could total 21,000 cars and 300 buses. These conditions are substantially worse than the 18,000 cars projected for football games, and it is unlikely that any improvement, other than substantial rail access, could be achieved. The potential traffic congestion could be reduced if these events were not scheduled simultaneously on weekends during August.

Another problem related to baseball traffic is the weekend departure time (4 to 5 p.m.). It is predicted that 15,000 cars and 200 buses would attempt to leave during this time (Figure XI-4). Although this volume is less than that predicted for football games, it still would cause substantial problems, particularly on the western spur of the New Jersey Turnpike where demand would be 600 cars over maximum capacity. The situation could be eased by diverting Turnpike traffic to the eastern spur where capacity is available. Other roads in the area would be close to maximum capacity, so that there would be inconvenience and minor delays under optimum weather conditions.

Indoor Sport Arena Traffic

If no arena event were scheduled during racing events or ball games, no significant traffic impact is expected to result from arena utilization. If the sports arena were used as those in other cities for music concerts, boxing, skating, and large shows or circuses, however, concurrent schedulings might occur frequently, and problems with entering and departing traffic would be expected.

Summary and Recommendations

The potential for substantial impacts on traffic flow through the region is represented by planned events at the Sports Complex. The impact of traffic from professional football games could be substantially eased by adopting recommended temporary operational modifications in cooperation with the New Jersey Turnpike Authority, the New Jersey State Department of Transportation, and County administrations.

Two methods appear to be practical to ease the potential impacts of all events. One of these would be to encourage a better spread of arrival and departure times by offering special inducements (preferred parking, special prices in site facilities, exhibits related to patrons' interests) or penalties (staged parking, with last-in, last-out regulations, higher parking rates for late arrivals). The other would be to stimulate the greatest possible use of mass-transit facilities, particularly the Erie-Lackawanna Railroad. This stimulation might include guaranteed minimums to the railroad for "sports trains," provision of attractive station facilities adjacent to the site with innovative people-movers to transfer riders into the Complex, special combined rates for mass-transit fares and admission fees, etc.

Air Quality

(Environmental Research & Technology, Inc.)

Functions associated with the operation of the Sports Complex which may contribute to air pollution levels include continuous activities, such as hotel and office heating requirements and intermittent heavy traffic drawn by scheduled activities, such as the football games, horse races, and arena events. The two principal sources of pollution, thus, are motor vehicle related or heating related. The five pollutants examined are: total suspended particulates (Tsp); sulfur dioxide (SO_2); carbon monoxide (CO); total hydrocarbons less methane (HC); and nitrogen oxides (NO_x).

In this analysis, air pollution impacts were examined at two scales: local, or microscale impacts, are concerned with concentration patterns over short time periods (typically 1 hour averages) and over short distances (typically 1 to 5 kilometers); macroscale or regional impacts are evaluated by the annual average contributions of the facility to ambient air quality over the entire Meadowlands region. The results of the microscale analysis will reflect peak conditions affecting users of the Complex, while the regional impact is important in regard to long-term exposures of the local human population, wildlife, and vegetation. Microscale impact analyses included an average condition and worst-case conditions.

Although preliminary plans for the Sports Complex envision electric heating, which would produce no on-site air emissions, in these analyses heating plants fueled with distillate oil are assigned to the hotel, arena, stadium, and race-track facilities. This represents an aspect of conservatism in the analyses.

For the motor vehicle related sources, the distribution of automobiles and buses (on the highway network and while idling in the parking lot) was considered for football, horse racing, and arena events. For calculation of one hour average concentrations, the conservative assumption was made that the parking lot at the facility would fill (or empty) of the number of automobiles estimated for each activity, during the one hour period. The average emission rates during the one-year period were calculated with the further assumption that one half of the designated number of vehicles were idling for the complete hour in the parking lot and one half of the vehicles were distributed on the road network in the vicinity of the Sports Complex.

The year 1990 was chosen for analysis because all facilities should be completed by that date, and sufficient information on the predicted surrounding background air quality in 1990 was available from a current (unpublished) ERT study of the Hackensack Meadowlands area.

Measurements of five pollutants from two to five air monitoring stations operated by the New Jersey Department of Environmental Protection were averaged to evaluate the current air quality of the Hackensack Meadowlands area. (Station locations are delineated on Figure XII-C2 in the Inventory.) By comparison of the measured annual average values with the pertinent State or Federal standards or their equivalents, it is evident that the standards currently are exceeded for all five pollutants:

	Measured	Standard	Unit
Particulates	113.3	70.1	$\mu g/m^3$
SO_2	0.043	0.02	ppm
CO	4.24	1.25	ppm
HC	2.09	0.24	ppm
NO_2	0.113	0.05	ppm

From the numerous possible combinations of facility operations, activity levels, seasons, days of week, and hours of day, the cases outlined in Table XII-C2 were selected for study. Among all the possible sporting event combinations that may occur, the one of greatest potential impact is summer racing and arena events on a weekend evening. In all analyses, a conservative approach was used. In the evaluations of the peak exit hour for winter racing, for example, weekend estimates of automobile traffic were used, but a background inventory for a weekday was assumed. This yields a slightly greater impact than if combinations of weekday traffic and weekday background or of weekend traffic and weekend background had been used.

Estimates of emissions from the localized sources related to the Sports Complex were superimposed on the region-wide 1990 background air quality concentration resulting from all sources in the Greater New York area and the specific sources of the Hackensack Meadowlands Master Plan II projections. Because the background concentrations were determined on an annual average basis, adjustments were made in each of the short-term analyses to reflect seasonal differences and other factors. The rationale of these adjustments is discussed in Section XII (Chapter C) of the appended Inventory. The MARTIK dispersion model that was used in the analyses also is described in Section XII (Subchapter C.3).

Assessment of Impact

Regional Scale

Because the Sports Complex will be used intensively only part of the year, and substantial vehicular emissions will be limited to a few hours on each day

of intensive use, the probable regional impact (average annual contribution) of the proposed Complex will be negligible. During occasional time periods of one hour to one day, there will be small, but measurable, increases (less than 10%) in average pollutant concentrations over the Meadowlands region as a result of operation of the Complex.

The unpublished ERT study indicates that the particulate standard will not be met by the Meadowlands region in 1990, even in the absence of the Sports Complex. The Sports Complex will have a relatively minor impact upon ambient atmosphere particulate concentrations, but we project the standard will be violated anyway, because of the large background contribution.

The hydrocarbon compound 3 hour standard also is predicted by the ERT study to be exceeded by a factor between 6 and 10 in the Hackensack Region, 1990. The HC standard is designed not directly to protect public health, but to limit the formation of photochemical smog in the atmosphere. The current standard now is exceeded by a factor of 10 or more in virtually every major urban area in the United States. Because the regional background concentration will exceed the current HC standard by such a large factor, the impact of additional HC emissions from vehicles operating in the vicinity of the Sports Complex will be relatively small overall. The expected HC concentration levels at the Complex will be similar to those found now in the vicinity of large volume parking areas in urbanized regions.

Although the applicable standards will not be exceeded, elevated levels of CO and (to a lesser extent) NO_x will occur over the region during short time periods (such as one hour) while the Sports Complex facilities are in use. The population exposed to these elevated concentrations are predominantly transient: passengers and drivers in vehicles in the vicinity of the Complex, pedestrians

in the vicinity, employees and spectators at events, and animals stored at the facility. The model calculations indicate that regional patterns of vegetation damage from exposure to CO, SO_2, and NO_x are not expected.

Local or Microscale Impact

The model calculations indicate that in all cases the applicable one-hour standards (and the equivalent standards) will not be exceeded for CO, NO_x, and SO_2. Because these standards were developed to protect public health, with an adequate margin of safety, operation of the Sports Complex facilities should not constitute a health rish relative to these three pollutants.

Of the five pollutants considered, CO concentrations will be most influenced by activities at the Sports Complex. The region of significant increase of one-hour average CO concentrations compared to background levels will extend approximately 3 kilometers downwind from the parking areas approximately 25% of the time, when winds are light-to-moderate. The impact region will extend approximately 5 kilometers about 5% of the time, when wind speeds are 2 meters per second (approximately 4 mph) or less. Figure XII-B25 illustrates the one-hour impact of CO emissions during the highest emission case studied, the exit of 18,000 automobiles after completion of a football game. (Note that the one-hour standard for CO is met even in this case.)

The maximum CO concentrations, expected in the first few kilometers downwind from the parking areas, arise from the various sources in the following approximate proportions:

- 90% from emissions by idling automobiles in the parking lot,
- 10% from background (i.e., from sources not associated with the Sports Complex),

- 1 to 2% from automobiles moving on the highway links in the vicinity of the Sports Complex,
- less than 1% from buses carrying passengers to and from the Sports Complex.

In the design and planning phase, it will be possible to reduce the impact of idling automobiles by providing for dispersal of parking areas, staggering of arrival and departure times, and improvements in flow efficiency in the feeder roads.

The pattern of local NO_x impact is similar to that for CO, but the influence of automobiles idling in the parking lot is not as important in the case of NO_x. Elevated levels of one hour average concentration of NO_x will be observed over distances up to 5 kilometers from the Complex during major public activities, but concentration levels will be lower than the short period health effect level by an order of magnitude even in worst cases.

If oil-fired furnaces are used to heat the Complex facilities, there will be emissions of SO_2 and particulates (as well as some NO_x, CO, and HC), but the total emissions of SO_2 and particulates will be sufficiently small so that the Sports Complex will not significantly change the average background concentrations of these pollutants. (This assumes that the fuel combustion facilities are designed with adequate collection devices for particulates, and with stack height adequate to permit initial dilution of the effluent in the atmosphere.)

Elevated lead concentrations in ground cover, and some vegetation damage, is normally observed within the first few hundred meters along heavily travelled roadways. Similar patterns of localized impact can be expected along the access roads, and at the edges of the parking lots, at the Sports Complex.

PROPERTY OF
NEW JERSEY STATE LIBRARY
[redacted]
186 W. STATE ST. PO BOX 520
TRENTON, NJ 08625-0520

Physiography and Geology

Jack McCormick and Henry Harris

The Hackensack River watershed ranges in width from 4 to 7 miles and extends northwardly approximately 34 miles from Newark Bay in northeastern New Jersey to the vicinity of Haverstraw, New York. The River drains an area of approximately 197 square miles, approximately two-thirds of which is located in Bergen and Hudson Counties, New Jersey (J. J. Kassner, 1971).

The watershed generally is bounded on the east by the crest of the Palisades ridge and on the west and northwest by the crest of the Watchung and Ramapo Mountains (F. R. Harris, 1971). The topography in the upper two-thirds of the Hackensack Valley is characterized by low, broad hills which range in elevation from 100 to 600 feet above sea level. The general elevation of the land decreases toward the south, and the southerly third of the valley is wide and flat (J. J. Kassner, 1971). In its lower 10 miles, the valley has been partly drowned by the Atlantic Ocean and is under tidal influence (Heusser, 1949b). At the turn of the century, Vermeule (1897) determined that tidal marshes occupied 18,580 acres and fresh meadows covered 1,465 acres in the area commonly known as the Hackensack Marsh or Hackensack Meadowland (Map 3). The natural elevation of this meadowland ranges from approximately mean sea level (0 feet MSL) to 3 feet above mean sea level (+3 feet MSL; F. R. Harris, 1971).

The Hackensack River originates in the Palisades near Haverstraw, New York, and flows southward parallel to the Hudson River. Although the drainage basin is about 34 miles long, the river meanders so widely

that the actual channel length is approximately 50 miles (J. J. Kassner, 1971). Locations along the River usually are described in terms of "Hackensack River Miles" (HRM) as measured along the mid-line of the channel from "Zero Mile" at Newark Bay. (Zero Mile is defined as coincident with the United States Coast and Geodetic Survey navigation aid R "N" 2 in Droyers Point Reach opposite Roosevelt Stadium in Jersey City, New Jersey. The location of the navigation aid is delineated on Coast and Geodetic Survey Map Number C. G. & S. 287).

The lower Hackensack Valley, including the Hackensack Meadowlands, is situated in an ancient trough of the Triassic plain of the piedmont physiographic province (Heusser, 1949b; Lewis and Kümmel, 1910-1912). The trough is enclosed on the east by a diabase sill. The scarp face of this sill forms the scenic Palisades on the west bank of the Hudson River, opposite New York City. The sill dips gently to the west for approximately 1.25 miles and then plunges downward near the alignment of U. S. Highways 1 and 9 (Widmer, 1964; Schuberth, 1968).

On the west, the Hackensack Valley is edged by a basaltic ridge, known as the First Watchung Mountain, and by low hills formed on soft red shale and interstratified sandstone (Heusser, 1949b; Lewis and Kümmel, 1910-1912). These sedimentary rocks, which are members of the Brunswick Formation, the youngest of three formations that compose the Newark Series of Late Triassic age, also form the floor of the trough beneath the Meadowlands (F. R. Harris, 1971).

During the period of deposition of sediments of the Newark Series, three periods of volcanic activity occurred. In the first period, lava extruded through a long arcuate fault formed a basaltic layer

(the First Watchung). In later periods of volcanic activity, lava apparently flowed through a vertical fissure until it reached a weak zone in the sedimentary rocks and intruded into them. This intrusive flow formed a buried dike and a more nearly horizontal sill of diabase (the Palisades). Subsequent changes in the earth's crust faulted and tilted both the sediments and the igneous bodies so that they now dip 15 to 20 degrees to the northwest (F. R. Harris, 1971; Schuberth, 1968).

A prolonged period of erosion in post-Triassic time altered the relatively level landscape of the contemporary Hackensack region. The shales and sandstones were eroded deeply but the resistant igneous rocks eroded much more slowly. As a result, the basalt and diabase formations remained as elevated ridges and the area between them was excavated into the form of a broad valley with parts of its floor beneath modern sea level.

During the Pleistocene Epoch the Wisconsin continental glacier, the fourth and last massive ice sheet of the period, advanced over the Hackensack region to a front, or moraine, that extends along modern Long Island, through Brooklyn, across Staten Island, and onto the New Jersey mainland at Perth Amboy. As it advanced, this ice sheet, which is estimated to have been more than 1,000 feet thick in the Hackensack region, depressed the crust of the earth with its enormous weight. It gouged soil and rock from the land surface, planed off the crests of ridges, and scoured the slopes and floors of valleys. The soil and rock materials usually were transported only short distances before they were deposited as a heterogeneous mixture of clay, silt, sand, pebbles, and boulders known as till. Locally, the soft shales

and sandstones of the Newark Series form a large proportion of the coarser fraction of the till and produce its red or brown coloration. In the Meadowlands region, the till was deposited as a ground moraine beneath the glacier and is 5 to 20 feet thick under the area described below as the proposed project site (F. R. Harris, 1971).

As the ice sheet began to melt about 15,000 years ago, it shrank back from the high ridge of till, or terminal moraine, which had been pushed up in front of the ice. Apparently the moraine formed a dam across the outlets of Newark Bay and impounded the drainage from the melting glacier. As water accumulated between this natural dam and the glacier front, Glacial Lake Hackensack was formed. Similar lakes were formed in the Passaic watershed behind the Watchung Ridge (Glacial Lake Passaic), in the Hudson River drainage (Glacial Lake Hudson), and over Manhattan Island, northern Long Island, and Long Island Sound (Glacial Lake Flushing; Reed, 1927; Widmer, 1964; Schuberth, 1968).

Glacial Lake Hackensack occupied the area along the present course of the Hackensack River from a point 2 miles north of Perth Amboy northeast to the New Jersey-New York State line. Beyond the State line, the lake extended northward in a much narrower basin through West Nyack and then eastward to Mount Ivy, New York. At maximum, the lake was approximately 15 miles wide near the present location of the city of Hackensack (Schuberth, 1968).

During the first 2.5 millenia of its existence, Glacial Lake Hackensack received large volumes of rock flour (pulverized clays and silts) released from the melting glacial ice and fine sands eroded by rain and

melt-water. The materials settled to the bottom of the lake and formed a deposit of varved clay that lies over the glacial till. The clay bed ranges from 13 to 52.5 feet in thickness beneath the proposed project site and to more than 80 feet in thickness at other locations (F. R. Harris, 1971).

The term, "varve", is derived from the Swedish word for "seasonal deposit." At least 2550 varves have been identified in the clay bed beneath the Meadowland, and each is composed of two thin layers of sediment that are believed to represent seasonal deposits during a single year. The light-colored sand grains and coarser silt particles settled quickly, but the finer silt and clay particles were kept in suspension by waves and ripples generated by the wind. Thus, a coarse-textured section of a varve was deposited each summer. As the lake surface froze each winter, the water became less turbulent. As a result, silt and clay particles settled out of suspension and formed a darker-colored, finer-grained section of the annual varve.

Glacial Lake Hackensack was drained about ten thousand years ago (Widmer, 1964), but the exact mechanisms of its disappearance are not clear. It is possible that, as the glacier melted, the lake filled until its waters flowed over the moraine which dammed them. Such an overflow, once established, would quickly erode a channel through the unconsolidated morainal material and, thereby, would drain the lake. Whatever the proximate cause, however, the moraine long since has been breached; and the waters of the Hackensack River now flows into Newark Bay and then through the breaches to the ocean.

As the ice sheet melted, the glacier slowly retreated northward and the enormous load it imposed on the earth's crust was reduced. In response, the crust gradually rose until it returned approximately to its pre-glacial elevation. This crustal rebound increased the gradients and velocities of the local streams. The rejuvenated streams were able to carry much coarser materials, and this period now is evidenced by deposits of gravel, sand, and coarse silt that rest on the older varved clay bottoms of Glacial Lakes Hackensack, Passaic, and Hudson. These coarse deposits range from 2.5 to 5.5 feet in thickness beneath the proposed project site and to as much as 100 feet in thickness at other locations (Schuberth, 1968; F. R. Harris, 1971).

Subsequent to the disappearance of Glacial Lake Hackensack, perhaps during a world-wide warm period about 4 to 6 thousand years ago (Hypsothermal Time), the water table in the Hackensack region was about 20 feet lower than it is today. The upper 20 feet of the varved clay stratum became desiccated and now differs from the lower clay section in color and some physical properties (F. R. Harris, 1971).

The streams which flowed from the retreating glacier down the dry bed of Glacial Lake Hackensack were the ancestors of the present Hackensack River. The course of the River probably has remained unchanged in general form since Lake Hackensack disappeared.

The volume of water over the surface of the earth apparently has remained virtually constant over tens of millions of years. Because thousands of billions of gallons of water were frozen in ice sheets at the height of the glacial epoch, sea level throughout the world was lowered. As the ice sheets melted, water flowed back to the oceans

and sea level began to rise. In the lower Hackensack Valley, the sea rose rapidly enough to overtake the contemporary rise in land surface caused by crustal rebound. The lower Hackensack Valley was flooded, or "drowned" as the sea filled the narrow outlets through the Arthur Kill and Kill Van Kull. The valley now is under tidal influence to a point 22 channel miles inland from the head of Newark Bay (Waksman, 1943; Widmer, 1964, F. R. Harris, 1971).

The velocity of the modern Hackensack River through its estuary is so slow that the sediment load of the stream consists almost wholly of fine-grained materials (clay and silt). These materials, combined with similar fine-grained material carried into the estuary by the tides, settles out during the daily periods of slack water and is trapped by the dense vegetation of the marshes. Together with detritus from marsh vegetation, this alluvial material presently covers the tidal wetlands of the Hackensack region to thicknesses which range from 4 to 20 feet. The deepest deposits generally occur along the eastern and western margins of the Meadowlands (Vermeule, 1897, 1898; Waksman, 1943; HMDC, 1970; F. R. Harris, 1971). On the proposed site, the organic materials generally are from 5 to 8 feet thick (F. R. Harris, 1971).

Prior to extensive modifications by man, the drainage and morphology of the Hackensack Meadowlands were typical of estuaries and tidal marshes. Although the Meadowlands have been artificialized by extensive diking, ditching, and filling, the level topography, meandering channels, and poorly integrated drainage patterns which remain throughout the District are representative of the original character of the area (Lewis and Kümmel, 1910-1912; F. R. Harris, 1971; Maps 1 and 2). On the proposed site, these features are best preserved in the Berrys Creek Tidal Marsh.

II. The Hackensack River

The Hackensack River originates in the Palisades near Haverstraw, New York. It flows southward, parallel to and only a few miles to the west of the Hudson River. The river meanders widely, and its channel length is approximately 50 miles, although the straightline distance from the headwaters to the mouth at Newark Bay is only 34 miles.

In its lower section the Hackensack River has been drowned by the encroachment in Recent time of the Atlantic Ocean. The connection with the Ocean is long and, below Newark Bay, follows two narrow passages between Staten Island and the New Jersey mainland--Kill van Kull and Arthurs Kill. The upper section of the river is a freshwater stream sustained by runoff from low, broad hills that range in elevation from 100 to 600 feet above mean sea level.

The watershed is a shallow trough formed largely on the soft shales and sandstones of the Brunswick Formation (Newark Series, Triassic). Throughout most of its length, the watershed divide is the crest of the Palisades diabase sill along the east and the crests of several basaltic ridges, known as the First Watchung Mountain and the Ramapo Mountains, on the west.

In 1922 a 2.85 billion gallon reservoir was formed on the Hackensack River near the head of tide at Oradell (River Mile 22.5). The Oradell Dam now separates the river and its watershed into a controlled, freshwater area above and an estuarine, brackish water area below.

Controlled, Freshwater Area

The Oradell Dam is the property of the Hackensack Water Company, a privately-owned utility which supplies potable water to approximately 0.73 million persons in Bergen and Hudson Counties, New Jersey. A subsidiary, the Spring Valley Water Company, supplies an additional 0.2 million persons in Rockland County, New York. The combined service area of these companies includes approximately 260 square miles. The Oradell Reservoir and three other freshwater impoundments (DeForest Lake and Lake Tappan on the Hackensack River main stem, and Woodcliff Lake on Pascack Brook, a tributary) are the principal sources of supply for the Hackensack Water Company. The Company protects and patrols the reservoir areas and prohibits public use of the water surfaces and the lands immediately surrounding them. The Spring Valley Water Company draws from DeForest Lake, as well as from 45 wells and another service source (Mr. G. Haskew, Chief Engineer, personal communication). The city of West Nyack, New York, also obtains potable water from the River.

Oradell Dam intercepts the freshwater runoff from about 60% of the entire Hackensack River Watershed (113 square miles of the total 197 square miles). A substantial proportion of the natural flow, therefore, now is prohibited from reaching the estuary, at least until after it has passed through water mains and sewerage systems (J. J. Kassner, 1971).

On 90 to 100 days in nearly every year, virtually the entire yield of the upper Hackensack River basin is siphoned off into the mains of the Hackensack Water Company. During a four year dry period (1961-1964), discharges from the reservoir were less than 1 cfs for 30% of the time and

were no greater than 46 cfs in the remainder of the period. Particularly during such prolonged droughts and during the drier months of summer, therefore, little or no water flows from the reservoir into the estuarine section of the river. In a sense, then, the Hackensack has become two rivers that are connected by a complex array of water mains, alimentary canals, and sewerage systems.

Estuarine Section

Below the Oradell Dam (River Mile 22.5), the Hackensack River is a brackish estuary with semi-diurnal tides. From River Mile 13.8 to Newark Bay, the mainstream and its tributaries are bordered by a broad, level area composed of several thousands of acres of tidal marshes. Whereas the freshwater section is protected as a public water supply, the estuarine section is contaminated by discharges of treated and untreated sanitary wastes, industrial effluents, cooling waters, and millions of tons of trash that have been deposited on the tidal marshes.

The freshwater inflow to the estuary largely is controlled and limited by the Oradell Dam. This flow is monitored by stream gaging station 3785 which is located about 1 mile below the dam at New Milford, New Jersey. The station has been maintained by the United States Geological Survey since October 1921. The mean discharge during 48 years of record (1969) was 110 cubic feet per second (cfs), but the records note that there was "no flow on many days during most years."

The additional sources of freshwater flow in the estuarine section are the following eleven small tributaries:

Tributary	Position of Mouth (River Miles)	Approximate Drainage Area
Penhorn Creek	4.1 miles	3.8 sq. mil
Saw Mill Creek	5.9 miles	2.0 sq. mi.
Kingsland Creek	6.7 miles	1.5 sq. mi.
Unnamed Creek	8.3 miles	Indeterminate
Berrys Creek Canal	8.6 miles	8.4 sq. mi.
Mill Creek	10.4 miles	0.9 sq. mi.
Cromakill Creek	10.6 miles	5.1 sq. mi.
Bellmans Creek	11.2 miles	3.8 sq. mi.
Overpeck Creek	13.8 miles	17.1 sq. mi.
Coles and Mill Brook	19.4 miles	7.6 sq. mi.
French Brook	19.5 miles	1.0 sq. mi.

A channel was dredged by the United States Army, Corps of Engineers through a 16.5 mile reach from Newark Bay to a point approximately 1.5 miles north of Interstate Highway 80 at Bogota, New Jersey. This channel is used by barge traffic and other navigation, including a small number of pleasure craft. The controlling depth in the 6 mile undredged segment of the river below the Oradell Dam is approximately 2 feet (Public Health Service, 1965; J. J. Kassner, 1971).

The long, narrow connections between the Hackensack River and the sea modify the tidal regime of the estuary. On flood tides, water from Raritan Bay surges through Arthur Kill and water from Upper New York Bay

flows through Kill van Kull into the broad, shallow basin of Newark Bay. As the level of the Bay rises, water floods into the Passaic and Hackensack River valleys.

Along most of the coast, the change of tide is rapid. But the Kills below Newark Bay restrict the outflow of tides from Newark Bay and its two major tributaries. Flood water high slack, therefore, usually persists for approximately 3 hours along the Hackensack River, and the low tide period may be as long as an hour. The local mean range of tide is 5.10 feet (Secaucus), with the mean high tide level at an elevation of 2.89 feet above mean sea level (J. J. Kassner, 1971). Spring high tides generally flood to an elevation of about 3.5 feet amsl.

On the basis of normal flows, the tidal prism for a tidal cycle in the Hackensack estuary is estimated to be slightly less than 800 million cubic feet of water. This is equivalent to approximately 4.5 billion gallons of water per tidal cycle (J. J. Kassner, 1971), and represents a flow of about 36,000 cfs.

Extreme high tides are a function of the occurrence and coincidence of storm high tides and of riverine floods. The flood of record in the vicinity of the proposed site for the Sports Complex reached an elevation of approximately 8.4 feet above mean sea level. This flood, which is considered to have a return period of about 40 years, was experienced on a high tide that was coincident with the passage of Hurricane Donna in September 1960. The 100-year storm in the area is expected to produce a 10-foot tide (F. H. Harris, 1971).

Velocities of tidal currents in the Hackensack estuary are moderate. At the mouth of the river, the currents average about 0.9 knot on flood tides, and 0.8 knot on ebbing tides. At times of spring tides, both the ebb and flood velocities are about 1.1 knots (J. J. Kassner, 1971).

In a typical estuary, the advective flux, or the freshwater flow from the upper watershed areas, maintains a net seaward movement of the water mass and of any pollutant load. Substantial stream flows and thorough tidal circulation, combined with the assimilative capacity of the estuarine biotic system, generally are sufficient to produce reasonable water quality even in estuaries which are heavily used and subject to numerous discharges (J. J. Kassner, 1971).

Owing to its tortuous connection to the Atlantic Ocean, the lower Hackensack River never was a "typical" estuary. After it was beheaded by the Oradell Dam, however, it became even more unique. Now it essentially is a trough, open fully only at the end adjacent to Newark Bay, in which tidal waters slosh back and forth, but from which they are flushed exceptionally slowly (Kassner, 1971).

This was demonstrated lucidly by a dye test in the autumn of 1964 (Public Health Service, 1965). The dye was released near the Bergen County Sewer Authority treatment plant at Little Ferry (River Mile 12.7). Three days elapsed before the first trace reached the river mouth on Newark Bay. Most of the dye, however, remained near the sewage plant during the 19 days of observations.

The test demonstrated that, with little freshwater flow entering the estuary, there was virtually no net seaward movement of contaminated water. Pollution discharged into the Hackensack River, therefore, will difuse

slowly, but largely it may oscillate up and down the estuary with the tides. Its centroid may return to the release point during each cycle (J. J. Kassner, 1971).

III. Vegetation of the Hackensack Meadowlands

Little is known of the vegetation that may have grown around Glacial Lake Hackensack 10,000 years and more ago. Probably it was a tundra somewhat similar to the vegetation now found around Tasersiaq and other glacial lakes in Greenland.

Sometime after the lake drained, but before the sea invaded the Hackensack Valley, the clay bottom of the modern meadowlands was covered by a swamp forest in which black ash *(Fraxinus nigra)* was a prominent tree. Conifer forests, particularly a type composed of fir, may have preceded the ash swamp, but they are not represented in the fossil pollen deposit (Heusser, 1949b).

After a time, black spruce *(Picea mariana)* and larch *(Larix laricina)* invaded the ash swamp forest. Black ash persisted in the mixed forest for a time, but ultimately it was eliminated. Presumably, its decline was a response to the rising level of the local water table as the sea reoccupied the sections of the coastal plain that had been exposed during the period of maximum glacial advance.

The spruce-larch swamp forest occupied the basin for a long period of time. As the slow encroachment of the sea continued to the south and east of the valley, the level of the local water table rose in response. Peat deposits, formed of fallen leaves, twigs, cones, tree trunks, and root systems, accumulated above the clay and the level of the organic soils kept pace with the rising water table (Heusser, 1949b).

As recently as 1889 black spruce and larch still were present in the Hackensack swamp forests. By this time, however, southern white cedar

(Chamaecyparis thyoides) had become the predominant tree. Stumps and logs of white cedar, however, are found only in the uppermost section of the peat in the Hackensack meadows (Heusser, 1949a, b). Unfortunately, the pollen of white cedar deteriorates rapidly and the species is not represented in the microfossil record (Harmon and Tedrow, 1969). This typically southern species, however, appears to have invaded the region relatively recently. It seems likely that its arrival may have been coincident with a world-wide warm period, known as Hyposothermal Time, which occurred from 6 to 4 thousand years ago.

Brackish water may have first entered the Hackensack Meadowland region while spruce-larch forests were predominant. Heusser (1949b) found pollen of an indicator plant, three-square bulrush *(Scirpus olneyi)*, at depths as great as 6 feet beneath the modern surface. As the level of the sea continued to rise, brackish water flowed over more and more highly elevated areas of the meadowlands and farther up the estuary.

Apparently in response to this invasion of the sea, the margins of the cedar swamp forests began to die. By 1896, Vermeule (1897) noted that virtually every living swamp forest was surrounded by a zone of dead trees and peat which he labeled as "cedar swamp bottom" on his map (Map 4). By the late 1940's, about half a dozen living cedars in an area near Moonachie were the only remnants of the once-extensive forests (Heusser, 1949b). At least in part, the complete elimination of the conifer swamp forests from the Hackensack Valley was a natural phenomenon related to the dynamic changes that characterize areas along the shores of the world's oceans.

Harmon and Tedrow (1969:63) concluded that the data collected in their studies of organic deposits in the meadowlands did not indicate that the change from forest to marsh vegetation was brought about by natural events. In particular, they observed no uniform increase in the salt content of incrementally higher sections of the peat, and inferred that the "rise in sea level apparently occurred principally in the time before the vegetation change took place..." The absence of dead cedars on the surface and the presence of sawed-off stumps suggested to them that human influences were intense in the area. The evidence of fire was widespread in old cedar areas. In one place, at least 20 inches of peat had been burned away and the substrate level was effectively lowered.

Human influences also were recognized by Heusser (1949b). Cedars were cut for shipbuilding and road construction. Fires, mosquito ditching, and diking were cited as particularly effective in the destruction of the cedar forests. Ditching drained the more elevated areas and increased their susceptibility to fire. The outer margins of forest areas were more frequently flowed by the tides after ditching and, thus, were more exposed to brackish water excursions. The pollution of the water by industrial and sewage effluents, air pollution, reductions of freshwater inflow, and channel deepening also were considered by Heusser to be possible factors in the rapid conversion of the forested landscape to a marshland.

A number of studies of the flora of the Hackensack region, including the swamp forests, were conducted during the nineteenth century. These and more recent studies are summarized by Sipple (1971). The vegetation

of the region was mapped by Vermeule (1897, Map 4), the tidal marsh area was mapped by Lee, Tine, and Gillett (1936; Map 3), and a descriptive study of the marsh areas was made by Harshberger and Burns (1916).

The most recent studies of the vegetation of the Hackensack region were conducted by Potera (1970), Renlund (1970, and Hackensack Meadowlands Development Commission, 1970:27), and Sipple (1971, Map 6). Potera inventoried only the Sawmill-Kingsland Creek area which spans the Hudson-Bergen County line to the west of the Hackensack River. The two other studies, however, were comprehensive evaluations of the vegetation of the entire meadowlands area. Both studies indicated that common reed grasslands now cover most of the tidal marsh areas, as well as most diked marshes and many other habitats.

Vegetation

Horace Somes, James Morrow, and Jack McCormick

The existing vegetation on the proposed site for the New Jersey Sports Complex in the Hackensack Meadowlands District was studied in May and June 1972. The site, which is located in the municipality of East Rutherford, Bergen County, New Jersey, generally is bounded by Berrys Creek on the northwest, New Jersey Route 3 on the southwest, the New Jersey Turnpike on the southeast, and Paterson Plank Road on the northeast (Map 8, site#6-6A).

A vegetation map was prepared using a 1971 aerial photograph as the base map (scale: 1 inch = 200 feet). Vegetation type boundaries were determined by field inspections and interpretation of stereo infra-red photographs taken 5 April 1972 (scale: 1 inch = 6,600 feet; supplied by the New Jersey Department of Environmental Protection; map 1).

Geographical Divisions of the Site

To simplify discussion of the area, the proposed site was divided into eleven subareas on the basis of physical features (Figure 1). These subareas are:

- Berrys Creek Tidal Marsh
- Turnpike Tidal Marsh
- Diked Marsh
- Impounded Wetland
- Dike
- Paterson Plank Fill
- Maislin Fill
- South-central Fill
- Sportland Fill
- Route 20 East Fill
- Woodland

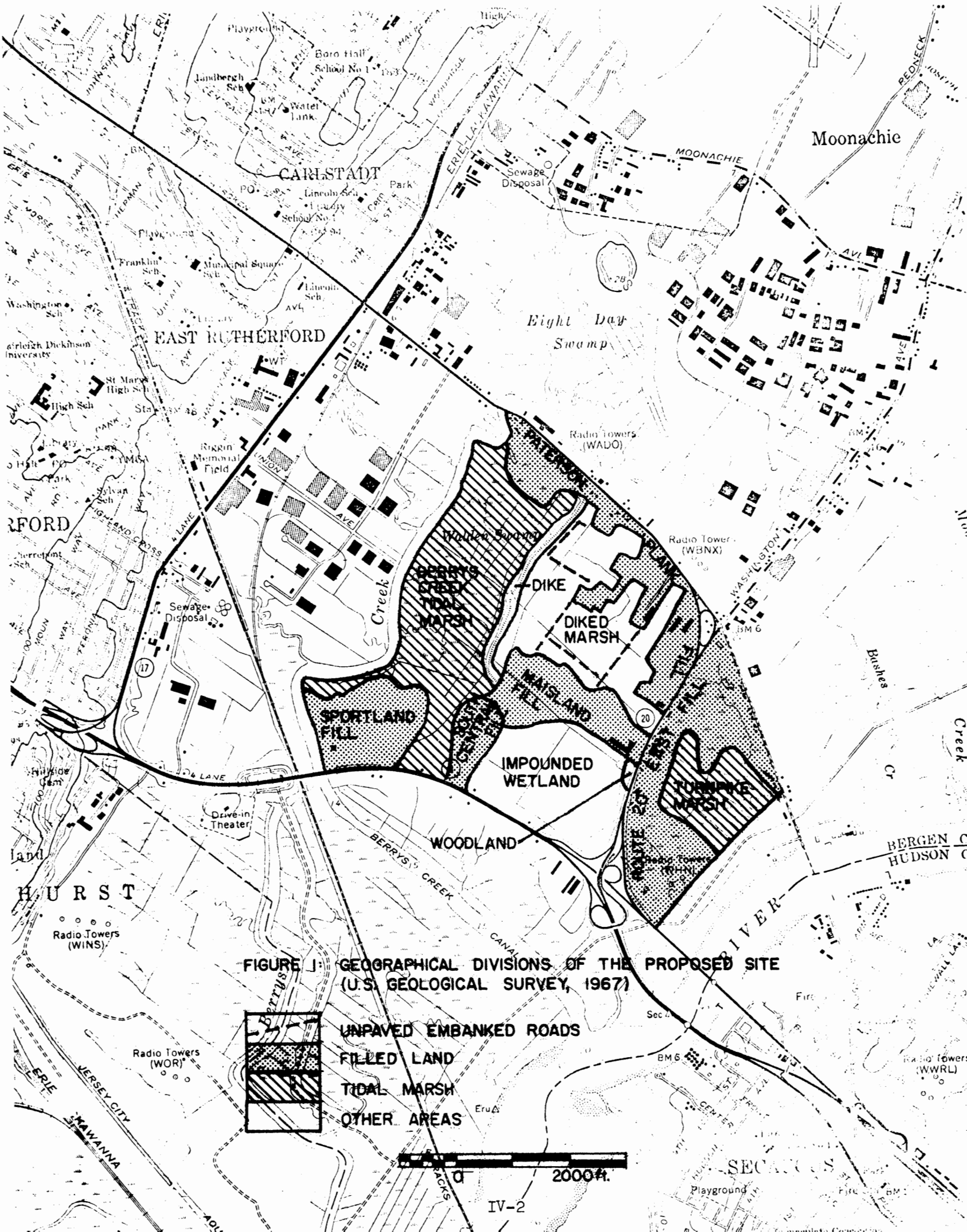


FIGURE 1: GEOGRAPHICAL DIVISIONS OF THE PROPOSED SITE (U.S. GEOLOGICAL SURVEY, 1967)

Previous Studies of the Proposed Site

The earliest published information on the vegetation of the proposed Sports Complex site is contained in a map of Hackensack Meadows prepared by Vermeule (1897). The approximate boundaries of the site were established by comparison on 1972 aerial photographs of the following landmarks shown on the map: Berrys Creek, Paterson Plank Road, the Hackensack River, and residual high ground near modern Route 20 (maps 1, 4, 9).

The modern dike which parallels Berrys Creek approximates the western edge of a southern white cedar swamp forest which occupied the site in 1896. The forest extended streamward of the dike alignment only at the extreme southwest end, near the South-central Fill. Another line on the Vermeule map, which indicates the boundary of "cedar swamp bottom," generally is streamward of the dike at the southwest (Sportland Fill area) and at a point approximately 1,700 feet south of the Paterson Plank Road. These "bottoms" represented the remnants of swamp forests which apparently were killed by tidal flooding before Vermeule's study.

Virtually all of that section of the proposed site between the modern dike and modern Route 20 is shown on Vermeule's map as swamp forest. Approximately at the location of the Woodland area (Figure 1), a ridge of higher ground without swamp forest is delineated.

The cedar swamp forest extended east of Route 20 for a distance of approximately 90 feet in the southern two-thirds of the site and 50 feet for an additional 100 feet or so. The cedar swamp bottom, however, covered most of the western half of the tract between Route 20 and the New Jersey Turnpike.

Sipple (1971) employed sixteen types to map the vegetation of the Hackensack Meadows from aerial photographs taken in June 1969 and field examinations made during 1969 and 1970. Most of the area now proposed as the site for the New Jersey Sports Complex is shown on Sipple's map to be covered by common reed grass, ruderal (weedfield) vegetation, and a small stand of cattails. Other parts of the site were categorized as developed land or open water (Map 6). Generally, the map is descriptive of 1972 conditions except that the Paterson Plank Fill and the Maislin Fill were enlarged in the intervening three years and new fill was established (as along Route 20). An island of ruderal vegetation delineated by Sipple within the common reed grassland in the Impounded Wetland apparently was a misinterpretation. The area probably was covered by a viable birch-aspen shrubland in 1969 although most of the trees and shrubs subsequently have been killed by flooding.

A winter survey of the vegetation was made in 1969-1970 by Drs. Molly Geller and Robert Renlund of the New Jersey Marine Sciences Consortium (Anon., 1972). Geller and Renlund also used aerial photographs taken in 1969 and compiled a vegetation map of the Hackensack Meadows (Hackensack Meadowlands Development Commission, 1970:27; Renlund, 1970). In the area now proposed as the site for the Sports Complex, all vegetation was categorized as common reed grassland.

In a text on the vegetation of the Hackensack Meadowlands (Anon., 1972), the proposed site is described in part, reportedly in the words of Geller and Renlund, under the subtitle, "Walden and Eight Day Swamps:"

"The coming of industry has changed the conditions here so the remaining vegetation visible is Phragmites of lowest vigor. There is no tree or bush; no other plant in the vast area. The enlargement of Paterson Plank Road and Route #17 is further changing the area, leaving an uncertain future for the sparse vegetation which persists."

Under the subtitle, "Berry's Creek Canal area, vicinity Rutherford," the area of the Sportland Fill is described:

"The westward part of this region is upland field and non-tidal. The vegetation shows milkweeds, goldenrods, Indian grass, and the skeletons of the white cedars remaining from the former bog regime . . . Phragmites, where not covered by garbage fill, is of vigor one. The fill is high, and banked by mud dredged from the marshes."

Neither Sipple nor Geller and Renlund included any recommendations concerning the Berrys Creek Tidal Marsh or other sections of the proposed site. Professor Renlund, however, in a telephone conversation on 9 June 1972 explained that it had appeared to him developmental pressures were so great the site would soon be filled.

Vegetation Types

Thirteen vegetation types were recognized on the proposed Sports Complex site during the present investigation. Owing to the small areal extent of

many of these types, the thirteen field types are combined into the five general types which, together with bare fill and open water, are depicted on Map10. Field types were combined as follows:

Type on Map	Field Types
Common reed grassland	Upland reed
	Tidal reed
	Impounded reed
	Lowland reed
	Water-hemp
	Switchgrass
	Narrow-leaved cattail
	Broad-leaved cattail
	Salt reed-grass
Oak woodland	Oak woodland
Birch-aspen shrubland	Birch-aspen shrubland
Flooded shrubland	Flooded shrubland (dead or dying)
Vegetated fill	Vegetated fill
Barren fill	
Open water	

Boundaries between areas of fill and natural organic soils are shown on Map 9. Comparison of the vegetation and wetland maps will afford a characterization of any segment of the proposed site.

Common reed grasslands, which in many places are composed of plants 8 to 10 feet tall, cover approximately 53% of the proposed site and occur in habitats as diverse as tidal mudflats and elevated trash landfills (Table).

Table . Approximate acreage of vegetation types and landscape conditions on the proposed Sports Complex site in June 1972.

	Acres	% of Site
Vegetated Areas		
Common Reed Grassland	415	53
Vegetated Fill	98	13
Flooded Shrubland	8	1
Birch-Aspen Shrubland	0.5	<1
Oak Woodland	0.2	<1
Subtotal:	522	67
Areas Without Vegetation		
Barren Fill	230	29
Open Water	28	4
Subtotal:	258	33

Near Berrys Creek, for example, areas occupied by common reed are subject to diurnal flooding by tides. Other reed stands grow in constantly flooded impoundments, in diked areas that are flooded only occasionally, and on high ground that is well above the level of the highest flood of record.

Most stands are tall, dense, nearly pure growths of common reed (*Phragmites communis = P. australis*). In many places, particularly on the edges of filled lands, however, the reed stands are short (4 to 8 feet) and have a mixed undergrowth of ragweed, nightshade, pokeweed, goldenrod, pigweed, bindweed, blackberry, thistle, and various grasses and sedges. Elderberry, quaking aspen, and tree-of-heaven also occur in a few upland reed areas.

Small areas of water-hemp, switchgrass, salt reed-grass, and cattails that were distinguished in the field mapping are included on the smaller-scale map reproduced in this report. These types are described, and their general locations are mentioned, in discussions of subareas of the site.

The term, "vegetated fill," was selected to describe an array of vegetation, excepting common reed grasslands, that grows on soil, peat, and trash landfills over 13% of the site. In most places, this vegetation is composed of a mixture of species that includes shepherd's purse, ragweed, speedwell, wild carrot, goldenrod, pigweed, thistle, white campion, sour-grass, pokeweed, and cow cress. Small saplings and sprouts of black locust, tree-of-heaven, princess tree, and mulberry are scattered in these areas. Grassy roadsides and mowed lawns also were included in the vegetated fill type. Bluegrass, fescue grass, white campion, red clover, and white clover are frequent on roadsides. Common horsetail covers a large roadside area along Route 20 near the oak woodland.

Viable birch-aspen shrublands and flooded shrublands, in which most of the trees and shrubs were dead or dying, occupy less than 2% of the site. Quaking aspen and gray birch are the principal woody species in these scrubs, but several other shrubs, particularly blackberry, are associates.

The oak woodland type is represented only by a single stand which covers less than 1 acre in the southeastern section of the proposed site. White, black, and chestnut oaks are the predominant tree species.

Approximately one-third of the proposed site is not covered by vegetation. The largest proportion of the non-vegetated area is represented by barren landfills (230 acres, 29% of site area). Recently-placed fills, paved roads, unpaved roads, parking lots, and storage yards are included in this category.

Open water is exposed in about 28 acres (4% of the site) in both tidal and non-tidal areas. In tidal areas all channels and mudflats virtually are devoid of rooted plants, but mats of blue-green algae cover a number of mudflats. The surface of the water in many ditches and puddles in the non-tidal areas was covered with duckweed. Marshmallow is a common shrub-form herb along banks or in shallow sections of ditches in the Diked Marsh.

Contemporary Vegetation

Berrys Creek Tidal Marsh

Most of Berrys Creek Tidal Marsh is covered by dense stands of common reed grass in which water-hemp forms a sparse, discontinuous understory. Pure stands of water hemp are scattered along banks of the creek and ditches.

The largest colony observed was 8 feet wide and 15 feet long. Most colonies, however, were only 2 to 4 feet in diameter.

Many small, isolated stands of narrow-leaved cattail and salt reed-grass are scattered throughout the tidal marsh, particularly along the streams. The ground surface in the marsh was flooded by 2 or more inches of water at high tide and drained completely at low tide during the period of investigation.

Open water in the marsh is entirely tidal, and occurs primarily in three main tributaries to Berrys Creek and one large drainage ditch that extends from a tide gate to the Creek. At low tide an extensive system of mudflats is exposed along these waterways, and many logs and stumps of southern white cedar are visible, particularly in the southeastern half of the area. The only vegetation on the mudflats is a thin (1/8-inch thick), discontinuous mat of blue-green algae. In the section of the marsh between the Sportland Fill and the South-central Fill there are many mudflats of variable size, shape, and location. These flats appear to be unrelated to the drainage pattern of the section and have been subject to tidal scouring that has removed from 1 to 2 feet of organic soil. Numerous stumps and logs of white cedar are exposed in this area.

Turnpike Tidal Marsh

The Turnpike Tidal Marsh is covered by common reed grass. The area is connected to the Hackensack River through a culvert (approximately 48 inches in diameter) located approximately 800 feet southwest of the Paterson Plank Road. This culvert limits tidal flow to the marsh and apparently has reduced tidal flushing.

Diked Marsh

The Diked Marsh, which is isolated from the Berrys Creek Tidal Marsh by an earthen dike, is covered predominantly by a common reed grassland. Goldenrods, knotweed, water hemp, and pigweed form a discontinuous understory, particularly in areas that have been disturbed by all-terrain vehicles or fire. Bindweed, nightshade, water-hemp, blackberry, jewelweed, blueflag, elderberry, and marshmallow occur occasionally, and dense colonies of marsh fern, as large as 15 feet in diameter, are scattered through the area. These colonies may represent relicts from the cedar forest that once covered the site.

Stands of narrow-leaved cattail were observed in several places. A switchgrass stand with scattered, short (5 feet tall) reed grasses occupies a small impounded area between the dike, the Paterson Plank Fill, and a small embankment that apparently was constructed since 1969 to contain a contemplated fill. Pigweed, knotweed, water-hemp, spike rush, and a variety of grasses, sedges, and rushes form a dense undergrowth in this stand.

In another impounded area, located in the north-central section adjacent to the Paterson Plank Fill, common reed grass is mixed with broad-leaved cattail. Vegetated and barren fills in this same area represent other embankments that traverse the marsh.

Several drainage ditches (open water) traverse the marsh. At low tide, water flows from these ditches through a tide gate (approximately 2,000 feet from the north end of the dike) into the Berrys Creek Tidal Marsh. At the time of the present field investigation, the gate was jammed open by trash (mostly lumber) and some water flowed into the Diked Marsh during

flood tides. Flow in the ditches, however, generally is very slow and duckweed covers the surface in some areas.

Impounded Wetland

Water in the Impounded Wetland, which was as deep as 2.5 feet during early June 1972, is contained by the South-central Fill on the west, the Maislin Fill on the north, and a small fill along Route 20 which has blocked a drainage culvert. The site is covered by common reed grass, but dead blackberry plants protrude above the water throughout the area. The firm condition of these shrubs suggests that they were alive during the growing season of 1971. A small stand of cattail occupies the northeastern corner of the site next to the Maislin Fill. Broad-leaved cattail and narrow-leaved cattail composed approximately equal proportions of this stand.

A flooded shrubland covers the north-central section of the Impounded Wetland and extends northwestward to the Maislin Fill. This type appears to have been a birch-aspen shrubland before it was inundated by water as deep as 2.5 feet. Many gray birches in this area are dead, and a number of quaking aspens are dead or in very poor condition. Dead blackberry bushes are abundant. One sweet pepperbush and one steeplebush, both in poor condition, also were observed. A smaller stand of flooded shrubland, composed only of dead blackberry, is located in the Impounded Wetland along the west and south boundaries of an oak woodland and birch-aspen shrubland.

Numerous white cedar stumps and logs were noted throughout the Impounded Wetland. Many of the stumps project above the water surface, and several of the logs were floating. All of the stumps and logs had been charred extensively by fire.

Dike

An earthern dike, approximately 3,700 feet long and 7 to 8 feet high, extends from the Paterson Plank Fill to the west end of the Maislin Fill, and separates the Berrys Creek Tidal Marsh from the Diked Marsh. This dike is covered by common reed grass. On the section that is flooded by tides, the reeds form a thick stand, as tall as 8 feet, with only occasional bindweed and water-hemp as associates. On sections not affected by tides, the stand is more open and numerous other kinds of plants occur in the understory.

Paterson Plank Fill

There are several businesses and residences on the Paterson Plank Fill. Paved roads, unpaved roads, parking lots, loading zones, and storage areas associated with the businesses are extensive. Vegetated areas are small and consist principally of lawns. Oldfield vegetation and common reed grass grow in an irregular strip, generally less than 150 feet wide, along the edges of the fill.

Maislin Fill

The Maislin Fill is of recent origin and is nearly barren. A few colonies of oldfield vegetation, however, have become established along the margins, particularly at the northwest side of the fill. The northernmost segment of this trash fill was burning during the entire period of the present investigation (18 May through 7 June 1972).

South-central Fill

The South-central Fill was placed more than four years ago and is covered principally by oldfield vegetation. Common reed grass forms a band along the north edge of the fill and extends into low areas near the center of the fill.

Sportland Fill

The Sportland Fill appears to be of about the same age as the South-central Fill and also supports an oldfield vegetation with common reed grass along the wetland edges. Sportland, a privately-operated miniature golf course, driving range, and trap range, occupies the western and southwestern sections of this site. Within this complex, the vegetation is a mowed grassland.

Route 20 East Fill

A large proportion of the Route 20 East Fill is covered by weed fields and common reed grassland. Barren areas occur around businesses and residences along Route 20 opposite the Maislin Fill and along Paterson Plank Road.

Woodland-Shrubland

A small woodland (about 0.2 acre) along State Highway 20 occupies a remnant on an island of high ground mapped by Vermeule (1897). The overstory of this stand is composed of approximately fifteen white oaks (maximum

diameter 12 inches) and several smaller red oaks and chestnut oak sprouts with a maximum diameter of 3 to 4 inches. European buckthorn, blackberry, gray birch, sassafras, black cherry, red maple, elderberry, winged sumac, smooth sumac, northern arrowwood, highbush blueberry, sweet pepperbush, and maleberry form a thick undergrowth that has a maximum height of 5 to 7 feet.

The woodland is edged on the west and south by a 50- to 60-foot wide band of birch-aspen shrubland. Gray birch (maximum diameter 2 inches) and quaking aspen (3 inches) are the principal species in this scrub. Northern arrowwood, sassafras, blackberry, elderberry, European buckthorn, dogbane, and goldenrods also occur in this shrubland. Two sprouts of princess tree (2 to 3 feet tall) also were noted. The plants form a dense cover, 5 to 8 feet tall, through which several 10 to 15 feet tall aspens project.

Figure 1. Common and scientific names of the plants cited in the text. Nomenclature follows Gray's Manual of Botany, Eighth Edition.

Arrowwood, northern	*Viburnum recognitum*
Ash, black	*Fraxinus nigra*
Aspen, quaking	*Populus tremuloides*
Bindweed	*Convolvulus* sp.
Birch, gray	*Betula populifolia*
Blackberry	*Rubus* sp.
Blueberry, highbush	*Vaccinium corymbosum*
Blueflag	*Iris* sp.
Buckthorn, European	*Rhamnus frangula*
Campion, white	*Lychnis alba*
Carrot, wild	*Daucus carota*
Cattail, broad-leaved	*Typha latifolia*
Cattail, narrow-leaved	*Typha angustifolia*
Cedar, white	*Chamaecyparis thyoides*
Cherry, black	*Prunus serotina*
Clover, red	*Trifolium repens*
Clover, white	*Trifolium pratense*
Cress, cow	*Lepidium campestre*
Dock, yellow	*Rumex crispus*
Dogbane	*Apocynum* sp.
Duckweed	*Lemna* sp.
Elderberry, Common	*Sambucus canadensis*

Fern, cinnamon	*Osmunda cinnamomea*
Fern, marsh	*Dryopteris thelypteris*
Fern, sensitive	*Onoclea sensibilis*
Goldenrod	*Solidago* spp.
Grasses	Family Gramineae
Horsetail, common	*Equisetum arvense*
Jewelweed	*Impatiens* sp.
Knotweed	*Polygonum* sp.
Larch, American	*Larix laricina*
Locust, black	*Robinia pseudo-acacia*
Maleberry	*Lyonia ligustrina*
Mallow, marsh	*Hibiscus palustris*
Maple, red	*Acer rubrum*
Mulberry	*Morus* sp.
Nightshade	*Solanum* sp.
Oak, chestnut	*Quercus prinus*
Oak, red	*Quercus rubra*
Oak, white	*Quercus alba*
Pepperbush, sweet	*Clethra alnifolia*
Pigweed	*Chenopodium alba*
Pokeweed	*Phytolacca americana*
Purse, shepherd's	*Capsella bursa-pastoris*
Ragweed	*Ambrosia artemisiifolia*
Reed, common	*Phragmites communis*

Reed-grass, salt	*Spartina cynosuroides*
Rush, spike	*Eleocharis olivacea*
Rushes	Family Juncaceae
Sassafras	*Sassafras albidum*
Sedges	Family Cyperaceae
Speedwell	*Veronica* sp.
Spruce, black	*Picea mariana*
Steeplebush	*Spiraea tomentosa*
Sunflower, common	*Helianthus annuus*
Switchgrass	*Panicum virgatum*
Thistle	*Cirsium* sp.
Tree, princess	*Paulownia tomentosa*
Tree-of-heaven	*Ailanthus altissima*
Water-hemp	*Acnida cannabina*

PROPERTY OF
NEW JERSEY STATE LIBRARY
186 W. STATE ST. PO BOX 520
TRENTON, NJ 08625-0520

Wildlife Populations

David Zumeta and Jack McCormick

Bird, mammal, amphibian, and reptile populations of the proposed site were surveyed from 30 May to 2 June 1972. Information concerning previous observations on the vertebrates of the site was obtained from Donald Smith, Hackensack Meadowland Development Commission, and Richard Kane, Urner Bird Club. Both Mr. Smith and Mr. Kane participated in field observations with Jack McCormick & Associates.

Habitats discussed in this report are described more fully in the chapter on the vegetation of the proposed Sports Complex site. Locations of areas mentioned in the text are identified in Figure

Bird Populations

Previous Studies of the Hackensack Meadowlands

The only comprehensive study of bird populations of the Hackensack Meadowlands region was conducted by Black (1970) from 1961 to 1969. The area on the west side of the Hackensack River survey by Black, however, extended southward from State Highway 3 and did not include the proposed Sports Complex site. He listed a total of 207 species, to which fourteen species subsequently have been added (Richard Kane, personal communication). In the extensive mudflats of the Kingsland-Sawmill Creeks area, which also is located to the south of the proposed site, Potera (1970) recorded 43 species during the period from July to October 1970.

Contemporary Avifauna of the Proposed Site

Sixty-five kinds of birds, including 26 nesting species, are known to occur on the proposed Sports Complex site (Table 1). Many other species doubtlessly visit the site during the migratory periods.

At least 37 species are known to utilize the Diked Area. Fourteen of these nest in the area, and four others probably nest there. The most common breeders are mallard, black duck, blue-winged teal, common gallinule, and ring-necked pheasant. Numerous gallinules, including several young, were observed in ditches in the western section of the Impounded Wetland. One green heron and one black-crowned night heron were noted in the Flooded Shrubland near the Maislin Fill.

A king rail was heard calling in the north-central section of Diked Marsh; this very uncommon species may still breed in the area. Spotted sandpipers breed near mudflats along ditches, and numerous kinds of songbirds are uncommon to abundant breeders throughout the area.

Twenty-eight kinds of birds were observed in tidal marshes on the proposed site. Ten species are known to nest in this habitat, and two others are believed to nest there. Herons are not known to breed on the proposed Sports Complex site, and few are observed in the area except during migration periods. At least four species which are known to have been common local breeders in the past no longer breed here. The Virginia rail and sora rail still are common migrants, but the least bittern and American bittern probably do not visit the site now. The American coot also appears to have been eliminated from the proposed Sports Complex site even though 300 breeding pairs were reported in the Hackensack Meadows in 1962 (Bull, 1964). The number of breeding and migrating sandpipers apparently is much smaller than in the past (Black, 1970). This reduction probably

reflects the highly polluted conditions and consequent lack of aquatic insects and other invertebrates in the tidal mudflats along Berrys Creek and the smaller tidal channels.

Extensive alteration of the site by diking and land fills has enabled some kinds of birds to increase in numbers. The common gallinule, for example, has replaced the American coot throughout the Meadowlands. It is believed that the remarkable increase in gallinule populations was correlated with the diking of the tidal marshes. The diking created a more favorable environment for gallinules by reducing the salinity of the water (Bull, 1964). The long-billed marsh wren, which breeds abundantly in the tidal marsh habitat and less commonly in the diked marsh habitat, probably has decreased in abundance.

The marsh hawk and the short-eared owl, which are common to abundant during migration and winter in diked marsh and tidal marsh habitats, feed almost exclusively on house mice that inhabit garbage land-fills. Several species of native songbirds thrive in both types of marshland habitat. They probably are favored by the dense cover afforded by common reed grass and do not utilize the polluted water. The yellowthroat, swamp sparrow, and song sparrow breed very commonly and the red-winged blackbird breeds abundantly in marshland habitats.

Landfill areas are utilized by at least 35 species of birds, 13 of which are known to breed and 4 of which are suspected to breed. The ring-necked pheasant, mourning dove, yellowthroat, red-winged blackbird, American goldfinch, and song sparrow are the most common breeders. Several species of breeding songbirds, particularly the robin and yellow warbler,

primarily are associated with the small woodland area adjacent to Route 20. Many other species undoubtedly visit this woodland during migration.

Garbage dumps in the New York area generally attract many thousands of gulls, especially in winter, and represent some of the best sites for the observation of the rarer arctic and European gull species (Richard Kane, personal communication). Smoke from persistent garbage fires in the Maislin Fill, however, apparently discourages most gulls from feeding or roosting in the proposed Sports Complex site (Donald Smith, personal communication).

At least 10 species of birds are known to occur in moved lawns. Four of these are breeding species and one probably breeds. The killdeer is a common breeder. The horned lark probably breeds occasionally in barren landfill areas. Both species frequently feed on mowed lawns, and several kinds of migratory songbirds, notably the savannah sparrow, visit mowed areas.

Only five species are known to inhabit buildings. The rock dove, starling, and house sparrow, all introduced species, are common to abundant breeders. The barn swallow probably is a common breeder on buildings along the Paterson Plank Road, as well as on the bridge that carries the Road across Berrys Creek. The house finch, a species introduced recently from the western United States, probably is an occasional breeder around buildings throughout the site.

Eleven species spend most of their time in the air. The red-tailed hawk and rough-legged hawk, which are common in migration and winter, feed principally on mice and, to a lesser extent, other mammals. Three species of gulls commonly are observed to soar over the area. The common nighthawk, chimney swift, and four species of swallows, all of which are insect feeders, are uncommon to abundant during migration and summer.

Table 1. Birds of the proposed New Jersey Sports Complex site, prepared from the records of Donald Smith, Hackensack Meadowland Development Commission, and field observations by Richard Kane, Urner Bird Club, and Jack McCormick & Associates 30 May to 2 June 1972. Asterisks indicate species known to nest on the site. Asterisks preceded by question marks indicate species believed to nest on the site. Abbreviations used for habitats indicate: B - Buildings, DM - Diked marsh, LF - Landfill areas, mostly weedfields, ML - Mowed lawns and roadsides, O - Observed flying, TM - Tidal marsh. Symbols for relative abundance indicate: a - abundant, c - common, u - uncommon, r - rare.

	Habitat	(March-May) Spring	(June-July) Summer	(Aug.-Nov.) Fall	(Dec.-Feb.) Winter
Great blue heron	TM,DM	c	r	c	r
Green heron	TM,DM	u	u	u	
Common egret	TM,DM	r	r	r	
Snowy egret	TM,DM	r	r	r	
Black-crowned night heron	TM,DM	u	u	u	r
*Mallard	TM,DM	c	c	c	
*Black duck	TM,DM	c	c	c	
?*Gadwall	TM,DM	r	r	r	
Green-winged teal	TM,DM	c	r	c	
*Blue-winged teal	TM,DM	c	c	c	

	Habitat	(March-May) Spring	(June-July) Summer	(Aug.-Nov.) Fall	(Dec.-Feb.) Winter
Red-tailed hawk	O	c		c	c
Rough-legged hawk	O	c		c	c
Marsh hawk	DM,TM,LF	c	r	c	c
Sparrow hawk	LF	u	u	u	u
*Ring-necked pheasant	DM,LF	c	c	c	c
?*King rail	DM,TM	r	r	r	
Virginia rail	TM,DM	c		c	
Sora rail	TM,DM	c		c	
*Common gallinule	TM,DM	a	a	a	u
*Killdeer	ML,LF	c	c	c	u
Common snipe	DM,TM	c		c	
*Spotted sandpiper	DM,TM	c	u	c	
Greater yellowlegs	TM,DM	c	u	c	r
Lesser yellowlegs	TM,DM	u	r	u	
Great black-backed gull	O	c		c	c
Herring gull	O	c	c	c	c

	Habitat	(March-May) Spring	(June-July) Summer	(Aug.-Nov.) Fall	(Dec.-Feb.) Winter
Ring-billed gull	O	c	c	c	r
*Rock dove	B,LF	c	c	c	c
*Mourning dove	LF,ML,DM	a	a	a	c
Short-eared owl	DM,TM,LF	c		c	a
Common nighthawk	O	u	u	u	
Chimney swift	O	c	c	c	
Yellow-shafted flicker	LF,DM	c	u	c	
Eastern kingbird	LF	u	r		
?*Traill's flycatcher	DM,LF	u	r	u	
?*Horned lark	ML,LF	c	u	c	r
Tree swallow	O	c	u	a	
Bank swallow	O	c	c	c	
Rough-winged swallow	O	u	u		
?*Barn swallow	O,B	a	c	a	
Blue jay	LF	u	u	u	u
Common crow	LF,ML	c	c	c	
*Long-billed marsh wren	TM,DM	a	a	a	
Mockingbird	LF,DM	u	u	u	
Catbird	LF	u		u	
*Robin	LF	u	u	u	

	Habitat	(March-May) Spring	(June-July) Summer	(Aug.-Nov.) Fall	(Dec.-Feb.) Winter
*Starling	B,LF,ML,DM	a	a	a	a
*Yellow warbler	LF	u	u	u	
*Yellowthroat	DM,TM,LF	c	c	c	
American redstart	LF,DM	c	r	c	
*House sparrow	B,LF	c	c	c	c
Bobolink	DM,TM,LF	c		a	
Eastern meadowlark	LF,ML	u		u	
*Red-winged blackbird	TM,DM,LF,ML	a	a	a	u
Common grackle	DM,TM,LF,ML	c	c	c	
Brown-headed cowbird	LF,DM,TM	c	r	c	
?*Indigo bunting	LF,DM	u	u	u	
?*House finch	LF,B	r	r	r	r
*American goldfinch	LF,DM	c	c	c	
Savannah sparrow	ML,LF	c		c	
Slate-colored junco	LF,ML	c		c	u
Tree sparrow	LF	u		u	u
White-throated sparrow	LF	c		c	u
*Swamp sparrow	DM,TM,LF	c	c	c	
*Song sparrow	DM,LF,TM	a	c	a	

Mammal Populations

At least ten species of mammals are known to occur in the diked marsh and landfill habitats on the proposed Sports Complex site (Table 2). The muskrat, long-tailed weasel, and Norway rat are the only species in the tidal marsh habitat. Only the house mouse frequents the mowed lawn habitat.

Abundant species include the house mouse, muskrat, and Norway rat. One house mouse was trapped on the dike, one Norway rat was trapped in a small wooded area west of Route 20, and another Norway rat was trapped on an embanked road north of the Maislin fill area on the night of 31 May/1 June. Other Norway rats were observed at the southeastern corner of the Maislin Fill and on the South-central Fill. One muskrat was seen in the north-central section of Diked Marsh on 5 June. A muskrat house and numerous muskrat droppings were noted in the Impounded Wetland. Several hundred muskrats reportedly are caught on the site every year by local trappers (Donald Smith, personal communication.)

One eastern cottontail was observed on the South-central Fill, but this species is reported to be common in diked marsh and landfill habitats. Several species which are seldom common in highly polluted areas still are represented by occasional individuals in the Diked Marsh and landfill habitats. These include the opossum, striped skunk, raccoon, gray fox, red fox, and long-tailed weasel. Wild dogs and feral house cats also are reported to visit the site, but none was observed during field investigations.

Table 2. Mammals of the proposed Jersey Sports Complex site, Bergen County, New Jersey, prepared from records by Donald Smith, Hackensack Meadowland Commission, and field observations by Jack McCormick & Associates 30 May to 2 June 1972 .

	Habitat	Abundance
House mouse	LF,ML,DM	a
Eastern cottontail	LF,DM	c
Muskrat	TM,DM,LF	a
Raccoon	LF,DM	r
Opossum	DM,LF	u
Striped skunk	DM,LF	u
Gray fox	DM,LF	r
Red fox	DM,LF	r
Long-tailed weasel	TM,DM,LF	r
Norway rat	LF,DM,TM	a

Amphibian and Reptile Populations

Northern leopard frogs are reported to be common in the Diked Marsh, but only one individual was observed during this field investigation. Painted turtles were noted to be common in the Diked Marsh, and snapping turtles are common in the Diked Marsh and Berrys Creek Tidal Marsh. Eastern garter snakes are reported to be common in the diked marsh and on landfills, but no other snakes or lizards are known to occur on the site.

Geology of the Site

Henry Harris

Bedrock in the site area is soft red shale, with occasional inter beds of fine-grained sandstone, of the Brunswick Formation (Late Triassic). The formation is folded and faulted; bedding dips to the northwest at an angle of 15° to 20°. The surface of the bedrock is weathered to a maximum depth of 3 feet; weathered material consists primarily of clay and bedrock fragments (F. R. Harris, 1971:5, 17).

There are three major topographic features of the bedrock surface. The axis of a ridge strikes east-west, bisecting the site. The ridge crest has a maximum height of about 40 feet below mean sea level just south of the junction of Route 20 and the Paterson Plank Road. The crest slopes southwestwardly to a minimum height of about 170 feet below sea level at Berrys Creek just north of Route 3. The axis of a bedrock valley approximates the path of Berrys Creek along the western margin of the site. The maximum elevation of the axis of this valley is about 100 feet below sea level at the place where the Creek flows under Paterson Plank Road. The valley axis slopes southwardly to a minimum elevation of about 170 feet below sea level at Berrys Creek just north of Route 3. Another bedrock valley lies immediately to the southwest of Route 3. This valley descends from an elevation of about 70 feet below sea level at the junction of Routes 3 and 20 to an elevation of about 160 feet below sea level just south of the Berrys Creek bridge on Route 3 (F. R. Harris, 1971:figure 2).

Glacial till of Pleistocene age overlies the bedrock throughout the site. The till is red-brown in color, and consists primarily of fragments derived from the Brunswick Formation. Sizes of materials composing the till range from greater than 12 inches (boulder size) to less than .005 milli-

meters (clay size). The till is thickest (about 20 feet) in the bedrock valley which parallels Berrys Creek. It is thinnest (about 5 feet) along the axis of the bedrock ridge which bisects the site (F. R. Harris, 1971:5-6, 15; figures 3, 4).

Water-saturated varved silts and clays of Pleistocene age overlie the glacial till throughout the site. This varved stratum also is thickest (about 53 feet) in the bedrock valley which parallels Berrys Creek. It is thinnest (about 13 feet) along the axis of the bedrock ridge which bisects the site. The upper section (top 20 feet) of the varved material is gray-brown silt and clay; it differs from the lower section only in that it is relatively dessicated and slightly different in color (F. R. Harris, 1971:6, 12-15; figures 3, 4).

A thin layer (0-5.5 feet) of gray, medium to fine-grained sand overlies the varved material throughout the site. This sand, which is of Recent age, is missing along Berrys Creek, where it has been removed by erosion (F. R. Harris, 1971:6, 12; figures 3, 4).

The uppermost natural stratum in the site area is marsh material of Recent age. This is largely organic, water-saturated material, intermixed with small amounts of stream-deposited silt. The uppermost portion of this material, which is known as meadow mat, is a mixture of decomposed and partially decomposed rhizomes and leaves of common reed grass. The meadow mat grades downward into decomposed conifer forest material, or peat. The combined thickness of peat and meadow mat ranges from 0 to 8 feet. This material is missing from the channel of Berrys Creek, and the stream bottom is eroded about 3 feet into the varved material. (F. R. Harris, 1971:6, 10-11; figures 3, 4).

Most of the proposed site was covered by cedar forests at least from pre-colonial times to 1900 (Map 9). The upper 3-feet section of organic soils in the formerly forested area consists principally of fibrous, woody peat. Logs, stumps, and roots of trees occur in and on the peat. The lower section of the material largely is organic clay (Vermeule, 1897; Waksman, 1943; Harmon and Tedrow, 1969: their Maislin site is the Impounded wetland; their Koziol site is on the Route 20 East Fill.)

Stratigraphic Section

UNIT	AGE	THICKNESS	DISTRIBUTION	ATTITUDE	COMPOSITION	OTHER CHARACTERS
Fill	Recent to Present	0-10'	Irregular. Sometimes on marsh stratum, sometimes in excavations in marsh stratum. Sometimes associated with construction.	Horizontal	Sanitary Refuse, some demolition waste.	Sanitary Refuse evolves H_2S and CH_4 gases.
Marsh Stratum	Recent to Present	0-8'	All locations, except those excavated for fill and in Berry's Creek. Fairly even thickness.	Horizontal	Decomposing and decomposed organic material, with some stream-deposited silt.	Highly compressible, water saturated, unsuitable for building without surcharging and draining to relieve pore pressure, impermeable.
Sand	Recent	0-5.5'	All locations as a thin layer, except along Berrys Creek.	Essentially Horizontal	Unconsolidated, gray, medium to fine grained sand, with traces of silt.	Relatively incompressible, permeable.
Varved Stratum	Pleistocene	10-65'	All locations, thickest along bedrock channel, thinnest along bedrock ridge.	Horizontal	Upper Zone: 20' thick, gray-brown silt and clay, preconsolidated. Lower Zone: variable thickness.	Compressible, will support minor structures on spread footing or piles, impermeable.
Glacial Till	Pleistocene	10-20'	All locations, thickest along bedrock channel, thinnest along bedrock ridge.	Horizontal	Red-brown till, boulder (>12") to clay (.005 mm) sizes. Largely derived from bedrock.	Will support major structures on piles, variable permeability.
Weathered Bedrock	Post-Triassic Pre-Pleistocene	3'	All locations.	Parallels Bedrock Surface	Clay and other weathering products, fragments of bedrock.	Impermeable.
Bedrock	Late Triassic	-	All locations.	15-20° dip to NW	Brunswick Formations: soft red shale with occasional beds of fine sand.	Will support major structures on piles. Normally impermeable, except along fractures.

Water Quality Survey

Richard McLean and Jack McCormick

Two previous studies of the quality of water in Berrys Creek adjacent to the proposed site for the New Jersey Sports Complex were supplied by the Hackensack Meadowlands Development Commission. The earlier of these investigations was made by the Federal Water Pollution Control Administration (FWPCA) during the summer of 1964 (Public Health Service, 1966). FWPCA water quality stations were established near the mouth of Berrys Creek, about 2.4 miles from the proposed site (Station 222); near the mouth of the Berrys Creek Canal (= Erie Canal), about 1.3 miles from the proposed site (Station 225); at the Route 3 highway bridge adjacent to the site (Station 226); and at the Hoboken Road bridge about 1.7 miles north of the proposed site (Station 227).

Most FWPCA sampling was confined to stations on the Hackensack River mainstem, but a special phenol study was made on the Berrys Creek Canal and upper Berrys Creek in June 1964. Results indicated that phenols were present in concentrations ranging from 20 to 340 parts per billion whereas the desired standard listed by FWPCA was 5.0 parts per billion or less. Because the concentrations always were greatest at Station 227 and increased at all stations with time after high slack, the source (unidentified) was considered to be situated upstream from Station 227.

Results of analyses at Station 230 on the mainstem of the Hackensack River about 0.8 mile above the mouth of the Berrys Creek Canal probably are

most representative of the quality of water that enters Berrys Creek on flooding tides. In June the concentration of suspended solids at this station was 25 mg/l, or about half as great as that recorded about 1 mile downstream. This reflects the possible presence of a settleable load that is biologically effective by reducing light penetration, by clogging the gills and respiratory passages of animals, by covering eggs, spawning beds, and food organisms, and by transporting bacteria to the bottom where their activities may deplete the dissolved oxygen.

Turbidity (37 units) and color (76 units), both of which were measured in August, were well within standards set for potable water supply. Chloride measurements from 8 to 17 June 1964 indicated that salt water intrudes the full length of the Hackensack estuary, from Newark Bay to the Oradell Reservoir. At Station 230 the concentration of chlorides was 5,500 mg/l; the highest concentration, recorded near Newark Bay, was 9,400 mg/l.

Concentrations of organic nitrogen and organic phosphate (PO_4) near the Berrys Creek Canal both were in the intermediate range of mainstem values (4.65 and 4.7 mg/l, respectively). Optimum ratios of nitrogen to phosphorous in stream water generally are considered to be in the range of 15:1 to 30:1. The gross imbalance noted in the Hackensack River (approximately 1:1 at Station 230) reflects a severely upset condition that can be attributed to heavy discharges of poorly treated sewage and probably to some industrial effluents as well.

Chemical oxygen demand (C.O.D.) at high tide slack in June 1964 was 115 ppm. This value was the highest C.O.D. measured on the mainstem. At

Station 224, located about 0.25 mile below the mouth of the Berrys Creek Canal, the C.O.D. was 78 ppm. These readings indicate a significantly high concentration of oxygen demanding substances in the water.

Whereas C.O.D. measurements do not distinguish between oxidizable substances which are biologically inert and those which are biologically oxidizable, measurements of biological oxygen demand (B.O.D.) do make this distinction. At high slack in June 1964, B.O.D. at Station 230 was 3.7 mg/l. The first stage, 5-day B.O.D. of unpolluted surface waters generally ranges from 2 to 3 mg/l. In contrast, the Hackensack mainstem range was from 2.5 to 10.5 mg/l. At high slack, however, the highest B.O.D. concentration was only 6.8 mg/l. These concentrations, however, indicate that a significant load of organic pollution was being received by the river.

Correlated with the high B.O.D., the concentration of dissolved oxygen was only 2 mg/l, or approximately 22.5% as great as the saturation concentration. This low concentration probably enforces a lethal stress on most aquatic organisms. Most fish and other aquatic organisms, for example, are unable to live in water with less than about 4 mg/l of dissolved oxygen.

Coliform counts, both for total coliform and fecal coliform organisms, were surprisingly low at Station 230 during high water slack. Owing to the fact that two municipal treatment plants discharge into Berrys Creek north of Route 3, the coliform counts in the Creek probably are much higher than those for Station 230. Very high counts near the mouth of the Hackensack River led the FWPCA investigators to conclude that fecal contamination precludes the use of the tidal portion of river "for a municipal supply and

[it is] an undesirable location for any water contact sport or for the propagation of fish or shellfish."

The monitoring program by the Newark College of Engineering during the period from 15 June to 15 August 1971 utilized stations on Berrys Creek at the south and north boundaries of the proposed site (Station 9 at Route 3 and Station 4 at Paterson Plank Road, respectively) and a third station upstream from the site (Station 2). Results of the study indicate that dissolved oxygen was vitrually absent from the water of the creek. Total phosphate and nitrate concentration were very high and indicate substantial degradation of water quality by sewage and industrial discharges. As expected, the concentration of chlorides was highest at the downstream station (Route 3, 4670 ppm) and least at the upstream station (1770 ppm), but the influence of saline water is demonstrated throughout the reach.

The Hackensack Meadowlands Development Commission also supplied information concerning several industries which allegedly are under administrative order for discharging pollutants into Berrys Creek or its tributaries. These include two firms on the proposed site. A trucking company allegedly permits crankcase oil to flow into a ditch in the Diked Marsh area. A metal processing company allegedly discharges chromium and possibly other heavy metals, as well as substances with high C.O.D.'s into the Diked Marsh. Ditches in this marsh drain through a tide gate into the Berrys Creek Tidal Marsh and thence to the stream.

Stations Employed in the Present Survey

Station 1: Located in the Berrys Creek Tidal Marsh on the second channel north of the Sportland Fill.

Station 1A: Located in a common reed grass stand approximately 3 meters

south of the channel bank at Station 1.

Station 2: Located in the tidal marsh, 20 meters east of Berrys Creek, on the first channel north of a straight ditch connecting a tide gate with Berrys Creek.

Station 2A: Located in a common reed grass stand approximately 3 meters south of the channel bank at Station 2.

Station 3: Located in the Berrys Creek Tidal Marsh on a ditch near the dike and south of the tide gate.

Station 4: Located in the west-central section of the Diked Marsh along a ditch north of the tide gate.

Station 5: Located in the northern section of the Diked Marsh along a ditch that flows through a culvert in an embankment west of the Metro Industrial Park.

Station 6: Located in the east-central section of the Diked Marsh on a ditch approximately 100 meters south of the Metro Industrial Park parking lot.

Station 7: Located in the east-central section of the Diked Marsh south of Station 6. The ditch between the two stations is obscured by a solid waste landfill.

Station 8: Located in the Turnpike Tidal Marsh, near the Paterson Plank Road, on a channel draining through a culvert beneath the New Jersey Turnpike.

Methods

All stations were visited on 5 June 1972. Station 1 also was sampled on 31 May 1972. Water temperatures and dissolved oxygen concentrations

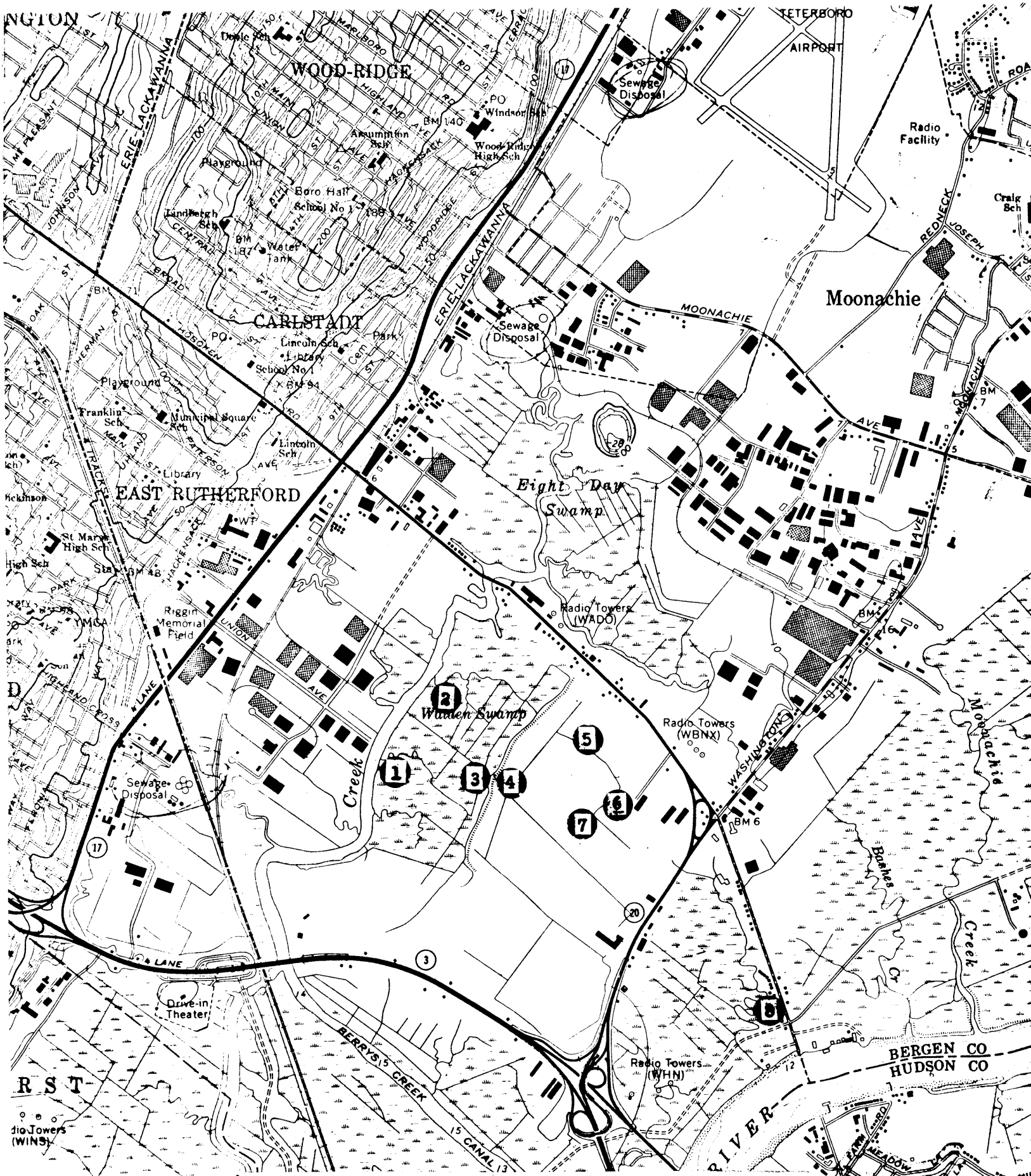


FIGURE 1: STATIONS EMPLOYED IN THE PRESENT STUDY

were measured in the field at Stations 1, 3, 4, 6, and 8 with an oxygen meter manufactured by the Yellow Springs Instrument Company (Model 51A). Samples of water were collected at times of ebbing or low tide and flooding or low tide at Stations 1, 6, and 8. These were refrigerated within 12 hours and submitted to Roy F. Weston, Inc., West Chester, Pennsylvania, for analysis of nitrate-nitrogen, nitrite-nitrogen, total phosphate, and cyanide in accordance with Standard Methods (Ed. 13). Specific conductance of subsamples was measured with platinum electrodes, a 60-cycle AC bridge, and a cathode ray oscilloscope (DuMont Model 164E) in accordance with Standard Methods (Ed. 13). Water reaction (pH) was determined with an electric meter (Heath Servo Digital pH/volt Meter, Model EU-302A). A Hach Colorimeter (Model DR-EL 1206-00) was employed to evaluate turbidity and color (apparent and true) by direct readings.

Samples of the substrate from a tidal channel and the tidal marsh (Stations 1, 1A, and 2A) were obtained with a Naumann bottom corer. These samples were submitted to Roy F. Weston, Inc., for analysis of heavy metal concentrations (chromium, arsenic, mercury).

Nets were used at Stations 1, 2, 3, 4, 5, and 6 to search for aquatic invertebrates. Muck from the channel bottom at Station 1 was obtained with a Petersen dredge and sieved. Logs, stumps, and submerged vegetation also were examined for invertebrates.

Gaseous bubbles were collected from the water at Station 7 with a weighted funnel equipped with tubing that was led into a water-filled bottle fitted with a petcock. After a sufficient volume of gas was collected, the bottle was retrieved, the petcock was opened, and the escaping gas was tested with a match.

Observations

The results of field measurements and laboratory analyses of water and substrate samples are summarized in Tables 1 and 2.

No macroscopic aquatic invertebrates were found in any dredging, net sample, or ocular examination in the Berrys Creek Tidal Marsh. Spring tails (collembola), however, were abundant on the bank of a ditch and on the water surface in the marsh at Station 3. Adult mosquitoes and dragonflies also were observed in flight at this station. Approximately ten killifish were seen at Stations 1 and 3. Oil slicks were noted on the water at Station 3 and an odor of sewage was strong.

The Turnpike Tidal Marsh appeared to be severely polluted and rubbish was abundant on channel banks as well as in the water. No invertebrates were revealed by a reconaissance search.

In the Diked Marsh, snails (genus *Physa*) were found at Station 4 along the ditch banks and under several waterlogged tree stumps. No other kinds of invertebrates were obtained here or at Stations 5 and 6, although killifish were observed at Stations 4 and 6. Blue-green algae were relatively abundant and duckweed plants occurred on the water surface. The ditch bottoms generally were composed of a black organic material which, presumably, represented oxidized forest peat. Gases were generated from this material and bubbles of gas were noticed at every station in the Diked Marsh. The odor in some places suggested that hydrogen sulfide was being generated. An ignition test at Station 7, where collected gas burned with a hot, yellowish-blue flame, suggested that large volumes of methane are generated on the site.

Discussion

The flood tide values for Station 1 are considered to describe the quality of water in Berrys Creek as it flows into the vegetated tidal marsh (Table 1). Values obtained on the ebbing tide are considered to represent the quality of the same water after a residence time of approximately 6 hours in the flooded marsh area. Differences between these two sets of values, therefore, should characterize any influence exerted on water quality by biological or chemical processes of the marsh. Similarly, the influence of the Turnpike Tidal Marsh should be characterized by differences between the values obtained at Station 8 on a flood tide (descriptive of the inflowing water from the Hackensack River) and on an ebb tide. Conditions in the Diked Marsh, in which no water-level fluctuation was noted during the sampling day, are represented by measurements made at Station 6. The measurements were made at times which corresponded to periods of flooding and ebbing tides in the nearby Berrys Creek Tidal Marsh (Table 1).

Dissolved oxygen virtually is absent from the water in Berrys Creek and in the tidal marsh channels. Although the two marsh areas did inject oxygen into the water during the tidal excursion sampled, the increase in dissolved oxygen concentrations was not sufficient to render the water suitable as an environment for aquatic animals.

Comparisons of differences for other individual parameters between flood and ebb tide measurements on the two tidal marshes reveals a general lack of consistency. Temperature and turbidity changes, however, may indicate a relative lack of circulation and longer residence time in the Turnpike Tidal Marsh than in the Berrys Creek Tidal Marsh. Nutrient

concentrations, which increased in the Berrys Creek marsh and generally decreased in the Turnpike Marsh, particularly when they are related to the reversed trend in turbidity, may indicate a substantial load of very mobile organic sediments in the Berrys Creek marsh. These sediments presumably originate principally from the two sewage plants that discharge to the creek.

Water temperature and dissolved oxygen both increased during the afternoon in the Diked Marsh (Station 6). Turbidity and the concentrations of nitrate- and nitrite-nitrogen also increased and may indicate the influence of the diurnal patterns of industries which are alleged to discharge wastes into the area.

Specific conductance measurements revealed higher values for water from the Berrys Creek Tidal Marsh and Diked Marsh areas than in water from the Turnpike Marsh which is connected directly to the Hackensack River. These results are interpreted to indicate that the water at the time of sampling was only slightly brackish and that chemical pollution was substantially greater in Berrys Creek and in the Diked Marsh than in the Hackensack River. The significant increase in the specific conductance of water during its residence in the Turnpike Tidal Marsh may indicate a local source of chemical pollution from an industrial discharge.

Analyses of water samples from the three main stations (Stations 1, 6, 8) indicate only traces of cyanide. Although it was alledged that significant quantities of this toxic substance have been released in industrial discharges, the current concentrations are not adequate to

account for the virtual absence of aquatic life. Occasional temporary excursions of water containing high concentrations of cyanide, however, could contribute to the biotic sterility without leaving persistent traces.

Water samples from the Berrys Creek Tidal Marsh and the Diked Marsh were introduced into tubes with lactose broth and subcultured into brilliant green lactose bile broth. Abundant gas was generated in all tubes. These results indicate that the areas are contaminated with coliform bacteria which probably originate from the local sewage treatment plants.

Only killifish and snails of the genus *Physa*, both of which are known to be resistant to water pollution, were found in water on the proposed site. Blue-green algae (*Oscillatoria* and *Anabaena*) that are present on the site also are characteristic of areas with heavy loads of organic pollution.

Chromium, arsenic, and mercury are present in unusually high concentrations in the muck beneath the surface and in the channels of the Berrys Creek Tidal Marsh. These persistent toxic pollutants, which represent a long-term public cost of unregulated discharges by private industries, appear to be contained principally in the upper 2 to 4 inches of the substrate. The present mobility of the substances is unknown. If they are absorbed by the common reed grass which grows in dense stands on the marsh surface, however, they may be circulated in detritus throughout the Newark Bay estuarine system. Any benthic macrofauna which might be enabled to occupy the area if dissolved oxygen concentrations and other water quality

characteristics were improved, probably would be killed by these metallic residues. Should such benthic organisms be able to survive, however, they could mobilize the toxic materials by roiling the sediments. As they ingest sediments or microorganisms from the sediments (bacteria were shown to be present by tests described above; nematodes were reported to be abundant by Dr. Edward MacNamara in a personal interview), the benthic macrofauna might incorporate and concentrate the metallic substances into their bodies. Wading birds, shorebirds, and other predators on the benthic fauna could further concentrate the materials and pass them to higher predators in the food web. Such higher predators include waterfowl hunters who frequent the region.

Table 1. Water quality analyses at stations in tidal and diked marshes on the proposed site of the New Jersey Sports Complex. Measurements at Station 1 were made on 31 May 1972. All other measurements were made on 5 June 1972.

Location	Berrys Creek Tidal Marsh			Diked Marsh			Turnpike Tidal Marsh	
Station Number	1		3	4	6		8	
Tide	High	Low	-	-	No Change		1/2 Flood	1/6 Ebb
Water Temperature Degrees C.	20.7	19.0	26.	27.3	22.0	25.2	24.0	24.9
Dissolved Oxygen mg/l	<0.1	1.4	0.8	0.9	0.9	2.6	2.2	6.4
pH Units	7.46	7.11	-	-	6.75	6.76	7.37	7.41
Specific Conductance Micro Mhos/Cm	2,468.0	2,400.8	-	-	1,970.7	1,985.6	1,178.9	
Turbidity JTU	60.	74.	-	-	196.	220.	26.	23.
Apparent Color APHA Units	183.	204.	-	-	>500.	>500.	95.	115.
True Color APHA Units	117.	112.	-	-	>500.	>500.	52.	71.
Nitrite-Nitrogen mg/l N	<0.001	0.002	-	-	0.002	0.12	0.10	0.002

Table 1. Water quality analyses (continued).

	1		3	4	6		8	
Nitrate-Nitrogen mg/l N	0.24	0.32	-	-	0.28	0.64	0.56	0.48
Total Phosphate mg/l P	2.1	2.4	-	-	0.55	0.50	1.45	1.45
Cyanide mg/l	< 0.05	< 0.05	-	-	< 0.05	< 0.05	< 0.05	< 0.05

New Jersey Sports Complex

Preliminary Noise Impact Statement

Bolt Beranek and Newman, Inc.

Summary

The Sports Complex site has a number of inherent advantages relative to its acoustic impact on its surroundings and the impact of the surroundings on it. First, the general area now is occupied primarily by industrial and transportation (highways and airports) facilities with the nearest residential areas about one mile distant. This means that the ambient noise levels in the area are significant in level (relative to the new levels caused by the Sports Complex) and rather constant in time character. As a result, the increase in noise levels at the nearest residences due to the site will be much less than if a quieter location had been chosen or if residences were nearer. In general, the noise increases at existing residences will vary from none to moderate (5 to 15 dBA, chiefly due to public address systems and increases in traffic flow before and after spectator events). In no case is a great (over 15 dBA) impact foreseen.

The second advantage of the site is that it is large. This allows the critical residential (Racetrack Dormitories and the Hotel-Motel Complex) buildings to be located at least several hundred feet from nearby highways. A moderate amount of concern with noise control in these buildings during their design will result in completely acceptable interior noise environments.

Impact of the Site on the Community

A. Spectator Traffic

One of the prime impacts on the community due to the Sports Complex will be the increase in the noise levels due to spectator automobile traffic before and after events. Table I shows the most frequent serious case, a weekday baseball game with all spectators leaving within one hour of the 11:00 p.m. game finish and the less frequent but worse case, a night football game departure period. As a model for evaluation purposes, we have considered the acoustic environment in a residence 200 feet from each highway listed, and assumed that the traffic speed is a nominal 60 mph.

An initial test for residence suitability relates to sleep interference. We have used the figure 40 dBA as the maximum interior noise levels for no sleep interference. This figure, plus an assumed 15 dBA reduction in noise levels due to passage from outside through partly opened windows, yields an outdoor criteria of 55 dBA at the residence. For 200 feet, distance to the roadway, this can be equated to a traffic flow of about 200 automobiles per hour (at 60 mph). Every location in the survey now equals or exceeds this criteria. We must then conclude that the whole local area is at present marginal with regard to sleep interference.

Another more general criterion for suitability that may be applied to evaluating the site is the first version of the Department of Housing and Urban Development's Noise Assessment Guidelines. The Guidelines describe four levels of acceptability - Clearly Acceptable (CA), Normally Acceptable (NA), Normally Unacceptable (NU), and Clearly Unacceptable (CU). (Later versions of the guidelines lump the NA and NU categories in a single category called "Discretionary"). The HUD Guidelines recognize that individual annoyance with noise varies and define bands of noise level ranging from low values where many people would agree to a lesser category

of acceptability through a range where opinions would differ to the upper limit where again a decision as to category may be reached.

Table I uses the four categories to assess the impact of Spectator automobile traffic. In no case is the change due to the increased traffic flow more than one category (in fact, there is never more than an 8 dB increase in noise levels) and the levels are always in the "Discretionary" category, never reaching Clearly Unacceptable levels. (For the assumed case, the traffic flows at the boundaries of the categories are:

CA to NA 0 to 130 vehicles per hour (vph)

NA to NU 130 to 1,200 vph

NU to CU 1,200 to 50,000 vph

We may conclude then, that at worst, the increase in local automobile traffic due to the Sports Complex will be moderate and will never cause clearly unacceptable living conditions in existing residential areas.

B. Football (or Baseball) Stadium Public Address System

Another prime source of noise from the site will be the public address systems used at the tracks and stadiums. Predicting the impact due to these systems is an uncertain task since the sound output is extremely variable due to a) the 30 dB dynamic range of normal speech, and b) the variations in speech levels that the announcer might use to be heard over crowd noise.

To take a worst case, the peak output of a good P.A. speaker system is often chosen to give levels of about 95 dBA at the most distant spectator. Since the nearest residences are at 6000' and there is some barrier effect due to the stadium structure, the levels at the residences would be about 63 dBA (assuming installation of a 10-foot-high sound barrier around the upper rim of the stadium). Evening traffic on Route 17 might be expected to result in levels between 70 and 80 dBA at 100 feet. At 1,000 feet farther away

from Route 17, these levels might be expected to drop from 50 to 60 dBA. The P.A. system peak levels will drop to about 60 dBA. So it is evident that if a peak in P.A. system sound levels coincides with a lull in traffic noise levels, the P.A. system might be identified. In summary, it will be a problem of marginal importance to existing residences.

Other noise problems to neighbors of the site probably will be slight in comparison to the roadway and stadium noise. For example, the arena and racetrack grandstands are to be enclosed and the Theme Park, while out-of-doors, is susceptible to noise control as through the use of rubber tires on any ride vehicles.

C. Wildlife

The impact on wildlife due to noise at the site cannot be precisely forecast. This is because animals have not shown any observable reactions to the relatively low noise levels (below 90 dBA) that will occur at the site. Construction noise levels, especially any blasting, will be higher but we would expect wild animals to avoid the specific areas where construction is in progress.

The question of annoyance of the horses in the stables is also pertinent. Although few data are available here, we would expect that as long as the noise levels are reasonable (below 80 dBA) and fairly constant, the horses should not be bothered. To illustrate: horses are often transported in very noisy environments - jet freighters or open trailers where

noise levels are over 80 dBA. We would expect noises of high level and an intermittent character or a very rapid rise time to be needed to disturb horses. The possibility of aircraft overflights disturbing horses might exist. This should be studied further.

Impact of Existing Noise Sources on Site

Teterboro Airport

The nearest airport is the Teterboro Airport about 2 miles north of the site. Although it has no civil air traffic, it is use extensively by jet powered business aircraft which are as noisy as the larger DC-9's, 727's, 737's, etc. The primary jet use runway at Teterboro is 1-19; about 90% of the jet aircraft operations occur on this runway. We are primarily concerned with flight paths which pass near the site: takeoffs on runway 19 and landings on runway 1. The extension of runway 1-19 passes just east of the site, about 1000-1500 feet east of the proposed location of the Hotel. According to predictions of noise levels using Composite Noise Ratings (CNR) and HUD Guidelines methods, the eastern portion of the site should be placed in a Normally Unacceptable category for normal residences. Because the Hotel will have air conditioning and fixed windows, the noise intrusion will be much less than in normal dwellings, so a change of one category would seem appropriate. The resulting Normally Acceptable rating would mean that some

concern should be shown to the abatement of the aircraft noise intrusion during the design of the Hotel. This would include such items as providing a masking ambient noise source such as air conditioning diffuser noise for each unit, providing adequate transmission loss in walls and glass, etc. The precise needs should be determined based upon on-site noise measurements.

Newark Airport

The impact upon the site due to the Newark Airport, located about 8 miles southwest of the site, is more difficult to predict. The western portion of the site is very close to an extension of Newark's Runways 4-22 (dual). For IFR landings, where the flight path closely follows the runway extension, aircraft will pass close to the site. For all other operations, we would expect that the aircraft would be turning between the airport and the site and not pass as close to the site. So, again, the design of the dormitories should be based on comprehensive noise measurements taken at the site. A complicating factor is that air traffic at Newark is expected to rise substantially in the near future when the new terminal area is completed. This will result in increased noise levels at the site. The worst case (straight line flight paths - no turns between site and airport) noise prediction places the western portion of the site in the Normally Unacceptable category. Again, this is a worst case prediction. The final prediction should be based on detailed CNR or NEF (Noise Exposure Forecast) methods which incorporate information on flight paths, aircraft types, etc. Contours of this sort are not available for either Newark or Teterboro airports.

Highway Traffic

1) Dormitories

The dormitories will be located near the stables and west of the horse racetrack. The controlling noise source for this location (other than aircraft noise) is truck traffic on Patterson Plank Road. A dorm 1500 feet from the road would be in the Normally Acceptable category. A location 800 feet from Patterson Plank Road would be Normally Unacceptable. Both of these locations are within the HUD "Discretionary" category and, as such, would require adequate noise control features to be incorporated in their design, in order to result in completely satisfactory interior environments.

2) Hotel

The controlling traffic noise source for the Hotel is truck traffic on Route 20. Noise from the New Jersey Turnpike and associated post-toll station accelerations is also important. The strict application of the HUD Guidelines puts the Hotel site in the Normally Unacceptable category. To compensate for the closed windows in the air-conditioned building, we change the category one step to Normally Acceptable. This site is in HUD's "Discretionary" category and will require adequate noise control treatment to result in a completely satisfactory interior noise environment.

3) Other Structures - Stadiums, Tracks, Etc.

The highway noise levels within the open stadiums, tracks, etc., will be well within desirable limits for sporting events. Normal crowd

noise is apt to be much louder than the highway noise. Music, or other fine art uses should be studied before becoming an integral part of the use plan. A well-designed P.A. system will easily be heard over highway noises. With possible brief (a few seconds) interruptions from aircraft over flights, the spectator environment should be fully acceptable.

Table 2. Heavy metal analyses of sediment samples from the Berrys Creek Tidal Marsh. (Analyses were conducted by Roy F. Weston, Inc.)

Station Number	1			1A		2	
Locale	Channel Bottom			Phragmites Stands			
Sample Number	4a	4b	4c	4d	4e	5a	5b
Depth From Surface Inches	0-2	2-4	4-6	0-2	4-6	0-2	3-5
Chromium mcg/gm dry wt.	1,900	590	30	620	260	430	740
Arsenic mcg/gm dry wt.	70.0	26.3	8.75	29.8	67.6	34.2	33.6
Mercury mcg/gm dry wt.	74.0	38.0	0.32	19.0	7.4	26.0	44.0

TABLE I

SPECTATOR AUTOMOBILE TRAFFIC NOISE IMPACT

	Road	Community	Traffic Level Vehicles per hour			Present* Category	Category* With Peak Baseball Traffic	Category With Peak Football Traffic
			Present 11-12 pm	Baseball 11-12 pm	Football 11-12 pm			
1.	Rte. 3 West of site	Rutherford	600	2000	2100	NA	NU	NU
2.	Rte. 17 North of site	Wood-Ridge	300	2600	3300	NA	NU	NU
3.	Rte. 3 East of N. J. Turnpike	Secaucus	800	3800	2800	NA	NU	NU
4.	Washington Avenue North of site	Little Ferry	200	500	700	NA	NA	NA

*See text for key

Water Pollution

Bolt Beranek and Newman, Inc. and

Jack McCormick & Associates

Three potential water pollution sources are associated with the Sports Complex:

Sanitary sewage and other high BOD effluents from the toilet, food preparation, and hotel facilities;

Runoff and seepage associated with the animals kept at the racetrack; and

Runoff associated with the parking lots.

These sources deserve careful attention, particularly in view of the poor water quality extant in Berrys Creek and the Hackensack River. (The condition of surface waters is described in a chapter on Water Quality.)

Sanitary Sewage

Based on the water use for the Complex, a sanitary sewage flow averaging 770,000 gallons per day and peaking to 1,070,000 gpd is expected. The sewage would pass through gravity-flow lines to the East Rutherford pumping station, which is on the site, and then would be pumped to the Bergen County Sewer Authority trunk lines for treatment at Little Ferry.

The original capacity of the Little Ferry plant was 20 mgd when it was placed in service in 1951. Subsequent expansions increased the plant capacity to 50 mgd by 1964. The plant includes primary and secondary treatment with a design BOD reduction of 80%. Chlorination of the plant effluent (to 38 ppm chlorine) is practiced from May 15 to October 15 prior to discharge into the Hackensack River.

During the period January 1966 through July 1969, reported average influent, effluent, and treatment efficiencies were:

	Average Influent	Average Effluent	Average % Reduction
BOD	211 ppm	28 ppm	87%
Suspended Solids	292 ppm	32 ppm	89%

Wastes from the plant include grit washed from the sewage (which is buried on-site) and digested sludge (which is barged to a sea disposal point).

At the present time, the Little Ferry plant is operating at a minimum of 80% removal and about 50 ppm BOD in the effluent. The plant is at or slightly above capacity. Plans have been prepared for an expansion of the plant to 75 mgd. Implementation of the expansion appears to hinge on passage of water quality legislation currently before the United States Congress. Other steps, such as setting the priority of the Little Ferry expansion and designation of the design treatment level, are the responsibilities of the New Jersey Department of Environmental Protection. Treatment levels to be specified will depend on the results of a contract study of the Hackensack River estuary by Teledyne Isotopes, of Westwood, New Jersey, which is expected to be completed in September 1972. If the plans

were approved by 1 January 1973, if money were available by 1 July 1973, and if the plant construction were completed in the minimum 18 months estimated to be required, new capacity would be available on 1 January 1975.

In plans for the expansion of the BCSA Little Ferry Plant, the proposed site for the Sports Complex was considered to be destined for full industrialization. The sewage flow from the site was estimated to be 2500 gallons per acre per day. From the authorized 750 acres, therefore, a flow of 1.875 mgd was anticipated. This is 1.105 mgd more than is estimated to be generated by the Sports Complex as currently conceived.

After treatment in the expanded Little Ferry plant, if the plant were to operate at minimum levels of 80% removal of BOD and suspended solids, the outfall from the 0.77 mgd average flow would contain approximately 320 lb/day of BOD (50 ppm). Occasional peak flows of 1.07 mgd would contain 445 lb/day of BOD. The quantities would be halved if the plant provided 90% removal.

The earliest start-up date for an expanded BCSA Little Ferry plant is 1 January 1975. If construction of the Sports Complex is initiated as planned on 1 October 1972, the racing facility will be ready for operation in mid-1974, the football stadium will be completed by mid-1975, and other facilities will follow at presently undetermined dates. It appears, therefore, that wastewater from the racing facility will be discharged to the Little Ferry plant during a few months before expansion. The scheduling of all other facilities, however, will bring them into operation after the earliest possible start-up date for the expanded treatment plant.

If the approval, funding, or construction of the BCSA Little Ferry plant, or any combination of them, is delayed, the start-up date for the expanded plant will be postponed. Should this occur, it is likely that the stadium will be completed before the expanded plant is ready. It also is possible that the theme park, hotel, and arena also could be ready for operation before the expanded plant is on-line. If effluents from these facilities are routed to Little Ferry during the pre-expansion period, they will represent an additional overload. Loading a treatment plant above its design capacity necessitates a shorter processing period and results in decreased treatment effectiveness. The degree of decrement will depend on the total overload and on the dynamic response of the specific plant.

Recommendations on Sanitary Sewage

The Sports Authority should support strongly the expansion and upgrading of the Bergen County Sewage Authority treatment plant at Little Ferry. Within the limits of careful planning and design, fiscal responsibility, and quality construction, an as-early-as-possible start-up date for the expanded plant should be encouraged.

If plant expansion is complete by 1 January 1975, from 0.1 to 0.2 mgd of sewage outflow is expected to be generated. This would represent a 0.2% to 0.4% overload and will not produce any major stress on the efficiency of the Little Ferry plant. With an 0.2 mgd overload, an additional 83 lbs of BOD would be discharged daily (estimated on basis of 0.4% reduction of efficiency in treatment of 50.2 mgd flow). The

83 lbs would represent an additional contribution to the receiving stream of 0.4% (based on 80% treatment of 50 mgd design capacity, or 20,863 lbs/day BOD).

If the Little Ferry plant is not expanded by 1 January 1975, the Sports Authority should not initiate, or should postpone completion of the hotel, arena, and theme park until such time as an expanded plant is on line. The number of home games to be played in the Stadium during the pre-expansion period should be minimized and, if deemed necessary and desirable by State or Federal agencies with jurisdiction, an equalizing tank should be installed to avoid overloading the pumping or treatment facilities by peak flows.

Racetrack Runoff

The manure deposited in the horse stables and other areas at the racetrack are a significant though controllable source of water pollution. The primary points of concern are runoff from the stalls and manure pits. For the stall floors, tamped earth will be used and, at an appropriate depth, an impervious film and/or drains will be installed to either retain or provide controlled discharge of liquid wastes.

Practices in manure management vary widely. At the track in the Complex, the manure will be frequently removed from the stalls and transferred to manure pits; a chamber with concrete walls and floor will incorporate proper drains to the sanitary sewer. The pits will be equipped with elevated roofs to shed rainfall without closely

sealing the chamber.

Parking Lot Runoff

Berrys Creek currently is not able to absorb additional impure waste water flows. In view of the suspended solids, organic matter, oils, and perhaps lead (from settled auto exhaust particulate) which will be washed from the extensive (250 acres) parking facilities at the Complex during a rainfall, it is desirable that some form of treatment be provided to the runoff prior to its discharge. The total quantity of runoff approximates 225 million gallons per year (40± inches of rainfall and about 85% capture in the drainage system).

The treatment needs of flows of this nature are not well characterized. The lagoons, planned for operation in series, could serve as aerobic treatment ponds. In addition to, or in place of, such use of the lagoons, some form of mechanical or chemical treatment also may be necessary.

Solid Wastes

Bolt Beranek & Newman, Inc.

The solid wastes generated within the Sports Complex will arise in the course of a number of site operations:

Wastes generated during sporting events;

Wastes generated in the offices and living quarters;

Wastes generated by the Theme Park activity;

Wastes generated by the Hotel operation; and

Wastes generated in the horse stabling activity.

The total of these wastes is approximately 15,000 tons per year and, as discussed below, does not appear to present a significant environmental impact on or off the site.

A. Wastes generated during sporting events.

In order to estimate the quantity of solid wastes generated during the conduct of sporting events, data on refuse quantities and related attendance were solicited from Shaeffer Stadium in Foxboro, Massachusetts; Boston Garden in Boston, Massachusetts; Kansas City Stadium in Kansas City, Kansas; and Suffolk Downs Racetrack, Boston, Massachusetts. The reported generation rates varied from 0.2 to 0.5 lb/attendee/event with an average of 0.36 lb/attendee/event.

Based on the yearly attendance estimates shown in Table A, an annual solid waste generation rate of 1125 tons was calculated for the proposed New Jersey Sports Complex. Some portion of this waste, however, arises from normal human activity which has been temporarily displaced from elsewhere in New Jersey and New York. All of the 1125 tons, thus, does not

Table A

Total Estimated Attendance at Sporting Events

Event	Average Attendance	Events per Year	Attendance
Football Game (professional)	75,000	10	750,000
Football Game (collegiate)	40,000	10	400,000
Racing Day	25,000	160	4,000,000
Hockey Game	15,000	40	600,000
Basketball Game	10,000	40	400,000
Miscellaneous Arena	10,000	10	100,000
		Total	6,250,000

Table B

Summary of Waste Generation by Visitors and Disposition

Source	Quantity (Tons/Yr.)	%	Probable Disposition
Sporting Events	1125	7.8	HMDC Landfill (recycle?)
Offices/Residences	650	4.5	HMDC Landfill
Theme Park	750	5.2	HMDC Landfill (recycle?)
Hotel	1850	12.9	HMDC Landfill
Horse Stables	10,000	69.6	C & C Composting Company
Total	14,375	100.0	

represent "new" waste but in part is comprised of waste discarded at the Complex instead of "at home".

The composition of the wastes generated at sporting events is highly variable, and, to a large extent, reflects the methodology selected by the Concessionnaire in the food services activity. To some extent, the quantity of waste may be reduced by the use of paper containers for beverages instead of glass bottles or cans. If the more substantial containers are used, however, the uniformity of the service throughout the complex suggests that recycling should be practiced. All-steel cans, for example, can be separated readily from other refuse by magnetic separation techniques. Aluminum cans are separable by ballistic means followed with magnetic separation to remove stray ferrous metal objects discarded by the patrons. An alternative, returnable bottles, may also be possible although the problems of safety (broken bottle shards) and the cost of brand segregation requirements may mitigate against this approach. In any event, recycling opportunities should be explored and, if appropriate, made a part of the contract with the food service concessionnaires.

To the extent possible, the use of plastic should be minimized in favor of paper or other bio-degradable food service materials. This is of importance to ease compaction both on-site and in a landfill disposal system (the most likely method for disposal to be used in the near-term) and to enhance rapid decomposition in either landfills or incinerators. In the event that incineration is selected as a major method of waste disposal for the region, care should be taken to minimize or eliminate the use of chlorinated polymeric materials (e.g. PVC) to reduce the generation of hydrochloric acid with its attendant corrosion and air pollution characteristics in the combustion process.

The solid wastes from the Sports Complex will be disposed of in one of the active landfills within the Hackensack Meadowlands District (Map 7; from a sketch map supplied by the Hackensack Meadowlands Development Commission). The relatively small quantity of refuse generated in the Complex and the environmental performance standards applicable to the operation of landfills in the Meadowlands District should minimize any adverse environmental impact.

B. Wastes generated in the offices and living quarters

The 50 employees working at the football stadium on non-game days, the 1200 employees working at the track, the estimated 30 steady employees at the indoor arena the 50 to 75 employees at the Theme Park, and the 100 employees at the Hotel facility also will generate wastes. Assuming the generation of 1.5 lb/employee/day (PED) for the football, track, and arena employees, 2.5 PED for the hotel employees, and 3.0 PED for the 600 or so live-in employees at the track, it is estimated that 650 tons/year of solid waste will be generated on the Sports Complex site by workday and residence activity. These wastes, a heterogeneous mixture similar to mixed municipal refuse (excluding yard wastes) probably will not be not susceptible to recycling. The HMDC landfill option described above probably will be made available for this purpose.

C. Wastes generated in the Theme Park Activity

No definitive plans or projections were available for the proposed Theme Park. To provide a preliminary assessment of its impact, however, the daily attendance was assumed to be 5000 and the operating season is considered to span 200 days. The annual attendance, therefore, should approach one million patrons. Based on experience in park and playground areas, a refuse generation rate of 1.5 lb/patron/day was assumed. This yields a generation rate of 750 tons/year. Consideration of recycling opportunities should be made in this case as for the sports facilities. Similarly, consideration should be given to restricting the use of plastic containers and plates by the food service concessionaires. Facilities regulated by HMDC should be utilized for disposal of non-recyclable wastes.

D. Wastes generated in the Hotel operations

The proposed hotel associated with the Sports Complex is to have 1500 rooms and include space for expositions and conventions. Based on an assumed average occupancy of 70% and room use by an average of 1.9 persons (characteristic of similar convention hotels in the area) a typical refuse generation rate of 5 lb/guest/day yields a waste generation rate of 1850 tons/year. In view of the expected high food waste content, these wastes will require disposal on a daily basis. Careful consideration should be given to housekeeping in the waste storage area to avoid attracting and breeding insect and rodent species. Attention to such matters and regular emptying and clean-out of the refuse receptacles should avoid any adverse environmental impact.

Wastes containing high fractions of food scraps are ideal for composting. The small quantity of material available for composting, however, probably will make this disposal alternative uneconomical. Disposal in the HMDC landfill, therefore, is appropriate.

E. Wastes generated by horse stabling activity

The racetrack facility, as presently planned, will accommodate 1500 horses. During the year, however, arrivals and departures suggest an average occupancy of 1250 animals for the estimated 220 days per year of the racing season. This will result in the generation of from 9000 to 12,000 tons per year of a mixture of manure and bedding straw. This mixture has a high organic content, and could attract flies, produce odors, and constitute a health hazard if it were not handled and stored properly. The Sports Authority is negotiating for the regular removal and offsite use of this material by the C & C Composting Company, Avondale, Pennsylvania.

For some years, C & C Composting Company has carried out an operation wherein selected animal manures are shredded, composted in windrows and, following innoculation with spores, used for commercial mushroom culture in southeastern Pennsylvania. (When the composted manure is "worn-out" as a medium for mushroom culture, it reportedly is sold locally for use as a soil conditioner.) This appears to be a continuing outlet for the manure from the Sports Complex. It is our understanding that the composting company will provide the labor, machinery and transportation equipment needed for this operation. Requirements for environmental safeguards to be employed by the composting company will be included in a contract for services.

F. Waste generation Summary and General Remarks

The total waste generation rate anticipated for the Sports Complex is outlined in Table B. Consistent with the probable waste management practices described above, no significant additional adverse environmental impact will be produced by its disposal. Also the control which can be exercised by the Sports Authority in selecting the type of beverage containers used in the complex offers the opportunity for an effective and possibly remunerative recycling activity.

One aspect of the solid waste management program for the Sports Complex, however, deserves special attention: litter problems. Unfortunately, many Americans, especially when enjoying recreational activities, are prone to litter. In view of the large amount of waste cups, food wrappers, tickets, and programs which will be given to the patrons of activities at the Complex, the Authority must expect to mount an effective and extensive litter control program. Such a program, including encouragement of patron cooperation, is important not only from the standpoint of aesthetics but also to avoid the placement of water-catching debris which will provide breeding places for mosquitoes. Because mosquito control will be important to the maintenance of an acceptable environment for outdoor activities, this second aspect can be of great importance. Effective litter prevention practices will include the placement and regular emptying of numerous refuse containers throughout the complex.

Traffic Analysis

Kenneth O. Shepard

Analysis Procedures

This summary of current traffic analysis, which is drawn largely from reports by Wilbur Smith and Associates (1971, 1972), evaluates the impact of trips by attendees to football, flat racing, harness racing, baseball, and indoor sports activities on expressways and roads in the vicinity of the proposed site. Relevant information includes:

1) Projected attendance by type of event and time of occurrence
2) Projected origin and direction of arrival by attendees
3) Projected mode of travel
4) Existing and proposed transportation facilities and estimated capacities
5) Traffic counts by facility by hour
6) Projected normal traffic in 1975

Projected attendance and mode of travel

The projected attendance by type of event and time of occurrence is described in Table 1. Large scale events which occur at times that would conflict with normal traffic are football games on autumn Sundays, thoroughbred racing on weekday afternoons, and baseball games on weekend afternoons. Other events, if they occur singly, would be of much smaller scale and do not conflict in time with normal peak traffic volumes.

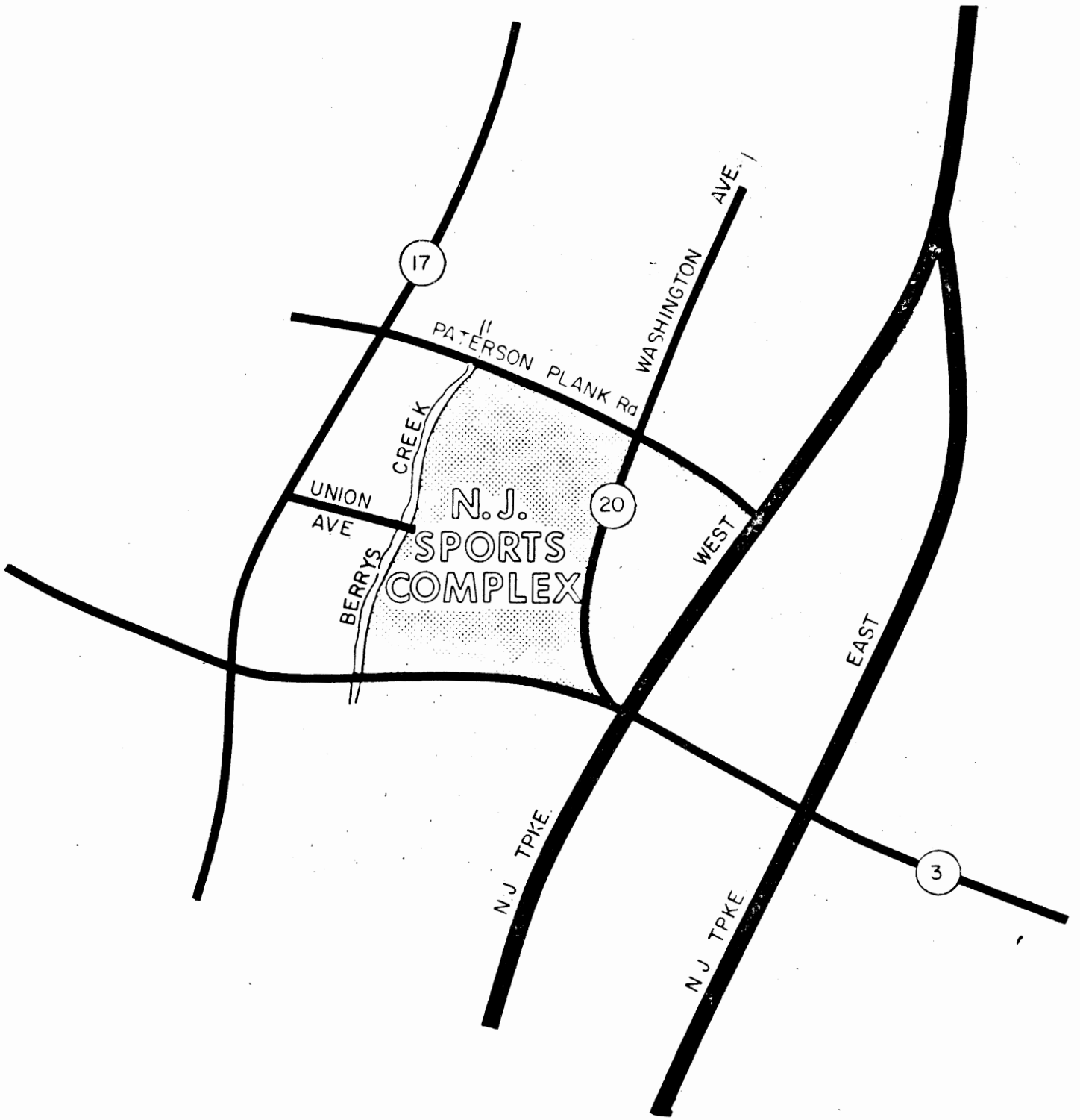
In this analysis it is assumed that all attendees will use either automobiles or buses and, therefore, will use the highway system. The number of attendees that can be encouraged to use bus transportation is critical and has been assumed at 27% of all attendees for football games and 20% for all other activities. If railroad access is utilized by a greater proportion of patrons, the traffic estimates will be reduced.

Projected attendee origins

The geographical distribution of attendee origins was developed based on actual visitor travel patterns surveyed at recent home games of the New York Football Giants. Attendee travel paths were developed by analyzing alternative "best" routes in terms of convenience, time, and cost, and projected site oriented traffic was assigned to existing and proposed road facilities. The assignment of attendees for racing, baseball, and indoor sports activities to specific highways by mode by time of day is presented in Table 2. Attendee assignments for football games is summarized in Table 3.

Existing and Proposed Highway Facilities

Descriptions of the location and characteristics of existing and proposed highway facilities were developed in cooperation with the New Jersey Department of Transportation, the New Jersey Turnpike Authority, and the New York Port Authority (Figure 1).



Highway facilities in the vicinity of the proposed site.

Figure 1

Traffic Counts and Projected Volumes

Traffic count information for 1971 and 1972 for specific traffic hours were obtained from the same agencies mentioned above. Normal traffic volumes for 1975, the date the Sports Complex is expected to open, were developed by multiplying the 1972 counts by an 8% annual growth rate. The three-year growth factor is 1.27. The growth rate may in fact be lower and certainly would not be expected to continue for over five years, but it has been used to keep conclusions conservative.

Traffic: Summary and Recommendations

Among the events scheduled for the Sports Complex the occasional autumn football games and the almost daily baseball and horse racing events will have significant impacts on the area traffic pattern.

Football Traffic

Traffic departing from football games on autumn Sundays between 4 and 5 p.m. will coincide with relatively heavy normal traffic flows. Approximately 18,000 cars and 400 buses will attempt to leave the site in one hour, and these volumes, even though distributed by direction to several facilities, will overload available capacities. For example, as shown in Figure 2, the projected peak hour departure volume north on the west branch of the New Jersey Turnpike is 5900, or 500 more than the maximum capacity under optimum conditions. Other links also are overloaded, but to a lesser extent. Because

the estimated capacities are for optimum conditions, either bad weather or accidents on the road could reduce capacities 10-20% and produce more strained conditions. Fortunately these peak congestion periods occur so infrequently (only 10 per year) that major temporary operational modification can be made to produce a tolerable traffic situation. Wilbur Smith and Associates (1971) suggested an "evacuation" or site departure traffic plan. In sum, this plan assumes close cooperation between the several transportation agencies to:

- convert several highways to one-way operation for short periods of time,
- close certain access ramps to give preference to traffic departing the site,
- complete certain already programmed highway improvements by 1975,
- construct specific internal roadways and ramps for better connection to existing highways.

To the extent to which more than 27% of the attendees can be induced to use special bus transportation, and if the Erie-Lackawanna Railroad can provide passenger service to the site vicinity, automobile congestion can be reduced. Further reductions could be achieved by inducing motorists to arrive early or remain on the site after a major sports event. Special prices might be offered in the Theme Park at these times, for example, or the exhibition center might provide a program related to the special interest of the patrons. Phased-release parking also could be used to distribute departure times.

Racing Traffic

Thoroughbred racing scheduled for January through March and in August will create a demand for attendee departures on weekdays between 4:30 and 6:30 p.m. (Figure 3). Although the number of departing cars (4-5,000) is only about one-third as many as predicted football game departures, the departure time will coincide with evening peak commuter traffic. In contrast to the football peak, which will occur only ten times per year, the racing traffic peak will be daily and, therefore, not conducive to the special traffic operation modifications suggested in the Smith plan.

The coincident loading of the site demand on the normal peak demand in 1975 approaches estimated facility capacity under optimum conditions. This will mean daily delays and inconvenience for normal road users; in bad weather or with accidents, longer delays can be expected.

Reduction of congestion can best be obtained by more extensive use of public transporation with park and ride programs either by bus or by rail.

Baseball Traffic

Baseball games occur approximately 80 times on weekday nights and weekend afternoons. Weekend afternoon games during August will cause the most serious problems when 15,000 cars and 200 buses attempt to reach the baseball game between 12:30 and 1:30 p.m. at the same time that 6,500 cars approach the horse racing event. This traffic could total 21,000 cars and 300 buses. These conditions are substantially worse than the 18,000 cars

projected for football games and it is unlikely that any improvement, other than substantial rail access, could be achieved. At this time it appears that these events could not be scheduled simultaneously as now assumed. Either horse racing would have to be canceled during home baseball games or the games during August weekends would have to be scheduled away from the home field.

Another problem related to baseball traffic is the weekend departure time (4 to 5 p.m.). It is predicted that 15,000 cars and 200 buses would attempt to leave during this time (Figure 4). Although this volume is less than that predicted for football games, it still would cause substantial problems, particularly on the western spur of the New Jersey Turnpike where demand would be 600 cars over maximum capacity. Wilbur Smith and Associates suggested diverting traffic to the eastern spur where capacity is available. Other roads in the area would be close to maximum capacity so that there would be inconvience and minor delays under optimum weather conditions.

Indoor Sport Arena Traffic

Wilbur Smith and Associates (1972) assumed that no arena event will be scheduled during racing events or ball games. If this scheduling is imposed, no significant traffic impact is expected to result from arena utilization.

If the sports arena were used as those in other cities for music concerts, boxing, skating, and large shows or circuses, concurrent schedulings might occur frequently and problems with entering and departing traffic would be expected.

Recommendations for further study

Because traffic congestion associated with infrequent football games and daily racing events are envisioned, the following should be given further analysis:

1. Given the changed location of the football stadium, the origin of attendees may shift, thereby altering the route of travel and traffic impact corridors. The attendance origin pattern should be reviewed.

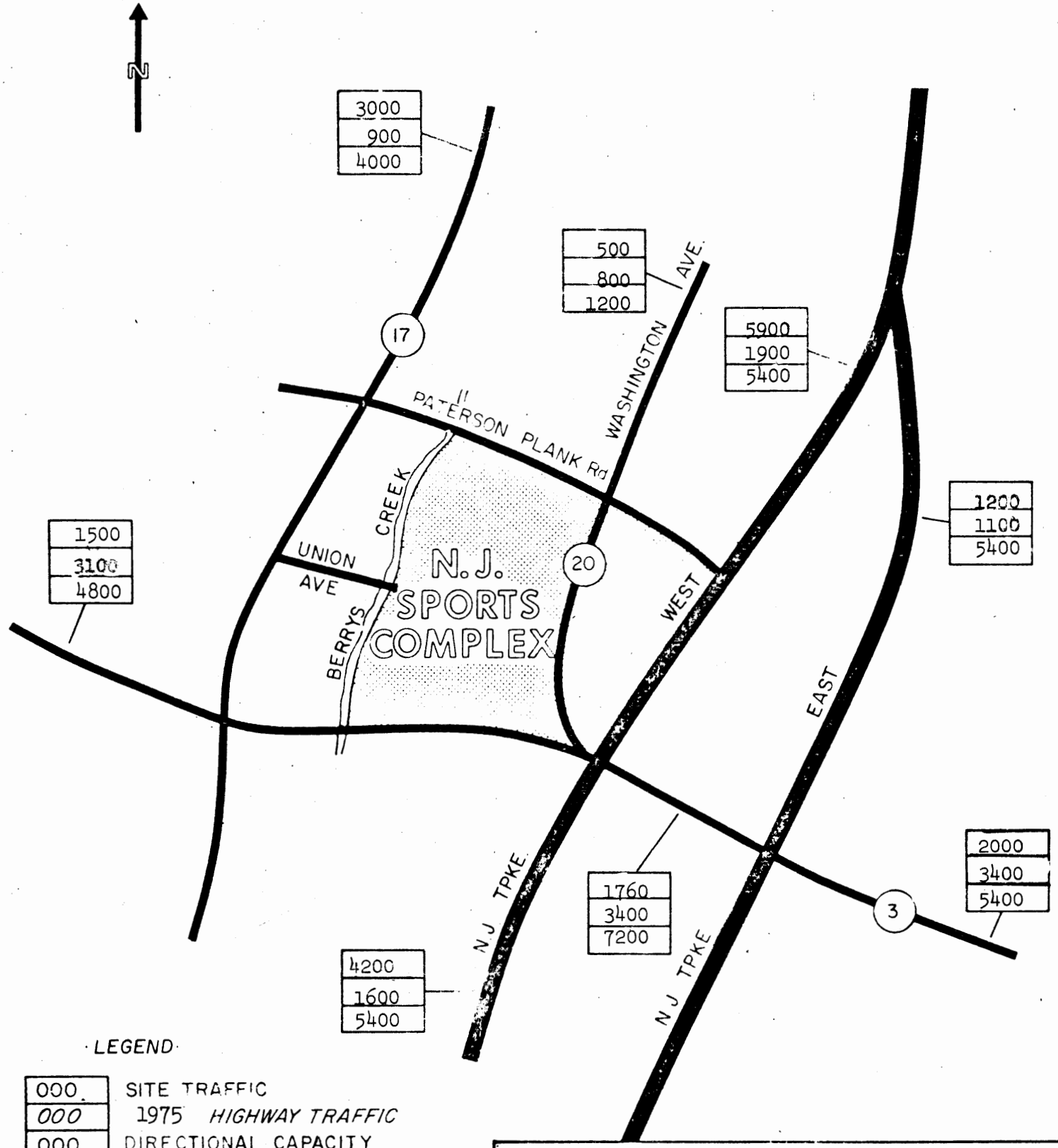
2. The potential for changing the timing of events should be evaluated to see if hours of conflict with normal traffic could be reduced.

3. Attendee tolerance for up to an hour delay in departing from the site should be reviewed to determine the reasonableness of departure demand. Tolerance to an even longer departure time would of course ease the congestion problem.

4. The studies by Wilbur Smith and Associates assume that no two events will occur simultaneously. This should be validated. If schedules do coincide, traffic problems will be greater than predicted.

5. Although the projected choice of bus travel at 20 to 26% seems reasonable-to-high, this assumption should be checked against travel experience at other large events in the Metropolitan area and be analyzed in terms of travel time, cost, and convenience. This is a critical assumption, and if the current estimate is high, traffic congestion could be greater. In contrast, if the convenience of the Port Authority Bus terminal is greater than expected, or if other park and ride facilities are feasible, conditions may turn out better than supposed.

The traffic analysis has been done on projected traffic volumes in 1975. Assuming an 8% or lower annual growth rate in traffic, conditions in 1980 or beyond may prove highly undesirable unless major new highway or mass transit facilities are constructed.

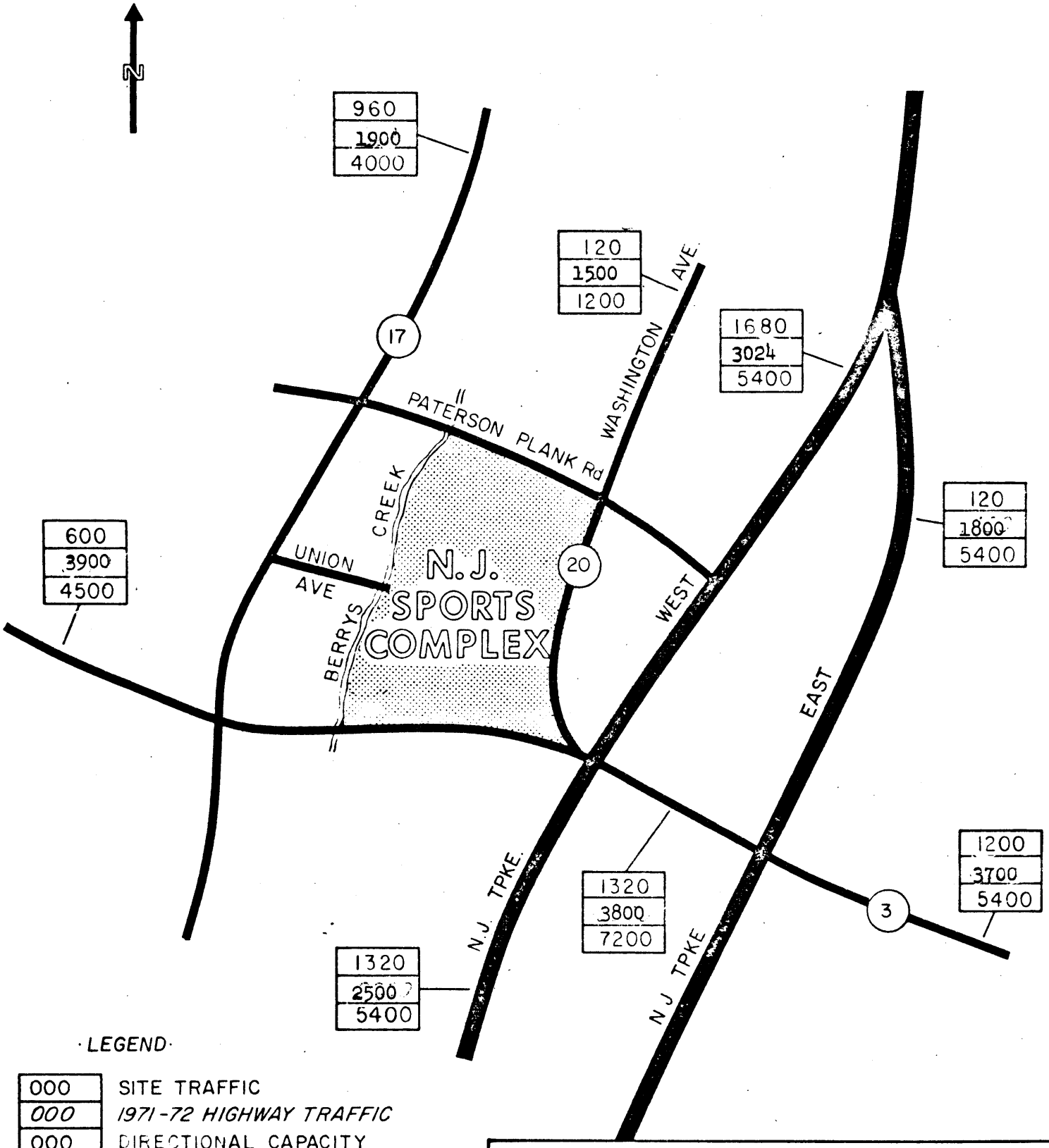


FOOTBALL

WINTER WEEK-END

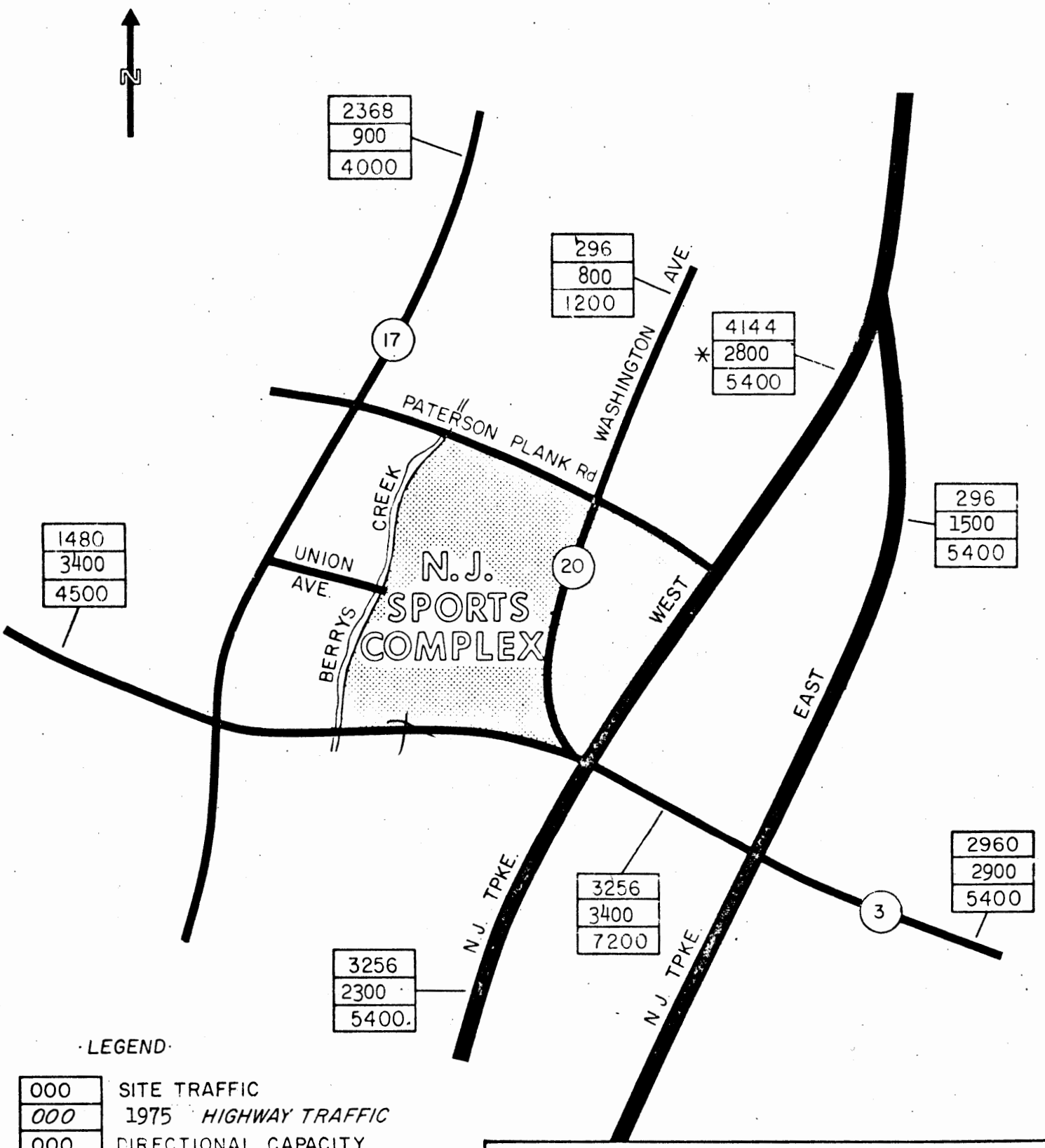
4:30-5:30 PM.

FIGURE 2



THOROUGHBRED RACING
WINTER WEEK-DAY
4:30-5:30 PM.

FIGURE 3



BASEBALL
SUMMER WEEK-END
4-5 OR 5-6 P.M.

Figure 4

Table 1

Anticipated Visitation for Various Events

New Jersey Sports Complex

Item	Football	Harness Racing	Thoroughbred Racing				Baseball	Indoor Sports Arena
Primary Period of Occurrence	Autumn Sundays 1-4 p.m.	May-July Sept-Oct 8-11 p.m. (A)	Winter Jan-March 12:30-4:30 p.m. (B)	(C)	Summer August 1:30-5:30 p.m. (D)	(E)	April-Sept (F) Weekday 7:30-11 p.m. (G) Weekend 1:30-4 p.m.	All Year (H) Weekday 8-11 p.m. (I) Weekend 2-5 p.m.
Peak Visitors	75,000	10,000 20,000	Weekday 15,000	Weekend 25,000	Weekday 18,000	Weekend 25,000	50,000	15,000
% + No. by Bus	27% 20,000	20% 4,000	20% 3,000	5,000	3,600	5,000	20% 10,000	10% 1,500
% + No. by Car	73% 55,000	80% 16,000	80% 12,000	20,000	14,400	20,000	80% 40,000	90% 13,500
Persons Per Car	3.0	2.5	2.0	2.5	2.0	2.5	2.7	2.5
No. of Cars	18,330	6,400	6,000	8,000	7,200	8,000	14,800	5,400
No. of Buses @ 50 Persons/Bus	400	80	60	100	72	100	200	30
Peak Exit Hour	4-5 p.m.	11-12 p.m.	4:30-5:30 p.m.	4:30-5:30 p.m.	5:30-6:30 p.m.	5:30-6:30 p.m.	Weekday 11-12 p.m. Weekend 4-5 p.m.	Weekday 11-12 p.m. Weekend 5-6 p.m.
Peak Exit Traffic (Cars)	18,330	6,400	6,000 $4,200_1$	8,000 $6,400_2$	7,200 $5,000_1$	8,000 $6,400_2$	14,800	5,400

(continued)

Table 1 (continued)

Anticipated Visitation for Various Events

New Jersey Sports Complex

Item	Football	Racing	Thoroughbred Racing				Baseball	Indoor Sports Arena
Primary Period of Occurrence	Autumn Sundays 1-4 p.m.	May-July Sept-Oct 8-11 p.m. (A)	Winter Jan-March 12:30-4:30 p.m. (B)	(C)	Summer August 1:30-5:30 p.m. (D)	(E)	April-Sept (F) Weekday 7:30-11 p.m. (G) Weekend 1:30-4 p.m.	All Year (H) Weekday 8-11 p.m. (I) Weekend 2-5 p.m.
Peak Entrance Hour	12-1 p.m.	7-8 p.m.	Weekday 11:30-12:30 p.m.	Weekend 11:30-12:30 p.m.	Weekday 12:30-1:30 p.m.	Weekend 12:30-1:30 p.m.	Weekday 6:30-7:30 p.m. Weekend 12:30-1:30 p.m.	Weekday 1-2 p.m. Weekend 7-8 p.m.
Peak Entrance Traffic (Cars)$_3$	14,700	5,100	4,800	6,400	5,700	6,400		4,300

Footnotes:

1 - 70% of peak exit, thoroughbred weekday only
2 - 80% of peak exit, thoroughbred weekend only
3 - 80% of all entrants; all events

Table 2

Anticipated Distribution of Vehicular Traffic

Racing, Baseball, and Miscellaneous Events

Origin	Estimated Per Cent of Passenger Cars[1]	Harness Racing	Thoroughbred Racing				Baseball		Indoor Sports Arena	
		Summer Weekday (A)	Winter Weekday (B)	Winter Weekend (C)	Summer Weekday (D)	Summer Weekend (E)	Summer Weekday (F)	Summer Weekend (G)	Weekday (H)	Weekend (I)
West Route 3	10	640	600	800	720	800b	1,480		540	
East Route 3	20	1,280	1,200	1,600	1,440	1,600	2,960		1,080	
North										
N.J. Turnpike (E.)	2	128	120	160	144	160	296		108	
N.J. Turnpike (W.)	28	1,792	1,680	2,240	2,016	2,240	4,144		1,512	
Route 17	16	1,024	960	1,280	1,152	1,280	2,368		864	
Washington Avenue	2	128	120	160	144	160	296		108	
South										
N.J. Turnpike (W.)	22	1,408	1,320	1,760	1,584	1,760	3,256		1,188	
TOTAL	100	6,400	6,000	8,0-0	7,200	8,000	14,800		5,400	
Time of Day		11-12 p.m.	4:30-5:30 p.m.	4:30-5:30 p.m.	5:30-6:30 p.m.	5:30-6:30 p.m.	11-12 p.m.	4-5 p.m.	11-12 p.m.	5-6 p.m.

1 - This represents an approximate percentage. It would vary depending on the relative use of public transport facilities and specific events.

Table 3

Travel Mode and Approach Directions of Patron Departures
after Professional Football Events

Origin	Patrons		Passenger Cars			Buses		
	Number	Per Cent of Total	Number of Patrons	Number of Cars [1]	Per Cent of Total Cars	Number of Patrons	Number of Buses [2]	Per Cent of Total Buses
West Route 3	4,500	6.0	4,500	1,500	8.2	-	-	-
East Route 3	21,000	28.0	6,000	2,000	10.9	15,000	300	75.0
North								
N.J. Turnpike (E.)	3,700	5.0	3,700	1,230	6.7	-	-	-
N.J. Turnpike (W.)	20,200	26.9	17,700	5,900	32.1	2,500	50	12.5
Route 17	9,000	12.0	9,000	3,000	16.6	-	-	-
Washington Avenue	1,500	2.0	1,500	500	2.7	-	-	-
South								
N.J. Turnpike (W.)	15,100	20.1	12,600	4,200	22.8	2,500	50	12.5
TOTAL	75,000	100.0	55,000	18,330	100.0	20,000	400	100.0

1 - Assuming a car occupancy of 3.0 persons
2 - Assuming a bus capacity of 50 persons

ERT Project P-484

AIR POLLUTION IMPACT STUDY OF THE NEW JERSEY SPORTS COMPLEX

JUNE 1972

John C. Goodrich
James R. Mahoney
Byron H. Willis

Prepared for

JACK McCORMICK & ASSOCIATES
DEVON, PENNSYLVANIA

ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.
429 Marrett Road, Lexington, Massachusetts 02173

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	GENERAL APPROACH	2
3.	CRITERIA	4
4.	SUMMARY OF RESULTS	8
	REFERENCES	18

Appendix A: Tabular Listing of Predicted Air Quality

Appendix B: Air Quality Contour Maps

Appendix C: Supplementary Technical Data

1. INTRODUCTION

Under contract to Jack McCormick & Associates, Environmental Research & Technology, Inc. (ERT) has undertaken an assessment of the expected air quality impact resulting from operation of the proposed New Jersey Sports Complex. In accordance with the terms of this agreement, the study includes an assessment of air quality in the 1990 time frame, and includes projections of the background air quality as well as the direct contributions from the use of the Sports Complex. Specific cases are examined which represent worst and average conditions associated with diurnal traffic fluctuations resulting from Sports Complex events and which also reflect seasonal uses of the Complex. Finally, comments are made concerning possible adverse effects of projected total air quality levels on users of the Complex, local residents, and other receptors.

In the body of this report we summarize the general approach used in the analysis, the criteria used for impact evaluation, and the results of the air quality impact analysis. We present in Appendix A the tabular listing of the predicted air quality data and in Appendix B the basic air quality contour maps for each case examined. In Appendix C we present all other supporting technical data, including a detailed discussion of the data, working assumptions, and cases examined.

2. GENERAL APPROACH

Because the impact on air quality resulting from the operations of the Sports Complex is predominantly related to automobile traffic and space heating of facilities, five pollutants are examined: total suspended particulates (Tsp); sulfur dioxide (SO_2); carbon monoxide (CO); total hydrocarbons less methane (HC); and nitrogen oxides (NO_X).

In this analysis air pollution impacts are examined at two different scales: the primary focus is on microscale impacts, which is concerned with concentration patterns over short time periods (typically 1 hour averages) and over short distances (typically 1 to 5 kilometers); the secondary focus is on macroscale or regional impacts, which is concerned with annual average concentrations and patterns extending over the entire Meadowlands region. The results of the microscale analysis will reflect peak conditions affecting users of the Complex, while the regional impact is important in terms of long-term exposures to local population and plant life.

The analytical procedures used in this study involved four steps:

1. Preparation of emission estimates, using the activity data available for the Sports Complex.

2. Translation of the emission data into projected patterns of pollutant concentrations in the vicinity of the Sports Complex using the ERT/MARTIK atmospheric dispersion model.

3. Estimation of total air quality through summation of regional emissions data and air quality projections (developed in a separate ERT air quality study of the Hackensack Meadowlands) with the projections relating specifically to the Sports Complex.

4. Comparison of the resulting patterns of pollutant concentrations with the applicable Federal and New Jersey standards for the various pollutants.

The diffusion model was validated using air quality measurements data from the New Jersey Dept. of Environmental Protection.

Data pertaining to the Sports Complex facilities, operations, and traffic were supplied to ERT by the Sports Authority and its consultants. The calculation of emissions from the Complex as well as from background sources was based on the most recent EPA emission factors and data resulting from an on-going ERT air quality study for the entire Meadowlands area.

For the purpose of this analysis, a number of specific cases were defined by ERT, representing a variety of different operating conditions for the Sports Complex and a number of different meteorological conditions. Combinations were selected for analysis which are representative of both worst and average case conditions resulting from both diurnal and seasonal variations in the use of the Complex.

3. CRITERIA

The primary assessment of the air quality impact of the Sports Complex is based on the comparison of pollutant concentrations resulting from the specific cases examined to applicable ambient air quality standards. The Federal and New Jersey standards are listed in Table 1. The significance of ambient air quality standards as criteria for impact evaluation is two-fold: they represent a legal requirement; and they bear a direct relationship to effects on health, vegetation, and the general welfare.

In terms of legal requirements, air quality standards represent concentration levels which may not be exceeded more often than explicitly designated by the standard. To assess compliance with standards, the 1-hr microscale pollutant concentrations should be compared to 1-hr standards, and the annual average regional scale pollutant concentrations should be compared to annual average standards. Since 1-hr and annual average standards do not exist for all pollutants, direct comparisons cannot be made. As a consequence, ERT has derived, where both possible and meaningful, equivalent values of standards for 1-hr and annual average concentrations. These equivalent values are listed in Table 2 along with an indication of the method of derivation.

Air quality standards also provide a useful reference for assessing impact on people, plant life, and other receptors. The standards represent levels which, based on air quality criteria and allowing an adequate margin of safety, are requisite to protect the public health and welfare.

TABLE 1

Federal Ambient Air Quality Standards Adopted by Environmental Protection Agency April 30, 1971; New Jersey Ambient Air Quality Standards for Sulfur Dioxide and Particulates

$\mu g/m^3$ (ppm)[5]

Pollutant	1-hr max conc.[1]	3-hr max conc.[1] 6 am - 9 am	3-hr max conc.[1]	8-hr max conc.[1]	24-hr max conc[1]	Annual Average
Sulphur Oxides as SO_2						
Primary Federal Std.					365 (0.14)	80 (0.03)[2]
Secondary Federal Std.			1300 (0.5)[9]		260 (0.1)	60 (0.02)[2]
N.J. Std., (Chapt.13)	668 (0.25)[6]				267 (0.10)[6]	53 (0.02)[2]
" "	534 (0.20)[7]				214 (0.08)[8]	45 (0.017)[3]
Particulates						
Primary Federal Std.					260	75[3]
Secondary Federal Std.					150	60[3]
N.J.Std.,(Chapt.13)					195[6]	65[3]
Carbon Monoxide						
Primary & Secondary Fed.Std.	40,000 (35)			10,000 (9)		
Hydrocarbons as CH_4						
Primary & Secondary Fed.Std.		160 (0.24)[4]				
Photochemical Oxidants as O_3						
Primary & Secondary Fed.Std.	160 (0.08)					
Nitrogen Dioxide as NO_2						
Primary & Secondary Fed.Std.						100 (0.05)[2]

1 Maximum Values in Federal Standards are not to be exceeded more than once per year.
2 Arithmetic mean
3 Geometric mean
4 Nonmethane hydrocarbons, expressed as methane (CH_4), for the 3-hr period 6 am - 9 am.
5 Conversions from micrograms per cubic meter to parts per million are made at one atmosphere pressure and 25° C for Federal standards - 20° C C for New Jersey standards.
6 Arithmetic average concentration not to be exceeded and to be attained no more than once in twelve consecutive months
7 Arithmetic average concentration to be attained or exceeded no more than nine times in twelve consecutive months.
8 Arithmetic average concentration to be attained or exceeded no more than four times in twelve consecutive months.
9 Any maximum three hour concentration not to be exceeded more than once per year.

Source: Environmental News Press Release, Friday, April 30, 1971; National Primary and Secondary Ambient Air Quality Standards
New Jersey Air Pollution Control Code, Chapter 13, Air Quality Standards

Thus compliance with the standards implies that, based on the best available evidence, no adverse effects will occur to normal segments of the population. As a further point of reference, ERT has listed in Table 2 the ambient pollutant concentrations which, according to EPA, could cause significant harm to the health of persons.

TABLE 2

EQUIVALENT STANDARDS

Pollutant	Equivalent 1-Hour			Equivalent Annual Average[1]			EPA-Designated Health Hazard Levels (6)			
							1-hour		24-hour	
	Value $\mu g/m^3$	Value ppm	Derivation[2]	Value $\mu g/m^3$	Value ppm	Derivation[2]	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm
TSP	-[5]	-	-	70.1	-[3]	From N.J. annual standard (geom. mean)	-	-	1,000	-[3]
SO_2	668	0.25	N.J. standard (not to be exceeded)	53.0	0.02	N.J. standard	-	-	2,620	1.0
CO	40,000	35.0	Fed. (secondary) standard	1425.0	1.25	Extrapolation from Fed. 8-hour standard using Larsen Model	144,000	125.0	-	-
HC	160	0.24	Fed. (secondary) 3-hour standard (4)	160.0	0.24[3]	Fed. (secondary) 3-hour standard (4)	-	-	-	-
NO_X	2,260	1.2	EPA Warning Level for episode conditions (6)	100.0	0.05[3]	Fed. (secondary) standard	3,750	2.0	-	-

(1) Annual arithmetic mean value, never to be exceeded.

(2) Extrapolations based on use of Larsen Model (EPA Office of Air Programs Pub. No. AP-89)

(3) Conversion to ppm not strictly possible without specifying composition of pollutant.

(4) Extrapolation of 3-hour standard to an annual or 1-hour standard not considered valid.

(5) Extrapolation of 24-hour standard to a 1-hour standard not considered valid.

(6) Fed. Register, Vol 36, No. 206, Sat., Oct 23, 1971.

4. SUMMARY OF RESULTS

Results of analysis are summarized in this section. The information is arranged into three categories:

a. General impact of the planned Sports Complex upon air quality.

b. Specific impact of the Complex upon human health, animals and vegetation in the vicinity.

c. Ranking of the impact for the various activity types planned for the Complex.

The conclusions presented in this section are based on the results of model calculations for 1990 emission parameters. The results appear in tabular form in Appendix A and in graphic form in Appendix B. Abstracts of the data also appear in Tables 3, 4 and 5 in this section.

4.1 General Impact of the Sports Complex on Air Quality

1. The most significant impact of the facility will result from motor vehicle emissions associated with the transport of patrons to the various activities planned for the Sports Complex. Thus the concentrations of CO, NO_x and hydrocarbon compounds (resulting from vehicle emissions) can be expected to increase in the immediate vicinity of the Complex during approximately a one hour period before and after public activities in the Complex. Some increases in particulate and SO_2 concentrations will also result, but these increases will be small compared to expected background concentrations for these pollutants.

TABLE 3

PEAK VALUES OF AIR QUALITY CALCULATED BY FACILITY

Facility	Met.	Particulates	SO_2	CO	HC	NO_2
		$\mu g/m^3$	ppm	ppm	$\mu g/m^3$	$\mu g/m^3$
Football (A)	Annual (11)	126	.011	2.82	1771	72
	4	187	.028	3.2	1187	146
	5	141	.018	2.2	962	98
	7	263	.031	7.4	2066	203
	8	236	.036	11.6	2588	281
	9	173	.024	7.3	1694	186
	10	368	.040	12.0	3555	350
Football (B)	Annual (11)	125	.011	2.47	1769	66
	1	204	.022	2.5	1233	127
	2	325	.034	3.6	1988	203
	6	142	.018	2.4	1087	104
Racing (C)	Annual (11)	249	.021	1.33	1765	53
	3	226	.038	1.2	649	84
	5	281	.033	0.93	779	82
	6	284	.036	1.2	897	85
Racing (D) - Winter	Annual (11)	250	.021	2.94	1765	55
	8	411	.051	6.5	1537	178
	10	679	.076	7.2	2503	248
Racing (E) - Summer	Annual (11)	63	.005	1.33	1765	52
	3	60	.010	1.2	649	82
	5	70	.009	0.93	779	82
	6	71	.009	1.2	897	85
Racing (F) - Summer	Annual (11)	63	.005	1.84	1765	55
	8	112	.017	5.6	1537	178
	10	179	.019	6.0	2503	247
Arena (G)	Annual (11)	125	.010	1.24	1764	52
	8	206	.025	3.7	1273	152
	9	160	.017	2.4	888	107
	10	340	.038	4.0	2240	221
Combined (H) - Summer	Annual (11)	66	.006	2.35	1768	66
	8	149	.023	8.7	2086	244
	10	216	.024	9.0	3052	313
Average (I)	Annual (11)	125	.010	0.94	1761	52
Background	Annual (11)	125	.010	0.94	1761	52

TABLE 4

PEAK VALUES OF AIR QUALITY CALCULATED - AVERAGE CASE

Facility	Significant Variation - Due to Facility		No Variation Due to Facility		
	CO	NO_2	Particulates	SO_2	HC
Football (A)	2.82	72	126	.011	1771
Football (B)	2.47	66	125	.011	1769
Racing, Winter (C)	1.33	53	249	.021	1765
Racing, Winter (D)	2.94	55	250	.021	1765
Racing, Summer (E)	1.33	52	63	.005	1765
Racing, Summer (F)	1.84	55	63	.005	1765
Arena (G)	1.24	52	125	.010	1764
Combined, Summer (H)	2.35	66	66	.006	1768
Average Annual Use (I)	0.94	52	125	.010	1761
Background	0.94	52	125	.010	1761

Variations for particulates, SO_2, HC are governed almost entirely by the assumptions made on variability in background concentrations.

TABLE 5

PEAK VALUES OF AIR QUALITY CALCULATED - WORST CASE*

Facility	Significant Variation - Due to Facility		No Variation Due to Facility		
	CO	NO_2	Particulates	SO_2	HC
Football (A)	12.0	350	368	.040	3555
Racing (D) - Winter	7.2	248	679	.076	2503
Racing (F) - Summer	6.0	247	179	.019	2503
Arena (G)	4.0	221	340	.038	2240
Combined (H) - Summer	9.0	313	216	.024	3052

*Met. Condition = 10; SE wind, 2 m/sec, stable, 100 meters mixing.

Variations for particulates, SO_2, HC are governed almost entirely by the assumptions made on variability in background concentrations.

2. Fuel combustion for heating and air conditioning will result in emissions of SO_2 and particulates (as well as some NO_x, CO and HC), but the total emissions of SO_2 and particulates will be sufficiently small so that the Sports Complex will not significantly change the average background concentrations of these pollutants. (This assumes that the fuel combustion facilities are designed with adequate collection devices for particulates, and with stack height adequate to permit initial dilution of the effluent in the atmosphere.)

3. Of the five pollutants considered, CO concentrations will be most influenced by activities at the Sports Complex. The region of significant increase of one-hour average CO concentrations compared to background levels will extend approximately 3 kilometers downwind from the parking areas approximately 25% of the time, when winds are light-to-moderate. The impact region will extend approximately 5 kilometers about 5% of the time, when wind speeds are 2 meters per second (approximately 4 mph) or less. Figure B-25 illustrates the one-hour impact of CO emissions during the highest emission case studied, the exit of 18,000 automobiles after completion of a football game. (Note that the one-hour standard for CO is met even in this case.)

4. The maximum CO concentrations, expected in the first few kilometers downwind from the parking areas, arise from the various sources in the following approximate proportions:

- 90% from emissions by idling automobiles in the parking lot
- 10% from background (i.e., from sources not associated with the Sports Complex)

- 1 - 2% from automobiles moving on the highway links in the vicinity of the Sports Complex. (However, a higher contribution from these road links will be found immediately downwind from each road.)

- less than 1% from buses carrying passengers to and from the Sports Complex.

5. The pattern of local NO_x impact is similar to that for CO, but the influence of automobiles idling in the parking lot is not as important in the case of NO_x.

6. Because the local CO impact results in such a large proportion from idling vehicles in the parking lot (i.e., because the influence of background concentrations is relatively small), the expected one-hour average patterns in the Sports Complex vicinity will be similar to those found in many other facilities of equivalent size in the United States. (It should be noted that, in the design and planning phase, it is possible to reduce the impact of idling automobiles by providing for dispersal of the parking areas, staggering of arrival and departure times, and improvements in flow efficiency in the feeder roads.)

7. The impact of activities at the Sports Complex on the air quality in the larger Meadowlands planning region will be small (less than a 10% increase in average concentrations) for time periods between one hour and one day. On an annual average concentration basis, the influence of the Sports Complex on the general Meadowlands region will be negligible.

4.2 Impact of the Sports Complex Related to Health Effects and Other Risks

1. The model calculations indicate that in all cases the applicable standards (and the equivalent standards, as defined in Table 2) will be met for CO, NO_x and SO_2. Since these standards were developed to protect public health, with an adequate margin of safety, operation of the Sports Complex facilities will not constitute a health risk relative to these three pollutants.

2. The ERT study of the Meadowlands region indicates that the particulate standard will not be met in 1990, even in the absence of the Sports Complex. (Thus, it is expected that emissions reductions in the Greater New York City area, larger than those projected in the Meadowlands study, will be implemented before 1990.) The Sports Complex will have a relatively minor impact upon ambient atmosphere particulate concentrations, but we project the standard to be violated anyway, because of the large background contribution.

3. The hydrocarbon compound 3 hour standard will be exceeded by a factor between 6 and 10. It should be noted that the HC standard is designed not directly to protect public health, but to limit the formation of photochemical smog in the atmosphere. The current standard is exceeded by a factor of 10 or more in virtually every major urban area in the United States at this time. Because the background concentration exceeds the current HC standard by such a large factor, it is not useful to comment on the impact of the additional HC emissions associated with vehicles operating in the vicinity of the Sports Complex. Instead, it is noted that the expected HC concentration levels will be similar to those found

in the vicinity of other large volume parking areas in urbanized regions. (Profile of expected background concentrations for the five pollutants are presented in Figures B-1 to B-5, in Appendix B.)

4. Although the applicable standards will be met, elevated levels of CO and (to a lesser extent) NO_x will occur during short time periods (such as one hour) when the Sports Complex facilities are in use. The population exposed to these elevated concentrations are predominantly transient: passengers and drivers in vehicles in the vicinity of the Complex, pedestrians in the vicinity, employees and spectators at events, and animals stored at the facility. The Master Plan for the Meadowlands region includes some residences (apartments) to the south of the Complex, with the closest units about 2 kilometers removed from the complex boundaries, and some to the east of the Complex, with some units at approximately a one kilometer distance, but most units 3 or 4 kilometers from the Complex. Therefore some exposure of residents to elevated levels of CO and NO_x will occur, but these exposures will not exceed the federal standards for CO and will be much less than the federal alert level established to protect public health from NO_x exposure.

5. Elevated lead concentrations in ground cover, and some vegetation damage is normally observed within the first few hundred meters along heavily travelled roadways. Similar patterns of localized impact can be expected along the access roads, and at the edges of the parking lots, at the Sports Complex. However, the model calculations indicate that regional patterns of vegetation damage from exposure to SO_2, CO and NO_x are not expected.

4.3 Ranking of Impact by Specific Cases of Facility Usage

1. The ranking of impact is based on expected CO concentrations, for the following reasons:

- CO impact of the Complex is the greatest of the five pollutants compared to background levels.
- Predicted concentrations of particulates, SO_2 and HC primarily reflect seasonal and diurnal changes in background levels, rather than contributions from the Sports Complex.
- Predicted NO_x concentrations reflect both the impact of the Complex and background variability, but the concentration levels are lower that the short period health effect level by an order of magnitude in worst cases.

Peak values of concentration predicted for any receptor location, for the facility uses and meteorological cases considered, are presented in Table 2.

2. The largest CO impact will result after football games. This occurs because the number of vehicles using the parking lots during football games is expected to be larger than during other activities at the Complex. The meteorological condition which causes the highest CO concentration during the exit from football games (in the early evening) is a stable wind from the SE. Because most of the local CO impact is caused by idling automobiles in the parking lot, the expected concentrations for other activities at the Complex will be proportional to the expected automobile volume in the parking lot for each activity.

3. Table 4 summarizes the highest concentration value (at any receptor location) for average meteorological conditions. (The Newark annual wind rose was used to define average meteorological conditions for these cases.) Again the football game - exit has the greatest impact. However, this average concentration is less than 3 ppm,compared to the federal one-hour standard of 35 ppm.

4. The peak values for the worst case meteorological condition are summarized in Table 5. These cases represent the evening and night activities, for which the stable meteorological conditions are most likely to occur. The very high particulate concentration calculated for winter racing results from an assumption of an increased particulate background in the winter months, and is not representative in this case.

4.4 Summary of Results

This subsection contains a brief summary of the most important results described above.

- Full operation of the Sports Complex facilities in 1990 will not cause the standards for CO, SO_2 and NO_x to be exceeded.

- The particulate and HC standards will be exceeded, even without the operation of the Sports Complex. The impact of the Complex on the existing background levels for these two pollutants will be relatively small overall.

- Elevated levels of one hour average concentration of CO and NO_x will be observed over distances up to 5 kilometers from the Complex, during major public activities.

- These elevated levels will result almost entirely from idling automobiles in the parking lot.

- The air pollution impact of the parking lot will be similar to that of similar sized parking lots in use at this time.

REFERENCES

1. "Outline Specifications: Football Stadium for the New York Football Giants, Inc., New Jersey Sports Complex"; Kivett and Myers, Ewing Cole Erdman & Eubank, July 15, 1971.

2. "Traffic and Access - New Jersey Sports Complex, Rutherford, New Jersey"; Wilbur Smith and Associates, New Haven, July 1971 (prepared for the New Jersey Sports and Exposition Authority).

3. "Supplemental Traffic Analysis - New Jersey Sports Complex"; Wilbur Smith and Associates, New Haven, February 1972.

4. "Compilation of Air Pollutant Emission Factors (Revised)"; U.S.EPA, Research Triangle Park, North Carolina, February 1972.

APPENDIX A

Tabular Listing of Predicted Air Quality

TABLES OF CALCULATED 1990 AIR QUALITY CONCENTRATIONS UNDER VARIOUS ASSUMPTIONS

Figure No.	Meteorological Condition (Met)	Facility Case (Case)	No. of Receptors	Maps
A-1	(11) - Annual Wind Rose	1990 Background	36	-
A-2	(11) - Annual Wind Rose	I - Annual Average	36	5 pollutants
A-3	(11) - Annual Wind Rose	A - Football (Exit hour)	36	CO, NO_2
A-4	(11) - Annual Wind Rose	B - Football (Entrance)	36	CO
A-5	(11) - Annual Wind Rose	C - Winter Racing (Enter)	36	CO
A-6	(11) - Annual Wind Rose	D - Winter Racing (Exit)	36	CO
A-7	(11) - Annual Wind Rose	E - Summer Racing (Enter)	36	CO
A-8	(11) - Annual Wind Rose	F - Summer Racing (Exit)	36	CO
A-9	(11) - Annual Wind Rose	G - Arena	36	CO
A-10	(11) - Annual Wind Rose	H - Combined	36	CO
A-11	(1) - S, Neutral (200 m.)	B - Football (Entrance)	41	CO
A-12	(2) - S, Neutral (100 m.)	B - Football (Entrance)	25	CO
A-13	(3) - WSW, Neutral (200 m.)	C - Winter Racing (Enter)	25	-
A-14	(3) - WSW, Neutral (200 m.)	E - Summer Racing (Enter)	25	-
A-15	(4) - WSW, Neutral (100 m.)	A - Football (Exit)	25	CO
A-16	(5) - E, Neutral	A - Football (Exit)	25	CO
A-17	(5) - E, Neutral	C - Winter Racing (Enter)	25	-
A-18	(5) - E, Neutral	E - Summer Racing (Enter)	25	-
A-19	(6) - SE, Neutral	B - Football (Entrance)	25	CO
A-20	(6) - SE, Neutral	C - Winter Racing (Enter)	25	-
A-21	(6) - SE, Neutral	E - Summer Racing (Enter)	25	-
A-22	(7) - S, Stable	A - Football (Exit)	25	CO
A-23	(8) - SW, Stable	A - Football (Exit)	25	CO
A-24	(8) - SW, Stable	D - Winter Racing (Exit)	25	-

TABLES OF CALCULATED 1990 AIR QUALITY CONCENTRATIONS UNDER VARIOUS ASSUMPTIONS, contd.

Figure No.	Meteorological Condition (Met)	Facility Case (Case)	No. of Receptors	Maps
A-25	(8) - SW, Stable	F - Summer Racing (Exit)	25	-
A-26	(8) - SW, Stable	G - Arena	25	-
A-27	(8) - SW, Stable	H - Combined	25	-
A-28	(9) - W, Stable	A - Football (Exit)	25	CO
A-29	(9) - W, Stable	G - Arena	25	-
A-30*	(10) - SE, Stable	A - Football (Exit	25	5 pollutants
A-31*	(10) - SE, Stable	D - Winter Racing (Exit)	25	-
A-32*	(10) - SE, Stable	F - Summer Racing (Exit)	25	-
A-33*	(10) - SE, Stable	G - Arena	25	-
A-34*	(10) - SE, Stable	H - Combined	25	-

*NOTE: Tables for Met. condition 10 were run with a unit wind speed of 1 m/sec. as a test; therefore, divide all concentrations shown in the tables by 2 to determine the concentrations used in the analysis, corresponding to a wind speed of 2 m/sec.

TAPE 16 LABEL=SOURCE GROUP # 5

RECEPTOR BACKGROUND CONCENTRATIONS

MARTIK RUN 2971 DATE JUN. 02/72 (UNIT 16)

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.000E 02	6.200E-03	7.000E-01	1.350E 03	4.000E 01
2	576.00	4521.00	0.0	1.030E 02	6.500E-03	7.000E-01	1.350E 03	4.000E 01
3	577.00	4521.00	0.0	1.032E 02	6.520E-03	7.123E-01	1.371E 03	4.008E 01
4	578.00	4521.00	0.0	1.054E 02	8.240E-03	7.230E-01	1.404E 03	4.084E 01
5	579.00	4521.00	0.0	1.100E 02	7.260E-03	7.457E-01	1.508E 03	4.297E 01
6	580.00	4521.00	0.0	1.164E 02	7.680E-03	7.656E-01	1.608E 03	4.595E 01
7	575.00	4520.00	0.0	1.030E 02	6.200E-03	6.800E-01	1.325E 03	4.000E 01
8	576.00	4520.00	0.0	1.050E 02	6.500E-03	6.800E-01	1.325E 03	4.000E 01
9	577.00	4520.00	0.0	1.063E 02	6.990E-03	6.788E-01	1.347E 03	4.057E 01
10	578.00	4520.00	0.0	1.016E 02	6.160E-03	6.907E-01	1.384E 03	3.977E 01
11	579.00	4520.00	0.0	1.123E 02	7.180E-03	7.834E-01	1.530E 03	4.458E 01
12	580.00	4520.00	0.0	1.157E 02	7.310E-03	7.372E-01	1.604E 03	4.589E 01
13	575.00	4519.00	0.0	9.800E 01	6.000E-03	6.600E-01	1.300E 03	3.900E 01
14	576.00	4519.00	0.0	9.807E 01	5.930E-03	6.742E-01	1.298E 03	3.832E 01
15	577.00	4519.00	0.0	1.022E 02	6.420E-03	6.760E-01	1.378E 03	3.979E 01
16	578.00	4519.00	0.0	1.071E 02	6.730E-03	7.291E-01	1.460E 03	4.203E 01
17	579.00	4519.00	0.0	1.133E 02	7.980E-03	7.550E-01	1.556E 03	4.491E 01
18	580.00	4519.00	0.0	1.236E 02	8.100E-03	9.406E-01	1.678E 03	5.089E 01
19	575.00	4518.00	0.0	9.800E 01	9.000E-03	6.500E-01	1.292E 03	3.800E 01
20	576.00	4518.00	0.0	9.859E 01	5.880E-03	6.583E-01	1.311E 03	3.850E 01
21	577.00	4518.00	0.0	1.063E 02	6.710E-03	7.190E-01	1.434E 03	4.180E 01
22	578.00	4518.00	0.0	1.076E 02	6.560E-03	7.009E-01	1.483E 03	4.222E 01
23	579.00	4518.00	0.0	1.166E 02	7.460E-03	8.345E-01	1.600E 03	4.715E 01
24	580.00	4518.00	0.0	1.183E 02	7.420E-03	7.457E-01	1.653E 03	4.749E 01
25	575.00	4517.00	0.0	9.838E 01	6.120E-03	6.492E-01	1.292E 03	3.823E 01
26	576.00	4517.00	0.0	1.059E 02	6.830E-03	6.922E-01	1.403E 03	4.144E 01
27	577.00	4517.00	0.0	1.102E 02	1.019E-02	7.197E-01	1.489E 03	4.345E 01
28	578.00	4517.00	0.0	1.116E 02	7.070E-03	7.494E-01	1.535E 03	4.444E 01
29	579.00	4517.00	0.0	1.160E 02	7.200E-03	7.238E-01	1.627E 03	4.647E 01
30	580.00	4517.00	0.0	1.226E 02	8.140E-03	7.585E-01	1.724E 03	4.986E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
31	575.00	4516.00	0.0	1.005E 02	6.160E-03	6.518E-01	1.319E 03	3.907E 01
32	576.00	4516.00	0.0	1.063E 02	6.620E-03	6.836E-01	1.408E 03	4.161E 01
33	577.00	4516.00	0.0	1.104E 02	7.620E-03	7.078E-01	1.499E 03	4.368E 01
34	578.00	4516.00	0.0	1.106E 02	7.140E-03	7.072E-01	1.542E 03	4.419E 01
35	579.00	4516.00	0.0	1.182E 02	7.740E-03	7.495E-01	1.659E 03	4.829E 01
36	580.00	4516.00	0.0	1.247E 02	8.220E-03	7.602E-01	1.761E 03	5.165E 01

Figure A-1 Met 11/Background

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	9.998E 01	6.202E-03	7.007E-01	1.350E 03	4.003E 01
2	576.00	4521.00	0.0	1.030E 02	6.502E-03	7.006E-01	1.350E 03	4.003E 01
3	577.00	4521.00	0.0	1.033E 02	6.527E-03	7.143E-01	1.371E 03	4.016E 01
4	578.00	4521.00	0.0	1.054E 02	8.248E-03	7.255E-01	1.404E 03	4.093E 01
5	579.00	4521.00	0.0	1.100E 02	7.271E-03	7.493E-01	1.509E 03	4.308E 01
6	580.00	4521.00	0.0	1.164E 02	7.693E-03	7.702E-01	1.609E 03	4.609E 01
7	575.00	4520.00	0.0	1.030E 02	6.202E-03	6.805E-01	1.325E 03	4.003E 01
8	576.00	4520.00	0.0	1.050E 02	6.505E-03	6.816E-01	1.325E 03	4.005E 01
9	577.00	4520.00	0.0	1.063E 02	7.001E-03	6.832E-01	1.347E 03	4.069E 01
10	578.00	4520.00	0.0	1.017E 02	6.180E-03	6.983E-01	1.385E 03	3.996E 01
11	579.00	4520.00	0.0	1.124E 02	7.206E-03	7.935E-01	1.532E 03	4.482E 01
12	580.00	4520.00	0.0	1.158E 02	7.326E-03	7.407E-01	1.604E 03	4.603E 01
13	575.00	4519.00	0.0	9.799E 01	6.004E-03	6.611E-01	1.300E 03	3.905E 01
14	576.00	4519.00	0.0	9.809E 01	5.937E-03	6.765E-01	1.299E 03	3.839E 01
15	577.00	4519.00	0.0	1.023E 02	6.460E-03	6.946E-01	1.381E 03	4.016E 01
16	578.00	4519.00	0.0	1.075E 02	6.826E-03	7.757E-01	1.468E 03	4.291E 01
17	579.00	4519.00	0.0	1.135E 02	8.014E-03	7.624E-01	1.557E 03	4.519E 01
18	580.00	4519.00	0.0	1.239E 02	8.120E-03	9.435E-01	1.679E 03	5.105E 01
19	575.00	4518.00	0.0	9.799E 01	9.004E-03	6.513E-01	1.292E 03	3.805E 01
20	576.00	4518.00	0.0	9.863E 01	5.892E-03	6.626E-01	1.312E 03	3.863E 01
21	577.00	4518.00	0.0	1.067E 02	6.791E-03	7.543E-01	1.440E 03	4.253E 01
22	578.00	4518.00	0.0	1.079E 02	6.639E-03	7.324E-01	1.488E 03	4.290E 01
23	579.00	4518.00	0.0	1.170E 02	7.528E-03	8.452E-01	1.602E 03	4.766E 01
24	580.00	4518.00	0.0	1.183E 02	7.439E-03	7.491E-01	1.654E 03	4.765E 01
25	575.00	4517.00	0.0	9.837E 01	6.124E-03	6.504E-01	1.292E 03	3.828E 01
26	576.00	4517.00	0.0	1.059E 02	6.833E-03	6.950E-01	1.403E 03	4.153E 01
27	577.00	4517.00	0.0	1.103E 02	1.021E-02	7.249E-01	1.490E 03	4.360E 01
28	578.00	4517.00	0.0	1.117E 02	7.098E-03	7.541E-01	1.536E 03	4.465E 01
29	579.00	4517.00	0.0	1.161E 02	7.220E-03	7.271E-01	1.627E 03	4.662E 01
30	580.00	4517.00	0.0	1.227E 02	8.155E-03	7.607E-01	1.724E 03	4.997E 01
31	575.00	4516.00	0.0	1.005E 02	6.164E-03	6.529E-01	1.319E 03	3.911E 01
32	576.00	4516.00	0.0	1.063E 02	6.627E-03	6.856E-01	1.408E 03	4.168E 01
33	577.00	4516.00	0.0	1.104E 02	7.629E-03	7.090E-01	1.499E 03	4.376E 01
34	578.00	4516.00	0.0	1.107E 02	7.151E-03	7.080E-01	1.543E 03	4.428E 01
35	579.00	4516.00	0.0	1.182E 02	7.749E-03	7.512E-01	1.659E 03	4.837E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	1.247E 02	8.226E-03	7.615E-01	1.761E 03	5.172E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29710020

END OF PROGRAM.

Figure A-2 Met 11/Case I - Annual Average

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.003E 02	6.260E-03	1.084E 00	1.356E 03	4.065E 01
2	576.00	4521.00	0.0	1.033E 02	6.565E-03	1.083E 00	1.356E 03	4.067E 01
3	577.00	4521.00	0.0	1.045E 02	6.718E-03	1.154E 00	1.386E 03	4.208E 01
4	578.00	4521.00	0.0	1.065E 02	8.435E-03	1.165E 00	1.422E 03	4.284E 01
5	579.00	4521.00	0.0	1.113E 02	7.518E-03	1.262E 00	1.533E 03	4.565E 01
6	580.00	4521.00	0.0	1.182E 02	8.000E-03	1.328E 00	1.639E 03	4.937E 01
7	575.00	4520.00	0.0	1.033E 02	6.257E-03	1.050E 00	1.330E 03	4.060E 01
8	576.00	4520.00	0.0	1.057E 02	6.633E-03	1.086E 00	1.337E 03	4.134E 01
9	577.00	4520.00	0.0	1.081E 02	7.329E-03	1.187E 00	1.377E 03	4.388E 01
10	578.00	4520.00	0.0	1.044E 02	6.714E-03	1.327E 00	1.435E 03	4.518E 01
11	579.00	4520.00	0.0	1.157E 02	7.860E-03	1.555E 00	1.596E 03	5.143E 01
12	580.00	4520.00	0.0	1.172E 02	7.594E-03	1.246E 00	1.628E 03	4.867E 01
13	575.00	4519.00	0.0	9.850E 01	6.096E-03	1.040E 00	1.309E 03	3.998E 01
14	576.00	4519.00	0.0	9.908E 01	6.121E-03	1.106E 00	1.316E 03	4.019E 01
15	577.00	4519.00	0.0	1.083E 02	7.701E-03	1.678E 00	1.501E 03	5.181E 01
16	578.00	4519.00	0.0	1.216E 02	9.890E-03	2.815E 00	1.761E 03	7.188E 01
17	579.00	4519.00	0.0	1.166E 02	8.617E-03	1.415E 00	1.605E 03	5.062E 01
18	580.00	4519.00	0.0	1.255E 02	8.411E-03	1.530E 00	1.699E 03	5.358E 01
19	575.00	4518.00	0.0	9.859E 01	9.109E-03	1.030E 00	1.302E 03	3.911E 01
20	576.00	4518.00	0.0	1.005E 02	6.230E-03	1.154E 00	1.340E 03	4.190E 01
21	577.00	4518.00	0.0	1.165E 02	9.237E-03	2.383E 00	1.661E 03	6.557E 01
22	578.00	4518.00	0.0	1.179E 02	8.853E-03	2.219E 00	1.686E 03	6.287E 01
23	579.00	4518.00	0.0	1.254E 02	9.033E-03	1.657E 00	1.666E 03	5.884E 01
24	580.00	4518.00	0.0	1.202E 02	7.790E-03	1.256E 00	1.676E 03	5.054E 01
25	575.00	4517.00	0.0	9.891E 01	6.222E-03	1.026E 00	1.301E 03	3.926E 01
26	576.00	4517.00	0.0	1.070E 02	7.045E-03	1.148E 00	1.422E 03	4.354E 01
27	577.00	4517.00	0.0	1.122E 02	1.060E-02	1.280E 00	1.524E 03	4.728E 01
28	578.00	4517.00	0.0	1.145E 02	7.663E-03	1.306E 00	1.566E 03	4.880E 01
29	579.00	4517.00	0.0	1.179E 02	7.613E-03	1.219E 00	1.649E 03	4.944E 01
30	580.00	4517.00	0.0	1.240E 02	8.467E-03	1.229E 00	1.739E 03	5.199E 01
31	575.00	4516.00	0.0	1.010E 02	6.253E-03	1.028E 00	1.328E 03	4.004E 01
32	576.00	4516.00	0.0	1.071E 02	6.783E-03	1.109E 00	1.422E 03	4.322E 01
33	577.00	4516.00	0.0	1.114E 02	7.816E-03	1.145E 00	1.513E 03	4.541E 01
34	578.00	4516.00	0.0	1.116E 02	7.352E-03	1.130E 00	1.554E 03	4.577E 01
35	579.00	4516.00	0.0	1.193E 02	7.996E-03	1.195E 00	1.671E 03	4.992E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	1.255E 02	8.420E-03	1.199E 00	1.771E 03	5.300E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29720020

END OF PROGRAM.

Figure A-3 Met 11/Case A

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.002E 02	6.248E-03	1.077E 00	1.355E 03	4.052E 01
2	576.00	4521.00	0.0	1.035E 02	6.553E-03	1.074E 00	1.355E 03	4.054E 01
3	577.00	4521.00	0.0	1.042E 02	6.680E-03	1.137E 00	1.383E 03	4.168E 01
4	578.00	4521.00	0.0	1.063E 02	8.398E-03	1.165E 00	1.418E 03	4.245E 01
5	579.00	4521.00	0.0	1.111E 02	7.470E-03	1.233E 00	1.528E 03	4.513E 01
6	580.00	4521.00	0.0	1.178E 02	7.940E-03	1.292E 00	1.633E 03	4.870E 01
7	575.00	4520.00	0.0	1.032E 02	6.246E-03	1.044E 00	1.329E 03	4.048E 01
8	576.00	4520.00	0.0	1.056E 02	6.608E-03	1.075E 00	1.335E 03	4.108E 01
9	577.00	4520.00	0.0	1.077E 02	7.264E-03	1.154E 00	1.371E 03	4.323E 01
10	578.00	4520.00	0.0	1.038E 02	6.607E-03	1.269E 00	1.425E 03	4.412E 01
11	579.00	4520.00	0.0	1.151E 02	7.731E-03	1.479E 00	1.583E 03	5.008E 01
12	580.00	4520.00	0.0	1.169E 02	7.545E-03	1.216E 00	1.623E 03	4.814E 01
13	575.00	4519.00	0.0	9.840E 01	6.078E-03	1.030E 00	1.307E 03	3.979E 01
14	576.00	4519.00	0.0	9.888E 01	6.085E-03	1.087E 00	1.312E 03	3.982E 01
15	577.00	4519.00	0.0	1.071E 02	7.450E-03	1.546E 00	1.476E 03	4.943E 01
16	578.00	4519.00	0.0	1.187E 02	9.271E-03	2.475E 00	1.701E 03	6.597E 01
17	579.00	4519.00	0.0	1.159E 02	8.506E-03	1.359E 00	1.595E 03	4.952E 01
18	580.00	4519.00	0.0	1.252E 02	8.363E-03	1.507E 00	1.695E 03	5.307E 01
19	575.00	4518.00	0.0	9.847E 01	6.089E-03	1.019E 00	1.300E 03	3.889E 01
20	576.00	4518.00	0.0	1.001E 02	6.163E-03	1.121E 00	1.335E 03	4.123E 01
21	577.00	4518.00	0.0	1.161E 02	8.742E-03	2.124E 00	1.616E 03	6.087E 01
22	578.00	4518.00	0.0	1.159E 02	8.424E-03	1.987E 00	1.646E 03	5.880E 01
23	579.00	4518.00	0.0	1.238E 02	8.803E-03	1.577E 00	1.653E 03	5.659E 01
24	580.00	4518.00	0.0	1.196E 02	7.734E-03	1.226E 00	1.672E 03	4.996E 01
25	575.00	4517.00	0.0	9.880E 01	6.204E-03	1.016E 00	1.299E 03	3.906E 01
26	576.00	4517.00	0.0	1.068E 02	7.006E-03	1.126E 00	1.418E 03	4.313E 01
27	577.00	4517.00	0.0	1.118E 02	1.053E-02	1.240E 00	1.517E 03	4.653E 01
28	578.00	4517.00	0.0	1.140E 02	7.578E-03	1.270E 00	1.560E 03	4.796E 01
29	579.00	4517.00	0.0	1.176E 02	7.557E-03	1.192E 00	1.645E 03	4.888E 01
30	580.00	4517.00	0.0	1.238E 02	8.429E-03	1.211E 00	1.736E 03	5.159E 01
31	575.00	4516.00	0.0	1.009E 02	6.236E-03	1.018E 00	1.326E 03	3.986E 01
32	576.00	4516.00	0.0	1.069E 02	6.754E-03	1.093E 00	1.419E 03	4.291E 01
33	577.00	4516.00	0.0	1.112E 02	7.784E-03	1.129E 00	1.511E 03	4.507E 01
34	578.00	4516.00	0.0	1.114E 02	7.323E-03	1.116E 00	1.552E 03	4.547E 01
35	579.00	4516.00	0.0	1.191E 02	7.966E-03	1.181E 00	1.668E 03	4.962E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	1.254E 02	8.396E-03	1.187E 00	1.769E 03	5.275E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29640020

END OF PROGRAM.

Figure A-4 Met 11/Case B

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	2.001E 02	1.242E-02	7.117E-01	1.352E 03	4.025E 01
2	576.00	4521.00	0.0	2.061E 02	1.302E-02	7.113E-01	1.352E 03	4.026E 01
3	577.00	4521.00	0.0	2.069E 02	1.311E-02	7.420E-01	1.376E 03	4.082E 01
4	578.00	4521.00	0.0	2.112E 02	1.655E-02	7.580E-01	1.410E 03	4.160E 01
5	579.00	4521.00	0.0	2.204E 02	1.462E-02	7.955E-01	1.517E 03	4.398E 01
6	580.00	4521.00	0.0	2.334E 02	1.548E-02	8.282E-01	1.619E 03	4.725E 01
7	575.00	4520.00	0.0	2.061E 02	1.242E-02	6.902E-01	1.327E 03	4.024E 01
8	576.00	4520.00	0.0	2.102E 02	1.305E-02	7.037E-01	1.329E 03	4.059E 01
9	577.00	4520.00	0.0	2.132E 02	1.410E-02	7.377E-01	1.357E 03	4.177E 01
10	578.00	4520.00	0.0	2.042E 02	1.253E-02	7.919E-01	1.402E 03	4.175E 01
11	579.00	4520.00	0.0	2.258E 02	1.462E-02	9.157E-01	1.553E 03	4.710E 01
12	580.00	4520.00	0.0	2.321E 02	1.474E-02	7.859E-01	1.612E 03	4.703E 01
13	575.00	4519.00	0.0	1.961E 02	1.204E-02	6.773E-01	1.303E 03	3.938E 01
14	576.00	4519.00	0.0	1.965E 02	1.193E-02	7.072E-01	1.304E 03	3.902E 01
15	577.00	4519.00	0.0	2.065E 02	1.330E-02	9.079E-01	1.421E 03	4.407E 01
16	578.00	4519.00	0.0	2.194E 02	1.459E-02	1.330E 00	1.565E 03	5.261E 01
17	579.00	4519.00	0.0	2.280E 02	1.622E-02	8.535E-01	1.573E 03	4.720E 01
18	580.00	4519.00	0.0	2.484E 02	1.634E-02	9.821E-01	1.686E 03	5.205E 01
19	575.00	4518.00	0.0	1.962E 02	1.804E-02	6.691E-01	1.295E 03	3.843E 01
20	576.00	4518.00	0.0	1.979E 02	1.189E-02	7.164E-01	1.321E 03	3.975E 01
21	577.00	4518.00	0.0	2.171E 02	1.433E-02	1.174E 00	1.513E 03	5.029E 01
22	578.00	4518.00	0.0	2.190E 02	1.395E-02	1.108E 00	1.554E 03	4.970E 01
23	579.00	4518.00	0.0	2.367E 02	1.550E-02	9.754E-01	1.623E 03	5.169E 01
24	580.00	4518.00	0.0	2.373E 02	1.499E-02	7.933E-01	1.661E 03	4.873E 01
25	575.00	4517.00	0.0	1.969E 02	1.228E-02	6.673E-01	1.295E 03	3.863E 01
26	576.00	4517.00	0.0	2.122E 02	1.374E-02	7.304E-01	1.409E 03	4.223E 01
27	577.00	4517.00	0.0	2.212E 02	2.054E-02	7.896E-01	1.501E 03	4.489E 01
28	578.00	4517.00	0.0	2.244E 02	1.436E-02	8.127E-01	1.546E 03	4.618E 01
29	579.00	4517.00	0.0	2.328E 02	1.456E-02	7.700E-01	1.635E 03	4.768E 01
30	580.00	4517.00	0.0	2.458E 02	1.640E-02	7.902E-01	1.729E 03	5.074E 01
31	575.00	4516.00	0.0	2.012E 02	1.236E-02	6.693E-01	1.322E 03	3.945E 01
32	576.00	4516.00	0.0	2.128E 02	1.330E-02	7.127E-01	1.413E 03	4.223E 01
33	577.00	4516.00	0.0	2.211E 02	1.532E-02	7.368E-01	1.504E 03	4.436E 01
34	578.00	4516.00	0.0	2.217E 02	1.436E-02	7.312E-01	1.546E 03	4.485E 01
35	579.00	4516.00	0.0	2.368E 02	1.557E-02	7.741E-01	1.663E 03	4.894E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	2.497E 02	1.651E-02	7.805E-01	1.765E 03	5.220E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 27650020

END OF PROGRAM.

Figure A-5 Met 11/Case C

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	2.001E 02	1.243E-02	2.114E 00	1.352E 03	4.030E 01
2	576.00	4521.00	0.0	2.061E 02	1.303E-02	2.114E 00	1.352E 03	4.032E 01
3	577.00	4521.00	0.0	2.070E 02	1.313E-02	2.173E 00	1.377E 03	4.099E 01
4	578.00	4521.00	0.0	2.113E 02	1.657E-02	2.212E 00	1.411E 03	4.177E 01
5	579.00	4521.00	0.0	2.205E 02	1.464E-02	2.299E 00	1.519E 03	4.421E 01
6	580.00	4521.00	0.0	2.336E 02	1.551E-02	2.374E 00	1.622E 03	4.754E 01
7	575.00	4520.00	0.0	2.061E 02	1.243E-02	2.052E 00	1.327E 03	4.029E 01
8	576.00	4520.00	0.0	2.103E 02	1.306E-02	2.069E 00	1.330E 03	4.062E 01
9	577.00	4520.00	0.0	2.133E 02	1.413E-02	2.110E 00	1.360E 03	4.206E 01
10	578.00	4520.00	0.0	2.044E 02	1.257E-02	2.198E 00	1.406E 03	4.222E 01
11	579.00	4520.00	0.0	2.261E 02	1.467E-02	2.515E 00	1.559E 03	4.770E 01
12	580.00	4520.00	0.0	2.322E 02	1.476E-02	2.272E 00	1.614E 03	4.726E 01
13	575.00	4519.00	0.0	1.962E 02	1.204E-02	2.001E 00	1.304E 03	3.946E 01
14	576.00	4519.00	0.0	1.966E 02	1.195E-02	2.063E 00	1.306E 03	3.918E 01
15	577.00	4519.00	0.0	2.070E 02	1.341E-02	2.319E 00	1.431E 03	4.512E 01
16	578.00	4519.00	0.0	2.206E 02	1.486E-02	2.937E 00	1.591E 03	5.521E 01
17	579.00	4519.00	0.0	2.283E 02	1.627E-02	2.386E 00	1.577E 03	4.769E 01
18	580.00	4519.00	0.0	2.485E 02	1.636E-02	2.873E 00	1.687E 03	5.228E 01
19	575.00	4518.00	0.0	1.962E 02	1.805E-02	1.973E 00	1.296E 03	3.852E 01
20	576.00	4518.00	0.0	1.980E 02	1.192E-02	2.047E 00	1.324E 03	4.004E 01
21	577.00	4518.00	0.0	2.181E 02	1.425E-02	2.725E 00	1.533E 03	5.237E 01
22	578.00	4518.00	0.0	2.199E 02	1.415E-02	2.611E 00	1.572E 03	5.149E 01
23	579.00	4518.00	0.0	2.375E 02	1.562E-02	2.679E 00	1.629E 03	5.269E 01
24	580.00	4518.00	0.0	2.375E 02	1.501E-02	2.296E 00	1.663E 03	4.899E 01
25	575.00	4517.00	0.0	1.970E 02	1.229E-02	1.970E 00	1.296E 03	3.872E 01
26	576.00	4517.00	0.0	2.123E 02	1.376E-02	2.124E 00	1.411E 03	4.241E 01
27	577.00	4517.00	0.0	2.213E 02	2.057E-02	2.246E 00	1.504E 03	4.522E 01
28	578.00	4517.00	0.0	2.247E 02	1.441E-02	2.327E 00	1.549E 03	4.655E 01
29	579.00	4517.00	0.0	2.329E 02	1.459E-02	2.229E 00	1.637E 03	4.793E 01
30	580.00	4517.00	0.0	2.459E 02	1.642E-02	2.315E 00	1.730E 03	5.091E 01
31	575.00	4516.00	0.0	2.012E 02	1.236E-02	1.977E 00	1.323E 03	3.953E 01
32	576.00	4516.00	0.0	2.129E 02	1.332E-02	2.087E 00	1.414E 03	4.237E 01
33	577.00	4516.00	0.0	2.212E 02	1.533E-02	2.159E 00	1.505E 03	4.451E 01
34	578.00	4516.00	0.0	2.217E 02	1.438E-02	2.151E 00	1.547E 03	4.498E 01
35	579.00	4516.00	0.0	2.369E 02	1.558E-02	2.279E 00	1.664E 03	4.907E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	2.497E 02	1.652E-02	2.305E 00	1.765E 03	5.231E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 REEL FILE SEQUENCE NUMBER 29660025

END OF PROGRAM.

Figure A-6 Met 11/Case D

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	5.010E 01	3.120E-03	7.117E-01	1.352E 03	4.023E 01
2	576.00	4521.00	0.0	5.151E 01	3.272E-03	7.113E-01	1.352E 03	4.024E 01
3	577.00	4521.00	0.0	5.204E 01	3.329E-03	7.420E-01	1.376E 03	4.078E 01
4	578.00	4521.00	0.0	5.307E 01	4.166E-03	7.580E-01	1.410E 03	4.154E 01
5	579.00	4521.00	0.0	5.544E 01	3.717E-03	7.955E-01	1.517E 03	4.390E 01
6	580.00	4521.00	0.0	5.879E 01	3.947E-03	8.282E-01	1.619E 03	4.714E 01
7	575.00	4520.00	0.0	5.159E 01	3.119E-03	6.902E-01	1.327E 03	4.021E 01
8	576.00	4520.00	0.0	5.273E 01	3.295E-03	7.037E-01	1.329E 03	4.047E 01
9	577.00	4520.00	0.0	5.375E 01	3.611E-03	7.377E-01	1.357E 03	4.172E 01
10	578.00	4520.00	0.0	5.175E 01	3.269E-03	7.919E-01	1.402E 03	4.165E 01
11	579.00	4520.00	0.0	5.731E 01	3.821E-03	9.157E-01	1.553E 03	4.695E 01
12	580.00	4520.00	0.0	5.835E 01	3.747E-03	7.859E-01	1.612E 03	4.684E 01
13	575.00	4519.00	0.0	4.916E 01	3.032E-03	6.773E-01	1.303E 03	3.934E 01
14	576.00	4519.00	0.0	4.937E 01	3.030E-03	7.072E-01	1.304E 03	3.897E 01
15	577.00	4519.00	0.0	5.320E 01	3.653E-03	9.079E-01	1.421E 03	4.397E 01
16	578.00	4519.00	0.0	5.857E 01	4.461E-03	1.330E 00	1.565E 03	5.242E 01
17	579.00	4519.00	0.0	5.772E 01	4.196E-03	1.535E-01	1.573E 03	4.687E 01
18	580.00	4519.00	0.0	6.243E 01	4.140E-03	9.621E-01	1.685E 03	5.180E 01
19	575.00	4518.00	0.0	4.919E 01	4.536E-03	6.691E-01	1.295E 03	3.839E 01
20	576.00	4518.00	0.0	4.995E 01	3.059E-03	7.164E-01	1.321E 03	3.968E 01
21	577.00	4518.00	0.0	5.738E 01	4.230E-03	1.174E 00	1.513E 03	5.006E 01
22	578.00	4518.00	0.0	5.733E 01	4.058E-03	1.108E 00	1.554E 03	4.938E 01
23	579.00	4518.00	0.0	6.121E 01	4.211E-03	9.753E-01	1.623E 03	5.114E 01
24	580.00	4518.00	0.0	5.975E 01	3.824E-03	7.933E-01	1.661E 03	4.853E 01
25	575.00	4517.00	0.0	4.936E 01	3.094E-03	6.673E-01	1.295E 03	3.859E 01
26	576.00	4517.00	0.0	5.332E 01	3.487E-03	7.304E-01	1.409E 03	4.217E 01
27	577.00	4517.00	0.0	5.579E 01	5.233E-03	7.896E-01	1.501E 03	4.477E 01
28	578.00	4517.00	0.0	5.675E 01	3.714E-03	8.127E-01	1.546E 03	4.592E 01
29	579.00	4517.00	0.0	5.860E 01	3.722E-03	7.700E-01	1.634E 03	4.748E 01
30	580.00	4517.00	0.0	6.175E 01	4.162E-03	7.902E-01	1.729E 03	5.058E 01
31	575.00	4516.00	0.0	5.041E 01	3.111E-03	6.693E-01	1.322E 03	3.941E 01
32	576.00	4516.00	0.0	5.341E 01	3.354E-03	7.127E-01	1.413E 03	4.217E 01
33	577.00	4516.00	0.0	5.550E 01	3.872E-03	7.366E-01	1.504E 03	4.427E 01
34	578.00	4516.00	0.0	5.563E 01	3.633E-03	7.312E-01	1.546E 03	4.473E 01
35	579.00	4516.00	0.0	5.943E 01	3.942E-03	7.741E-01	1.663E 03	4.885E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	6.261E 01	4.167E-03	7.805E-01	1.765E 03	5.211E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 296/0020

END OF PROGRAM.

Figure A-7 Met 11/Case E

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	5.013E 01	3.125E-03	1.065E 00	1.352E 03	4.029E 01
2	576.00	4521.00	0.0	5.164E 01	3.277E-03	1.064E 00	1.352E 03	4.029E 01
3	577.00	4521.00	0.0	5.214E 01	3.344E-03	1.105E 00	1.377E 03	4.095E 01
4	578.00	4521.00	0.0	5.316E 01	4.202E-03	1.128E 00	1.411E 03	4.171E 01
5	579.00	4521.00	0.0	5.556E 01	3.738E-03	1.181E 00	1.519E 03	4.413E 01
6	580.00	4521.00	0.0	5.895E 01	3.974E-03	1.227E 00	1.622E 03	4.743E 01
7	575.00	4520.00	0.0	5.162E 01	3.124E-03	1.033E 00	1.327E 03	4.026E 01
8	576.00	4520.00	0.0	5.279E 01	3.306E-03	1.050E 00	1.330E 03	4.058E 01
9	577.00	4520.00	0.0	5.391E 01	3.640E-03	1.092E 00	1.360E 03	4.201E 01
10	578.00	4520.00	0.0	5.200E 01	3.317E-03	1.162E 00	1.406E 03	4.212E 01
11	579.00	4520.00	0.0	5.761E 01	3.879E-03	1.340E 00	1.559E 03	4.754E 01
12	580.00	4520.00	0.0	5.648E 01	3.770E-03	1.167E 00	1.614E 03	4.708E 01
13	575.00	4519.00	0.0	4.921E 01	3.040E-03	1.012E 00	1.304E 03	3.943E 01
14	576.00	4519.00	0.0	4.946E 01	3.046E-03	1.053E 00	1.306E 03	3.913E 01
15	577.00	4519.00	0.0	5.373E 01	3.764E-03	1.304E 00	1.431E 03	4.502E 01
16	578.00	4519.00	0.0	5.983E 01	4.734E-03	1.844E 00	1.591E 03	5.502E 01
17	579.00	4519.00	0.0	5.799E 01	4.248E-03	1.256E 00	1.577E 03	4.735E 01
18	580.00	4519.00	0.0	6.257E 01	4.179E-03	1.463E 00	1.687E 03	5.203E 01
19	575.00	4518.00	0.0	4.925E 01	2.945E-03	9.988E-01	1.296E 03	3.848E 01
20	576.00	4518.00	0.0	5.011E 01	3.089E-03	1.060E 00	1.324E 03	3.998E 01
21	577.00	4518.00	0.0	5.844E 01	4.443E-03	1.647E 00	1.533E 03	5.213E 01
22	578.00	4518.00	0.0	5.821E 01	4.252E-03	1.560E 00	1.571E 03	5.117E 01
23	579.00	4518.00	0.0	6.194E 01	4.331E-03	1.428E 00	1.629E 03	5.214E 01
24	580.00	4518.00	0.0	5.990E 01	3.853E-03	1.178E 00	1.663E 03	4.879E 01
25	575.00	4517.00	0.0	4.941E 01	3.102E-03	9.964E-01	1.296E 03	3.868E 01
26	576.00	4517.00	0.0	5.341E 01	3.505E-03	1.086E 00	1.411E 03	4.235E 01
27	577.00	4517.00	0.0	5.596E 01	5.267E-03	1.167E 00	1.504E 03	4.511E 01
28	578.00	4517.00	0.0	5.699E 01	3.759E-03	1.203E 00	1.549E 03	4.629E 01
29	579.00	4517.00	0.0	5.875E 01	3.753E-03	1.143E 00	1.636E 03	4.773E 01
30	580.00	4517.00	0.0	6.187E 01	4.185E-03	1.177E 00	1.730E 03	5.076E 01
31	575.00	4516.00	0.0	5.046E 01	3.119E-03	9.995E-01	1.323E 03	3.949E 01
32	576.00	4516.00	0.0	5.349E 01	3.378E-03	1.062E 00	1.414E 03	4.231E 01
33	577.00	4516.00	0.0	5.559E 01	3.888E-03	1.098E 00	1.505E 03	4.442E 01
34	578.00	4516.00	0.0	5.571E 01	3.648E-03	1.091E 00	1.547E 03	4.486E 01
35	579.00	4516.00	0.0	5.952E 01	3.961E-03	1.155E 00	1.664E 03	4.899E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	6.268E 01	4.181E-03	1.166E 00	1.765E 03	5.223E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29680020

END OF PROGRAM.

Figure A-8 Met 11/Case F

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.001E 02	6.217E-03	7.098E-01	1.352E 03	4.020E 01
2	576.00	4521.00	0.0	1.031E 02	6.519E-03	7.095E-01	1.352E 03	4.021E 01
3	577.00	4521.00	0.0	1.036E 02	6.578E-03	7.373E-01	1.375E 03	4.068E 01
4	578.00	4521.00	0.0	1.057E 02	8.298E-03	7.525E-01	1.409E 03	4.145E 01
5	579.00	4521.00	0.0	1.104E 02	7.336E-03	7.877E-01	1.516E 03	4.378E 01
6	580.00	4521.00	0.0	1.169E 02	7.775E-03	8.184E-01	1.617E 03	4.699E 01
7	575.00	4520.00	0.0	1.031E 02	6.217E-03	6.885E-01	1.326E 03	4.019E 01
8	576.00	4520.00	0.0	1.052E 02	6.539E-03	6.999E-01	1.328E 03	4.041E 01
9	577.00	4520.00	0.0	1.068E 02	7.090E-03	7.285E-01	1.356E 03	4.156E 01
10	578.00	4520.00	0.0	1.024E 02	6.324E-03	7.761E-01	1.399E 03	4.139E 01
11	579.00	4520.00	0.0	1.133E 02	7.381E-03	8.950E-01	1.549E 03	4.663E 01
12	580.00	4520.00	0.0	1.162E 02	7.394E-03	7.782E-01	1.611E 03	4.675E 01
13	575.00	4519.00	0.0	9.813E 01	6.028E-03	6.745E-01	1.302E 03	3.930E 01
14	576.00	4519.00	0.0	9.836E 01	5.987E-03	7.020E-01	1.303E 03	3.888E 01
15	577.00	4519.00	0.0	1.040E 02	6.799E-03	8.717E-01	1.414E 03	4.335E 01
16	578.00	4519.00	0.0	1.114E 02	7.663E-03	1.236E 00	1.548E 03	5.086E 01
17	579.00	4519.00	0.0	1.143E 02	8.167E-03	8.380E-01	1.570E 03	4.667E 01
18	580.00	4519.00	0.0	1.243E 02	8.189E-03	9.755E-01	1.684E 03	5.174E 01
19	575.00	4518.00	0.0	9.815E 01	9.052E-03	6.661E-01	1.295E 03	3.834E 01
20	576.00	4518.00	0.0	9.914E 01	5.933E-03	7.072E-01	1.320E 03	3.952E 01
21	577.00	4518.00	0.0	1.099E 02	7.460E-03	1.103E 00	1.501E 03	4.885E 01
22	578.00	4518.00	0.0	1.106E 02	7.225E-03	1.044E 00	1.543E 03	4.836E 01
23	579.00	4518.00	0.0	1.192E 02	7.863E-03	9.531E-01	1.619E 03	5.069E 01
24	580.00	4518.00	0.0	1.188E 02	7.520E-03	7.858E-01	1.660E 03	4.843E 01
25	575.00	4517.00	0.0	9.851E 01	6.149E-03	6.644E-01	1.295E 03	3.855E 01
26	576.00	4517.00	0.0	1.062E 02	6.892E-03	7.244E-01	1.408E 03	4.208E 01
27	577.00	4517.00	0.0	1.108E 02	1.031E-02	7.787E-01	1.499E 03	4.460E 01
28	578.00	4517.00	0.0	1.125E 02	7.222E-03	8.027E-01	1.544E 03	4.577E 01
29	579.00	4517.00	0.0	1.165E 02	7.303E-03	7.627E-01	1.633E 03	4.738E 01
30	580.00	4517.00	0.0	1.230E 02	8.214E-03	7.851E-01	1.728E 03	5.051E 01
31	575.00	4516.00	0.0	1.006E 02	6.187E-03	6.665E-01	1.322E 03	3.937E 01
32	576.00	4516.00	0.0	1.065E 02	6.667E-03	7.081E-01	1.412E 03	4.210E 01
33	577.00	4516.00	0.0	1.106E 02	7.674E-03	7.322E-01	1.503E 03	4.421E 01
34	578.00	4516.00	0.0	1.109E 02	7.194E-03	7.274E-01	1.546E 03	4.468E 01
35	579.00	4516.00	0.0	1.185E 02	7.796E-03	7.701E-01	1.662E 03	4.879E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	1.249E 02	8.265E-03	7.772E-01	1.764E 03	5.207E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29690020

END OF PROGRAM,

Figure A-9 Met 11/Case G

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	5.026E 01	3.142E-03	1.079E 00	1.354E 03	4.051E 01
2	576.00	4521.00	0.0	5.178E 01	3.295E-03	1.074E 00	1.354E 03	4.052E 01
3	577.00	4521.00	0.0	5.259E 01	3.401E-03	1.131E 00	1.382E 03	4.161E 01
4	578.00	4521.00	0.0	5.358E 01	4.258E-03	1.158E 00	1.417E 03	4.240E 01
5	579.00	4521.00	0.0	5.611E 01	3.811E-03	1.223E 00	1.526E 03	4.506E 01
6	580.00	4521.00	0.0	5.966E 01	4.064E-03	1.280E 00	1.631E 03	4.862E 01
7	575.00	4520.00	0.0	5.174E 01	3.140E-03	1.041E 00	1.329E 03	4.046E 01
8	576.00	4520.00	0.0	5.307E 01	3.344E-03	1.070E 00	1.334E 03	4.105E 01
9	577.00	4520.00	0.0	5.461E 01	3.738E-03	1.142E 00	1.369E 03	4.316E 01
10	578.00	4520.00	0.0	5.312E 01	3.476E-03	1.248E 00	1.421E 03	4.402E 01
11	579.00	4520.00	0.0	5.901E 01	4.072E-03	1.452E 00	1.578E 03	4.996E 01
12	580.00	4520.00	0.0	5.905E 01	3.845E-03	1.208E 00	1.621E 03	4.802E 01
13	575.00	4519.00	0.0	4.941E 01	3.067E-03	1.026E 00	1.306E 03	3.976E 01
14	576.00	4519.00	0.0	4.985E 01	3.190E-03	1.081E 00	1.311E 03	3.977E 01
15	577.00	4519.00	0.0	5.622E 01	4.137E-03	1.499E 00	1.467E 03	4.928E 01
16	578.00	4519.00	0.0	6.590E 01	5.657E-03	2.351E 00	1.680E 03	6.574E 01
17	579.00	4519.00	0.0	5.919E 01	4.416E-03	1.339E 00	1.592E 03	4.929E 01
18	580.00	4519.00	0.0	6.315E 01	4.246E-03	1.498E 00	1.693E 03	5.291E 01
19	575.00	4518.00	0.0	4.948E 01	4.576E-03	1.015E 00	1.299E 03	3.886E 01
20	576.00	4518.00	0.0	5.084E 01	3.199E-03	1.109E 00	1.332E 03	4.114E 01
21	577.00	4518.00	0.0	6.337E 01	5.155E-03	2.032E 00	1.600E 03	6.055E 01
22	578.00	4518.00	0.0	6.243E 01	4.898E-03	1.904E 00	1.631E 03	5.852E 01
23	579.00	4518.00	0.0	6.468E 01	4.702E-03	1.547E 00	1.648E 03	5.582E 01
24	580.00	4518.00	0.0	6.056E 01	3.942E-03	1.218E 00	1.670E 03	4.980E 01
25	575.00	4517.00	0.0	4.962E 01	3.130E-03	1.012E 00	1.299E 03	3.903E 01
26	576.00	4517.00	0.0	5.385E 01	3.565E-03	1.116E 00	1.417E 03	4.308E 01
27	577.00	4517.00	0.0	5.676E 01	5.381E-03	1.226E 00	1.515E 03	4.644E 01
28	578.00	4517.00	0.0	5.795E 01	3.896E-03	1.257E 00	1.558E 03	4.771E 01
29	579.00	4517.00	0.0	5.939E 01	3.845E-03	1.183E 00	1.643E 03	4.870E 01
30	580.00	4517.00	0.0	6.233E 01	4.252E-03	1.204E 00	1.735E 03	5.144E 01
31	575.00	4516.00	0.0	5.066E 01	3.145E-03	1.014E 00	1.325E 03	3.983E 01
32	576.00	4516.00	0.0	5.382E 01	3.422E-03	1.087E 00	1.418E 03	4.286E 01
33	577.00	4516.00	0.0	5.595E 01	3.938E-03	1.123E 00	1.510E 03	4.500E 01
34	578.00	4516.00	0.0	5.605E 01	3.696E-03	1.111E 00	1.551E 03	4.538E 01
35	579.00	4516.00	0.0	5.988E 01	4.013E-03	1.176E 00	1.667E 03	4.952E 01

XII-31

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	6.297E 01	4.222E-03	1.183E 00	1.768E 03	5.266E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29700020

END OF PROGRAM.

Figure A-10 Met 11/Case H

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.292E 02	1.214E-02	6.967E-01	7.625E 02	8.595E 01
2	576.00	4521.00	0.0	1.375E 02	1.319E-02	7.261E-01	7.936E 02	9.024E 01
3	577.00	4521.00	0.0	1.562E 02	1.594E-02	1.455E 00	9.555E 02	1.107E 02
4	578.00	4521.00	0.0	1.615E 02	1.665E-02	1.393E 00	1.015E 03	1.114E 02
5	579.00	4521.00	0.0	1.805E 02	1.891E-02	8.904E-01	1.072E 03	1.152E 02
6	580.00	4521.00	0.0	2.035E 02	2.183E-02	9.692E-01	1.233E 03	1.273E 02
7	575.00	4520.00	0.0	1.241E 02	1.189E-02	6.754E-01	7.390E 02	8.305E 01
8	576.00	4520.00	0.0	1.327E 02	1.303E-02	6.941E-01	7.669E 02	8.713E 01
9	577.00	4520.00	0.0	1.459E 02	1.512E-02	1.359E 00	9.230E 02	1.021E 02
10	578.00	4520.00	0.0	1.555E 02	1.654E-02	1.420E 00	9.915E 02	1.083E 02
11	579.00	4520.00	0.0	1.730E 02	1.839E-02	8.366E-01	1.038E 03	1.102E 02
12	580.00	4520.00	0.0	1.947E 02	2.119E-02	8.952E-01	1.198E 03	1.211E 02
13	575.00	4519.00	0.0	1.192E 02	1.171E-02	6.646E-01	7.167E 02	8.051E 01
14	576.00	4519.00	0.0	1.273E 02	1.276E-02	6.559E-01	7.396E 02	8.348E 01
15	577.00	4519.00	0.0	1.505E 02	1.719E-02	2.486E 00	1.094E 03	1.186E 02
16	578.00	4519.00	0.0	1.583E 02	1.838E-02	2.524E 00	1.159E 03	1.233E 02
17	579.00	4519.00	0.0	1.657E 02	1.806E-02	8.116E-01	1.007E 03	1.057E 02
18	580.00	4519.00	0.0	1.877E 02	2.093E-02	8.672E-01	1.168E 03	1.167E 02
19	575.00	4518.00	0.0	1.124E 02	1.123E-02	6.267E-01	6.855E 02	7.632E 01
20	576.00	4518.00	0.0	1.215E 02	1.252E-02	6.458E-01	7.094E 02	8.030E 01
21	577.00	4518.00	0.0	1.296E 02	1.363E-02	6.691E-01	7.446E 02	8.487E 01
22	578.00	4518.00	0.0	1.354E 02	1.458E-02	6.420E-01	8.003E 02	8.698E 01
23	579.00	4518.00	0.0	1.621E 02	1.844E-02	8.645E-01	9.755E 02	1.058E 02
24	580.00	4518.00	0.0	1.761E 02	2.010E-02	8.282E-01	1.121E 03	1.105E 02
25	575.00	4517.00	0.0	1.093E 02	1.121E-02	6.182E-01	6.708E 02	7.464E 01
26	576.00	4517.00	0.0	1.127E 02	1.178E-02	5.819E-01	6.857E 02	7.504E 01
27	577.00	4517.00	0.0	1.217E 02	1.307E-02	5.617E-01	7.150E 02	7.858E 01
28	578.00	4517.00	0.0	1.312E 02	1.437E-02	6.139E-01	7.754E 02	8.419E 01
29	579.00	4517.00	0.0	1.542E 02	1.790E-02	7.680E-01	9.498E 02	9.899E 01
30	580.00	4517.00	0.0	1.748E 02	2.060E-02	8.336E-01	1.117E 03	1.102E 02
31	575.00	4516.00	0.0	1.049E 02	1.063E-02	6.052E-01	6.481E 02	7.183E 01
32	576.00	4516.00	0.0	1.056E 02	1.107E-02	5.396E-01	6.579E 02	7.047E 01
33	577.00	4516.00	0.0	1.174E 02	1.283E-02	5.367E-01	6.875E 02	7.571E 01
34	578.00	4516.00	0.0	1.259E 02	1.392E-02	5.643E-01	7.420E 02	8.026E 01
35	579.00	4516.00	0.0	1.430E 02	1.628E-02	6.720E-01	9.057E 02	9.123E 01

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
36	580.00	4516.00	0.0	1.638E 02	1.933E-02	8.045E-01	1.073E 03	1.042E 02
37	577.50	4519.50	0.0	1.553E 02	1.749E-02	2.427E 00	1.122E 03	1.202E 02
38	576.50	4518.50	0.0	1.317E 02	1.355E-02	6.863E-01	7.470E 02	8.617E 01
39	577.50	4518.50	0.0	1.554E 02	1.867E-02	3.211E 00	1.235E 03	1.303E 02
40	578.50	4518.50	0.0	1.545E 02	1.714E-02	8.342E-01	8.928E 02	1.019E 02
41	577.50	4517.50	0.0	1.278E 02	1.373E-02	6.032E-01	7.471E 02	8.246E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29560020

END OF PROGRAM.

Figure A-11 Met 1/Case B

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	2.086E 02	1.931E-02	1.130E 00	1.239E 03	1.392E 02
2	577.00	4521.00	0.0	2.494E 02	2.507E-02	2.313E 00	1.551E 03	1.760E 02
3	578.00	4521.00	0.0	2.618E 02	2.672E-02	2.287E 00	1.659E 03	1.810E 02
4	580.00	4521.00	0.0	3.249E 02	3.430E-02	1.545E 00	1.988E 03	2.034E 02
5	576.00	4520.00	0.0	2.139E 02	2.070E-02	1.118E 00	1.245E 03	1.407E 02
6	579.00	4520.00	0.0	2.777E 02	2.916E-02	1.350E 00	1.681E 03	1.773E 02
7	575.00	4519.00	0.0	1.914E 02	1.850E-02	1.067E 00	1.162E 03	1.297E 02
8	577.00	4519.00	0.0	2.335E 02	2.543E-02	2.923E 00	1.584E 03	1.728E 02
9	578.00	4519.00	0.0	2.469E 02	2.747E-02	2.932E 00	1.693E 03	1.810E 02
10	580.00	4519.00	0.0	2.987E 02	3.289E-02	1.394E 00	1.880E 03	1.866E 02
11	575.00	4518.00	0.0	1.829E 02	1.810E-02	1.025E 00	1.123E 03	1.245E 02
12	577.00	4518.00	0.0	2.103E 02	2.196E-02	1.076E 00	1.219E 03	1.375E 02
13	578.00	4518.00	0.0	2.204E 02	2.346E-02	1.039E 00	1.312E 03	1.415E 02
14	580.00	4518.00	0.0	2.850E 02	3.229E-02	1.348E 00	1.827E 03	1.792E 02
15	576.00	4517.00	0.0	1.804E 02	1.859E-02	9.381E-01	1.110E 03	1.204E 02
16	579.00	4517.00	0.0	2.429E 02	2.759E-02	1.194E 00	1.521E 03	1.558E 02
17	575.00	4516.00	0.0	1.673E 02	1.700E-02	9.778E-01	1.047E 03	1.150E 02
18	577.00	4516.00	0.0	1.884E 02	2.037E-02	8.644E-01	1.113E 03	1.217E 02
19	578.00	4516.00	0.0	2.024E 02	2.216E-02	9.104E-01	1.204E 03	1.291E 02
20	580.00	4516.00	0.0	2.537E 02	2.930E-02	1.234E 00	1.701E 03	1.613E 02
21	577.50	4519.50	0.0	2.450E 02	2.669E-02	3.197E 00	1.695E 03	1.822E 02
22	576.50	4518.50	0.0	2.109E 02	2.143E-02	1.077E 00	1.210E 03	1.374E 02
23	577.50	4518.50	0.0	2.378E 02	2.702E-02	3.613E 00	1.729E 03	1.837E 02
24	578.50	4518.50	0.0	2.457E 02	2.677E-02	1.282E 00	1.449E 03	1.608E 02
25	577.50	4517.50	0.0	2.089E 02	2.227E-02	9.796E-01	1.228E 03	1.346E 02

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29490020

END OF PROGRAM.

Figure A-12 Met 2/Case B

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.783E 02	1.607E-02	3.972E-01	4.226E 02	5.651E 01
2	577.00	4521.00	0.0	2.243E 02	2.207E-02	4.838E-01	5.270E 02	7.119E 01
3	578.00	4521.00	0.0	1.918E 02	1.604E-02	4.315E-01	4.505E 02	6.202E 01
4	580.00	4521.00	0.0	1.883E 02	1.666E-02	5.658E-01	4.595E 02	6.312E 01
5	576.00	4520.00	0.0	1.829E 02	2.250E-02	4.044E-01	4.360E 02	5.827E 01
6	579.00	4520.00	0.0	1.927E 02	1.591E-02	6.439E-01	4.887E 02	6.564E 01
7	575.00	4519.00	0.0	1.735E 02	1.565E-02	3.834E-01	4.177E 02	5.552E 01
8	577.00	4519.00	0.0	2.155E 02	2.285E-02	4.611E-01	5.095E 02	6.941E 01
9	578.00	4519.00	0.0	1.824E 02	1.576E-02	9.974E-01	5.258E 02	6.768E 01
10	580.00	4519.00	0.0	1.963E 02	1.562E-02	6.463E-01	4.930E 02	6.825E 01
11	575.00	4518.00	0.0	1.760E 02	1.626E-02	3.891E-01	4.263E 02	5.662E 01
12	577.00	4518.00	0.0	2.165E 02	2.649E-02	4.564E-01	5.157E 02	6.983E 01
13	578.00	4518.00	0.0	1.854E 02	1.656E-02	1.010E 00	5.358E 02	6.912E 01
14	580.00	4518.00	0.0	2.072E 02	1.709E-02	5.459E-01	4.953E 02	6.951E 01
15	576.00	4517.00	0.0	1.838E 02	1.689E-02	4.038E-01	4.447E 02	5.975E 01
16	579.00	4517.00	0.0	2.208E 02	2.010E-02	4.786E-01	5.188E 02	7.153E 01
17	575.00	4516.00	0.0	1.788E 02	1.801E-02	3.961E-01	4.356E 02	5.827E 01
18	577.00	4516.00	0.0	2.262E 02	2.302E-02	5.017E-01	5.466E 02	7.437E 01
19	578.00	4516.00	0.0	1.916E 02	1.854E-02	4.392E-01	4.712E 02	6.370E 01
20	580.00	4516.00	0.0	2.124E 02	1.785E-02	4.666E-01	5.170E 02	7.064E 01
21	577.50	4519.50	0.0	2.204E 02	2.213E-02	1.204E 00	6.388E 02	8.156E 01
22	576.50	4516.50	0.0	2.106E 02	3.853E-02	4.490E-01	5.017E 02	6.774E 01
23	577.50	4518.50	0.0	2.232E 02	2.339E-02	1.199E 00	6.423E 02	8.351E 01
24	576.50	4518.50	0.0	2.002E 02	1.768E-02	7.705E-01	5.292E 02	7.004E 01
25	577.50	4517.50	0.0	2.226E 02	2.467E-02	1.194E 00	6.487E 02	8.237E 01

END OF PROGRAM.

Figure A-13 Met 3/Case C

ARITHMETIC YEAR POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE 3	Y-COORD SCALE 6	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	4.456E 01	4.017E-03	3.972E-01	4.226E 02	5.651E 01
2	577.00	4521.00	0.0	5.607E 01	5.517E-03	4.838E-01	5.270E 02	7.119E 01
3	578.00	4521.00	0.0	2.806E 01	4.021E-03	4.315E-01	4.505E 02	6.202E 01
4	580.00	4521.00	0.0	4.795E 01	4.323E-03	3.653E-01	4.595E 02	6.312E 01
5	576.00	4520.00	0.0	4.573E 01	5.625E-03	4.044E-01	4.360E 02	5.827E 01
6	579.00	4520.00	0.0	4.955E 01	4.272E-03	6.437E-01	4.887E 02	6.562E 01
7	575.00	4519.00	0.0	4.337E 01	3.913E-03	3.634E-01	4.177E 02	5.552E 01
8	577.00	4519.00	0.0	5.390E 01	5.716E-03	4.611E-01	5.095E 02	6.941E 01
9	578.00	4519.00	0.0	4.929E 01	4.749E-03	5.973E-01	5.257E 02	6.752E 01
10	580.00	4519.00	0.0	5.027E 01	4.151E-03	6.462E-01	4.924E 02	6.688E 01
11	575.00	4518.00	0.0	4.401E 01	4.066E-03	3.891E-01	4.263E 02	5.662E 01
12	577.00	4518.00	0.0	5.414E 01	5.624E-03	4.564E-01	5.157E 02	6.983E 01
13	578.00	4518.00	0.0	5.021E 01	4.992E-03	1.019E 00	5.358E 02	6.912E 01
14	580.00	4518.00	0.0	5.248E 01	4.393E-03	5.459E-01	4.953E 02	6.951E 01
15	576.00	4517.00	0.0	4.596E 01	4.222E-03	4.038E-01	4.447E 02	5.975E 01
16	579.00	4517.00	0.0	5.540E 01	5.061E-03	4.786E-01	5.188E 02	7.153E 01
17	575.00	4516.00	0.0	4.470E 01	4.502E-03	3.961E-01	4.356E 02	5.827E 01
18	577.00	4516.00	0.0	5.656E 01	5.755E-03	5.017E-01	5.466E 02	7.437E 01
19	578.00	4516.00	0.0	4.795E 01	4.635E-03	4.392E-01	4.712E 02	6.370E 01
20	580.00	4516.00	0.0	5.310E 01	4.463E-03	4.666E-01	5.170E 02	7.064E 01
21	577.50	4519.50	0.0	5.992E 01	6.580E-03	1.204E 00	6.388E 02	8.156E 01
22	576.50	4518.50	0.0	5.273E 01	7.641E-03	4.490E-01	5.017E 02	6.774E 01
23	577.50	4518.50	0.0	6.095E 01	6.828E-03	1.199E 00	6.417E 02	8.198E 01
24	578.50	4518.50	0.0	5.223E 01	4.833E-03	7.704E-01	5.290E 02	6.974E 01
25	577.50	4517.50	0.0	6.015E 01	7.195E-03	1.194E 00	6.487E 02	8.237E 01

END OF PROGRAM.

Figure A-14 Met 3/Case E

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.356E 02	1.138E-02	9.293E-01	6.452E 02	8.625E 01
2	577.00	4521.00	0.0	1.733E 02	1.632E-02	1.132E 00	8.179E 02	1.101E 02
3	578.00	4521.00	0.0	1.994E 02	1.327E-02	1.071E 00	7.504E 02	1.029E 02
4	580.00	4521.00	0.0	1.605E 02	1.415E-02	1.661E 00	8.336E 02	1.115E 02
5	576.00	4520.00	0.0	1.395E 02	1.554E-02	9.482E-01	6.680E 02	8.923E 01
6	579.00	4520.00	0.0	1.676E 02	1.470E-02	2.127E 00	9.403E 02	1.212E 02
7	575.00	4519.00	0.0	1.336E 02	1.123E-02	9.101E-01	6.454E 02	8.580E 01
8	577.00	4519.00	0.0	1.678E 02	1.698E-02	1.095E 00	7.975E 02	1.083E 02
9	578.00	4519.00	0.0	1.615E 02	1.523E-02	2.715E 00	1.003E 03	1.250E 02
10	580.00	4519.00	0.0	1.713E 02	1.454E-02	2.110E 00	9.398E 02	1.247E 02
11	575.00	4518.00	0.0	1.357E 02	1.166E-02	9.242E-01	6.597E 02	8.761E 01
12	577.00	4518.00	0.0	1.686E 02	1.957E-02	1.082E 00	8.077E 02	1.089E 02
13	578.00	4518.00	0.0	1.641E 02	1.595E-02	2.745E 00	1.020E 03	1.275E 02
14	580.00	4518.00	0.0	1.751E 02	1.477E-02	1.477E 00	8.556E 02	1.189E 02
15	576.00	4517.00	0.0	1.417E 02	1.220E-02	9.584E-01	6.899E 02	9.244E 01
16	579.00	4517.00	0.0	1.844E 02	1.687E-02	1.195E 00	8.653E 02	1.194E 02
17	575.00	4516.00	0.0	1.377E 02	1.286E-02	9.419E-01	6.751E 02	9.016E 01
18	577.00	4516.00	0.0	1.762E 02	1.722E-02	1.170E 00	8.568E 02	1.158E 02
19	578.00	4516.00	0.0	1.592E 02	1.536E-02	1.056E 00	7.841E 02	1.056E 02
20	580.00	4516.00	0.0	1.767E 02	1.484E-02	1.166E 00	8.614E 02	1.175E 02
21	577.50	4519.50	0.0	1.853E 02	1.951E-02	3.234E 00	1.174E 03	1.447E 02
22	576.50	4518.50	0.0	1.641E 02	2.794E-02	1.068E 00	7.848E 02	1.057E 02
23	577.50	4518.50	0.0	1.866E 02	2.033E-02	3.222E 00	1.177E 03	1.459E 02
24	578.50	4518.50	0.0	1.749E 02	1.641E-02	2.303E 00	9.974E 02	1.281E 02
25	577.50	4517.50	0.0	1.865E 02	2.132E-02	3.205E 00	1.187E 03	1.457E 02

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNING SEQUENCE NUMBER 29510020

END OF PROGRAM.

Figure A-15 Met 4/Case A

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.141E 02	1.379E-02	5.577E-01	6.676E 02	6.570E 01
2	577.00	4521.00	0.0	1.100E 02	1.374E-02	5.347E-01	6.499E 02	6.317E 01
3	578.00	4521.00	0.0	1.068E 02	1.375E-02	5.183E-01	6.371E 02	6.097E 01
4	580.00	4521.00	0.0	1.025E 02	1.276E-02	4.762E-01	6.201E 02	5.804E 01
5	576.00	4520.00	0.0	1.196E 02	1.433E-02	5.663E-01	6.747E 02	6.924E 01
6	579.00	4520.00	0.0	1.148E 02	1.468E-02	5.260E-01	6.549E 02	6.569E 01
7	575.00	4519.00	0.0	1.300E 02	1.560E-02	9.559E-01	7.666E 02	7.968E 01
8	577.00	4519.00	0.0	1.316E 02	1.702E-02	1.662E 00	8.762E 02	8.951E 01
9	578.00	4519.00	0.0	1.187E 02	1.472E-02	5.311E-01	6.640E 02	6.795E 01
10	580.00	4519.00	0.0	1.141E 02	1.454E-02	5.227E-01	6.472E 02	6.518E 01
11	575.00	4518.00	0.0	1.355E 02	1.622E-02	9.842E-01	7.870E 02	8.349E 01
12	577.00	4518.00	0.0	1.374E 02	1.774E-02	1.705E 00	8.958E 02	9.333E 01
13	578.00	4518.00	0.0	1.282E 02	1.608E-02	5.920E-01	6.876E 02	7.507E 01
14	580.00	4518.00	0.0	1.202E 02	1.542E-02	5.196E-01	6.626E 02	6.846E 01
15	576.00	4517.00	0.0	1.326E 02	1.583E-02	6.111E-01	7.360E 02	7.760E 01
16	579.00	4517.00	0.0	1.276E 02	1.606E-02	5.543E-01	7.176E 02	7.351E 01
17	575.00	4516.00	0.0	1.407E 02	1.636E-02	6.391E-01	7.708E 02	8.184E 01
18	577.00	4516.00	0.0	1.341E 02	1.611E-02	6.621E-01	7.575E 02	7.976E 01
19	578.00	4516.00	0.0	1.305E 02	1.593E-02	6.410E-01	7.452E 02	7.739E 01
20	580.00	4516.00	0.0	1.244E 02	1.529E-02	5.674E-01	7.271E 02	7.259E 01
21	577.50	4519.50	0.0	1.191E 02	1.463E-02	5.510E-01	6.670E 02	6.886E 01
22	576.50	4518.50	0.0	1.353E 02	1.729E-02	1.649E 00	8.824E 02	9.111E 01
23	577.50	4518.50	0.0	1.369E 02	1.822E-02	2.159E 00	9.623E 02	9.830E 01
24	578.50	4518.50	0.0	1.221E 02	1.546E-02	5.861E-01	6.727E 02	7.076E 01
25	577.50	4517.50	0.0	1.275E 02	1.563E-02	5.772E-01	7.038E 02	7.384E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29520020

END OF PROGRAM.

Figure A-16 Met 5/Case A

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	2.280E 02	2.757E-02	3.714E-01	6.675E 02	6.565E 01
2	577.00	4521.00	0.0	2.195E 02	2.743E-02	3.546E-01	6.494E 02	6.295E 01
3	578.00	4521.00	0.0	2.137E 02	2.749E-02	3.455E-01	6.371E 02	6.096E 01
4	580.00	4521.00	0.0	2.049E 02	2.552E-02	3.175E-01	6.201E 02	5.804E 01
5	576.00	4520.00	0.0	2.387E 02	2.861E-02	3.759E-01	6.743E 02	6.905E 01
6	579.00	4520.00	0.0	2.295E 02	2.936E-02	3.504E-01	6.548E 02	6.566E 01
7	575.00	4519.00	0.0	2.546E 02	3.007E-02	5.157E-01	7.227E 02	7.545E 01
8	577.00	4519.00	0.0	2.477E 02	3.057E-02	7.614E-01	7.474E 02	7.677E 01
9	578.00	4519.00	0.0	2.372E 02	2.943E-02	3.537E-01	6.639E 02	6.792E 01
10	580.00	4519.00	0.0	2.262E 02	2.908E-02	3.485E-01	6.472E 02	6.518E 01
11	575.00	4518.00	0.0	2.643E 02	3.113E-02	5.300E-01	7.427E 02	7.905E 01
12	577.00	4518.00	0.0	2.591E 02	3.197E-02	7.744E-01	7.668E 02	8.130E 01
13	578.00	4518.00	0.0	2.567E 02	3.218E-02	3.881E-01	6.874E 02	7.802E 01
14	580.00	4518.00	0.0	2.405E 02	3.084E-02	3.464E-01	6.626E 02	6.846E 01
15	576.00	4517.00	0.0	2.644E 02	3.137E-02	4.041E-01	7.352E 02	7.722E 01
16	579.00	4517.00	0.0	2.553E 02	3.211E-02	3.695E-01	7.176E 02	7.351E 01
17	575.00	4516.00	0.0	2.809E 02	3.257E-02	4.244E-01	7.704E 02	8.164E 01
18	577.00	4516.00	0.0	2.673E 02	3.204E-02	4.389E-01	7.569E 02	7.946E 01
19	578.00	4516.00	0.0	2.607E 02	3.174E-02	4.263E-01	7.450E 02	7.728E 01
20	580.00	4516.00	0.0	2.487E 02	3.058E-02	3.783E-01	7.271E 02	7.259E 01
21	577.50	4519.50	0.0	2.364E 02	2.904E-02	3.606E-01	6.652E 02	6.805E 01
22	576.50	4518.50	0.0	2.557E 02	3.127E-02	7.536E-01	7.588E 02	7.926E 01
23	577.50	4518.50	0.0	2.517E 02	3.149E-02	9.278E-01	7.791E 02	8.023E 01
24	578.50	4518.50	0.0	2.439E 02	3.087E-02	3.895E-01	6.724E 02	7.062E 01
25	577.50	4517.50	0.0	2.545E 02	3.117E-02	3.830E-01	7.034E 02	7.362E 01

END OF PROGRAM.

Figure A-17 Met 5/Case C

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	579.00	4521.00	0.0	5.701E 01	6.894E-03	3.714E-01	6.675E 02	6.565E 01
2	577.00	4521.00	0.0	5.495E 01	6.867E-03	3.546E-01	6.494E 02	6.295E 01
3	578.00	4521.00	0.0	5.342E 01	6.873E-03	3.455E-01	6.371E 02	6.096E 01
4	580.00	4521.00	0.0	5.124E 01	6.381E-03	3.175E-01	6.201E 02	5.804E 01
5	576.00	4520.00	0.0	5.974E 01	7.160E-03	3.759E-01	6.743E 02	6.905E 01
6	579.00	4520.00	0.0	5.738E 01	7.341E-03	3.504E-01	6.548E 02	6.566E 01
7	575.00	4519.00	0.0	6.445E 01	7.690E-03	3.157E-01	7.226E 02	7.522E 01
8	577.00	4519.00	0.0	6.440E 01	8.191E-03	3.614E-01	7.474E 02	7.677E 01
9	578.00	4519.00	0.0	5.932E 01	7.359E-03	3.537E-01	6.639E 02	6.792E 01
10	580.00	4519.00	0.0	5.704E 01	7.269E-03	3.485E-01	6.472E 02	6.518E 01
11	579.00	4518.00	0.0	6.693E 01	7.959E-03	3.300E-01	7.423E 02	7.826E 01
12	577.00	4518.00	0.0	6.692E 01	8.494E-03	3.744E-01	7.662E 02	7.985E 01
13	576.00	4518.00	0.0	6.276E 01	7.835E-03	3.880E-01	6.851E 02	7.242E 01
14	580.00	4518.00	0.0	6.012E 01	7.710E-03	3.464E-01	6.626E 02	6.846E 01
15	576.00	4517.00	0.0	6.625E 01	7.872E-03	4.041E-01	7.352E 02	7.719E 01
16	579.00	4517.00	0.0	6.381E 01	8.029E-03	3.695E-01	7.176E 02	7.351E 01
17	575.00	4516.00	0.0	7.030E 01	8.159E-03	4.244E-01	7.704E 02	8.164E 01
18	577.00	4516.00	0.0	6.695E 01	8.031E-03	4.389E-01	7.569E 02	7.946E 01
19	578.00	4516.00	0.0	6.521E 01	7.947E-03	4.263E-01	7.450E 02	7.726E 01
20	580.00	4516.00	0.0	6.218E 01	7.646E-03	3.783E-01	7.271E 02	7.259E 01
21	577.50	4519.50	0.0	5.939E 01	7.295E-03	3.606E-01	6.652E 02	6.805E 01
22	576.50	4519.50	0.0	6.612E 01	8.315E-03	3.535E-01	7.585E 02	7.857E 01
23	577.50	4518.50	0.0	6.642E 01	8.654E-03	9.278E-01	7.791E 02	8.023E 01
24	578.50	4518.50	0.0	6.104E 01	7.724E-03	3.895E-01	6.724E 02	7.062E 01
25	577.50	4517.50	0.0	6.369E 01	7.804E-03	3.830E-01	7.034E 02	7.362E 01

END OF PROGRAM.

Figure A-18 Met 5/Case E

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.294E 02	1.571E-02	9.343E-01	8.477E 02	8.169E 01
2	577.00	4521.00	0.0	1.315E 02	1.597E-02	5.473E-01	7.778E 02	7.734E 01
3	578.00	4521.00	0.0	1.337E 02	1.645E-02	5.250E-01	7.662E 02	7.776E 01
4	580.00	4521.00	0.0	1.418E 02	1.823E-02	5.468E-01	7.730E 02	8.209E 01
5	576.00	4520.00	0.0	1.252E 02	1.559E-02	1.074E 00	8.518E 02	8.121E 01
6	579.00	4520.00	0.0	1.341E 02	1.713E-02	5.167E-01	7.666E 02	7.761E 01
7	575.00	4519.00	0.0	1.102E 02	1.334E-02	4.950E-01	7.211E 02	6.632E 01
8	577.00	4519.00	0.0	1.352E 02	1.827E-02	2.448E 00	1.087E 03	1.037E 02
9	578.00	4519.00	0.0	1.195E 02	1.471E-02	5.085E-01	7.440E 02	7.071E 01
10	580.00	4519.00	0.0	1.265E 02	1.699E-02	4.911E-01	7.190E 02	7.291E 01
11	575.00	4518.00	0.0	1.029E 02	1.257E-02	4.359E-01	6.894E 02	6.113E 01
12	577.00	4518.00	0.0	1.137E 02	1.424E-02	5.252E-01	7.308E 02	6.877E 01
13	578.00	4518.00	0.0	1.147E 02	1.450E-02	5.022E-01	7.276E 02	6.825E 01
14	580.00	4516.00	0.0	1.129E 02	1.438E-02	4.477E-01	7.068E 02	6.554E 01
15	576.00	4517.00	0.0	9.816E 01	1.225E-02	4.144E-01	6.760E 02	5.867E 01
16	579.00	4517.00	0.0	1.123E 02	1.455E-02	4.710E-01	7.197E 02	6.640E 01
17	575.00	4516.00	0.0	9.170E 01	1.165E-02	3.693E-01	6.433E 02	5.450E 01
18	577.00	4516.00	0.0	9.252E 01	1.206E-02	3.863E-01	6.453E 02	5.516E 01
19	578.00	4516.00	0.0	9.655E 01	1.248E-02	4.093E-01	6.579E 02	5.759E 01
20	580.00	4516.00	0.0	1.022E 02	1.339E-02	4.185E-01	6.738E 02	6.024E 01
21	577.50	4519.50	0.0	1.229E 02	1.518E-02	6.769E-01	7.788E 02	7.463E 01
22	576.50	4518.50	0.0	1.158E 02	1.444E-02	6.795E-01	7.592E 02	7.176E 01
23	577.50	4518.50	0.0	1.287E 02	1.721E-02	1.819E 00	9.715E 02	9.240E 01
24	578.50	4516.50	0.0	1.228E 02	1.579E-02	5.264E-01	7.592E 02	7.270E 01
25	577.50	4517.50	0.0	1.126E 02	1.456E-02	5.233E-01	7.203E 02	6.819E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29500020

END OF PROGRAM.

Figure A-19 Met 6/Case B

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	2.531E 02	3.020E-02	3.326E-01	8.030E 02	7.798E 01
2	577.00	4521.00	0.0	2.627E 02	3.188E-02	3.639E-01	7.775E 02	7.732E 01
3	578.00	4521.00	0.0	2.674E 02	3.289E-02	3.497E-01	7.661E 02	7.772E 01
4	580.00	4521.00	0.0	2.836E 02	3.646E-02	3.645E-01	7.730E 02	8.209E 01
5	576.00	4520.00	0.0	2.425E 02	2.945E-02	3.887E-01	7.961E 02	7.600E 01
6	579.00	4520.00	0.0	2.680E 02	3.425E-02	3.443E-01	7.666E 02	7.759E 01
7	575.00	4519.00	0.0	2.196E 02	2.655E-02	3.281E-01	7.205E 02	6.605E 01
8	577.00	4519.00	0.0	2.453E 02	3.061E-02	1.117E 00	8.972E 02	8.527E 01
9	578.00	4519.00	0.0	2.582E 02	2.926E-02	3.361E-01	7.434E 02	7.087E 01
10	580.00	4519.00	0.0	2.530E 02	3.398E-02	3.274E-01	7.190E 02	7.291E 01
11	575.00	4518.00	0.0	2.056E 02	2.513E-02	2.905E-01	6.893E 02	6.111E 01
12	577.00	4518.00	0.0	2.253E 02	2.809E-02	3.446E-01	7.291E 02	6.799E 01
13	578.00	4518.00	0.0	2.291E 02	2.890E-02	3.343E-01	7.274E 02	6.817E 01
14	580.00	4518.00	0.0	2.259E 02	2.875E-02	2.985E-01	7.068E 02	6.554E 01
15	576.00	4517.00	0.0	1.963E 02	2.450E-02	2.762E-01	6.760E 02	5.867E 01
16	579.00	4517.00	0.0	2.243E 02	2.903E-02	3.136E-01	7.196E 02	6.634E 01
17	575.00	4516.00	0.0	1.834E 02	2.330E-02	2.462E-01	6.433E 02	5.450E 01
18	577.00	4516.00	0.0	1.850E 02	2.411E-02	2.575E-01	6.453E 02	5.516E 01
19	578.00	4516.00	0.0	1.931E 02	2.496E-02	2.729E-01	6.579E 02	5.759E 01
20	580.00	4516.00	0.0	2.045E 02	2.678E-02	2.790E-01	6.738E 02	6.024E 01
21	577.50	4519.50	0.0	2.433E 02	2.960E-02	4.131E-01	7.630E 02	7.334E 01
22	576.50	4518.50	0.0	2.277E 02	2.806E-02	4.123E-01	7.424E 02	6.958E 01
23	577.50	4518.50	0.0	2.403E 02	3.037E-02	9.135E-01	8.438E 02	7.984E 01
24	578.50	4518.50	0.0	2.439E 02	3.128E-02	3.463E-01	7.577E 02	7.204E 01
25	577.50	4517.50	0.0	2.241E 02	2.879E-02	3.462E-01	7.195E 02	6.781E 01

END OF PROGRAM.

Figure A-20 Met 6/Case C

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	6.433E 01	7.772E-03	5.325E-01	8.088E 02	7.749E 01
2	577.00	4521.00	0.0	6.570E 01	7.973E-03	3.639E-01	7.775E 02	7.715E 01
3	578.00	4521.00	0.0	6.686E 01	8.226E-03	3.497E-01	7.661E 02	7.772E 01
4	580.00	4521.00	0.0	7.090E 01	9.114E-03	3.645E-01	7.730E 02	8.209E 01
5	576.00	4520.00	0.0	6.210E 01	7.682E-03	5.867E-01	7.958E 02	7.539E 01
6	579.00	4520.00	0.0	6.702E 01	8.563E-03	3.443E-01	7.666E 02	7.759E 01
7	575.00	4519.00	0.0	5.505E 01	6.656E-03	3.281E-01	7.205E 02	6.605E 01
8	577.00	4519.00	0.0	6.641E 01	8.351E-03	1.187E 00	8.970E 02	8.473E 01
9	578.00	4519.00	0.0	5.951E 01	7.309E-03	3.360E-01	7.430E 02	6.999E 01
10	580.00	4519.00	0.0	6.325E 01	8.495E-03	3.274E-01	7.190E 02	7.291E 01
11	575.00	4518.00	0.0	5.142E 01	6.285E-03	2.905E-01	6.893E 02	6.111E 01
12	577.00	4518.00	0.0	5.674E 01	7.082E-03	3.446E-01	7.291E 02	6.799E 01
13	578.00	4518.00	0.0	5.732E 01	7.235E-03	3.343E-01	7.274E 02	6.817E 01
14	580.00	4518.00	0.0	5.646E 01	7.188E-03	2.985E-01	7.068E 02	6.554E 01
15	576.00	4517.00	0.0	4.908E 01	6.124E-03	2.762E-01	6.760E 02	5.867E 01
16	579.00	4517.00	0.0	5.611E 01	7.266E-03	3.136E-01	7.196E 02	6.634E 01
17	575.00	4516.00	0.0	4.585E 01	5.825E-03	2.462E-01	6.433E 02	5.450E 01
18	577.00	4516.00	0.0	4.626E 01	6.028E-03	2.575E-01	6.453E 02	5.516E 01
19	576.00	4516.00	0.0	4.827E 01	6.241E-03	2.729E-01	6.579E 02	5.759E 01
20	580.00	4516.00	0.0	5.111E 01	6.694E-03	2.790E-01	6.738E 02	6.024E 01
21	577.50	4519.50	0.0	6.115E 01	7.532E-03	4.131E-01	7.627E 02	7.257E 01
22	576.50	4518.50	0.0	5.770E 01	7.164E-03	4.123E-01	7.424E 02	6.956E 01
23	577.50	4518.50	0.0	6.358E 01	8.397E-03	9.135E-01	8.438E 02	7.971E 01
24	578.50	4518.50	0.0	6.133E 01	7.868E-03	3.463E-01	7.577E 02	7.204E 01
25	577.50	4517.50	0.0	5.623E 01	7.237E-03	3.462E-01	7.195E 02	6.781E 01

END OF PROGRAM.

Figure A-21 Met 6/Case E

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.580E 02	1.599E-02	8.340E-01	8.940E 02	1.035E 02
2	577.00	4521.00	0.0	2.041E 02	2.285E-02	2.773E 00	1.285E 03	1.565E 02
3	578.00	4521.00	0.0	2.023E 02	2.274E-02	2.563E 00	1.327E 03	1.490E 02
4	580.00	4521.00	0.0	2.631E 02	3.024E-02	1.264E 00	1.516E 03	1.634E 02
5	576.00	4520.00	0.0	1.639E 02	1.724E-02	8.691E-01	9.032E 02	1.068E 02
6	579.00	4520.00	0.0	2.198E 02	2.492E-02	1.089E 00	1.254E 03	1.397E 02
7	575.00	4519.00	0.0	1.492E 02	1.577E-02	8.195E-01	8.500E 02	9.940E 01
8	577.00	4519.00	0.0	2.076E 02	2.698E-02	2.712E 00	1.763E 03	1.913E 02
9	576.00	4518.00	0.0	2.171E 02	2.872E-02	2.780E 00	1.834E 03	1.976E 02
10	580.00	4518.00	0.0	2.494E 02	2.963E-02	1.141E 00	1.464E 03	1.539E 02
11	575.00	4518.00	0.0	1.426E 02	1.531E-02	7.677E-01	8.175E 02	9.502E 01
12	577.00	4518.00	0.0	1.644E 02	1.841E-02	9.031E-01	8.870E 02	1.081E 02
13	578.00	4518.00	0.0	1.696E 02	1.961E-02	8.323E-01	9.429E 02	1.090E 02
14	580.00	4518.00	0.0	2.429E 02	2.975E-02	1.133E 00	1.435E 03	1.512E 02
15	576.00	4517.00	0.0	1.414E 02	1.628E-02	7.263E-01	8.220E 02	9.500E 01
16	579.00	4517.00	0.0	2.122E 02	2.681E-02	1.092E 00	1.202E 03	1.364E 02
17	575.00	4516.00	0.0	1.383E 02	1.556E-02	7.820E-01	7.877E 02	9.333E 01
18	577.00	4516.00	0.0	1.527E 02	1.790E-02	6.714E-01	8.243E 02	9.717E 01
19	578.00	4516.00	0.0	1.642E 02	1.929E-02	7.091E-01	8.842E 02	1.030E 02
20	580.00	4517.00	0.0	2.349E 02	3.068E-02	1.203E 00	1.425E 03	1.521E 02
21	577.50	4519.50	0.0	2.169E 02	2.829E-02	6.284E 00	1.902E 03	2.028E 02
22	576.50	4518.50	0.0	1.688E 02	1.845E-02	9.417E-01	8.945E 02	1.113E 02
23	577.50	4518.50	0.0	2.193E 02	3.012E-02	7.350E 00	2.066E 03	2.185E 02
24	578.50	4518.50	0.0	1.986E 02	2.377E-02	1.242E 00	1.072E 03	1.338E 02
25	577.50	4517.50	0.0	1.620E 02	1.859E-02	7.830E-01	8.873E 02	1.045E 02

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29530020

END OF PROGRAM.

Figure A-22 Met 7/Case A

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.323E 02	1.302E-02	8.514E-01	6.573E 02	8.627E 01
2	577.00	4521.00	0.0	1.478E 02	1.639E-02	1.058E 00	7.209E 02	9.962E 01
3	578.00	4521.00	0.0	1.556E 02	1.591E-02	1.059E 00	7.617E 02	1.052E 02
4	580.00	4521.00	0.0	2.075E 02	2.465E-02	2.824E 00	1.232E 03	1.558E 02
5	576.00	4520.00	0.0	1.367E 02	1.375E-02	8.764E-01	6.847E 02	9.016E 01
6	579.00	4520.00	0.0	1.861E 02	2.146E-02	4.134E 00	1.326E 03	1.604E 02
7	575.00	4519.00	0.0	1.284E 02	1.251E-02	8.241E-01	6.455E 02	8.500E 01
8	577.00	4519.00	0.0	1.445E 02	1.435E-02	9.208E-01	7.165E 02	9.725E 01
9	578.00	4519.00	0.0	2.357E 02	3.633E-02	1.158E 01	2.588E 03	2.813E 02
10	580.00	4519.00	0.0	1.951E 02	2.184E-02	1.252E 00	9.498E 02	1.315E 02
11	575.00	4518.00	0.0	1.273E 02	1.266E-02	8.203E-01	6.439E 02	8.498E 01
12	577.00	4518.00	0.0	1.421E 02	1.439E-02	8.935E-01	7.115E 02	9.591E 01
13	578.00	4518.00	0.0	1.539E 02	1.561E-02	9.394E-01	7.490E 02	1.025E 02
14	580.00	4518.00	0.0	1.807E 02	1.966E-02	1.102E 00	8.969E 02	1.210E 02
15	576.00	4517.00	0.0	1.370E 02	1.365E-02	8.594E-01	6.870E 02	9.318E 01
16	579.00	4517.00	0.0	1.581E 02	1.540E-02	1.034E 00	7.845E 02	1.088E 02
17	575.00	4516.00	0.0	1.283E 02	1.376E-02	8.178E-01	6.509E 02	8.748E 01
18	577.00	4516.00	0.0	1.452E 02	1.489E-02	9.308E-01	7.246E 02	9.954E 01
19	578.00	4516.00	0.0	1.529E 02	1.544E-02	1.054E 00	7.568E 02	1.063E 02
20	580.00	4516.00	0.0	2.055E 02	2.526E-02	1.087E 00	1.008E 03	1.353E 02
21	577.50	4519.50	0.0	1.608E 02	2.012E-02	1.975E 00	9.240E 02	1.209E 02
22	576.50	4518.50	0.0	1.401E 02	1.408E-02	8.867E-01	6.986E 02	9.418E 01
23	577.50	4518.50	0.0	2.061E 02	2.782E-02	7.743E 00	1.919E 03	2.186E 02
24	578.50	4518.50	0.0	1.728E 02	2.163E-02	2.175E 00	9.441E 02	1.304E 02
25	577.50	4517.50	0.0	1.510E 02	1.474E-02	9.039E-01	7.330E 02	1.006E 02

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29540020

END OF PROGRAM.

Figure A-23 Met 8/Case A

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	2.645E 02	2.603E-02	1.703E 00	6.573E 02	8.627E 01
2	577.00	4521.00	0.0	2.952E 02	3.273E-02	2.108E 00	7.205E 02	9.944E 01
3	578.00	4521.00	0.0	3.101E 02	3.166E-02	2.086E 00	7.574E 02	1.045E 02
4	580.00	4521.00	0.0	3.920E 02	4.506E-02	3.034E 00	1.068E 03	1.394E 02
5	576.00	4520.00	0.0	2.735E 02	2.749E-02	1.753E 00	6.847E 02	9.016E 01
6	579.00	4520.00	0.0	3.504E 02	3.454E-02	3.338E 00	1.016E 03	1.297E 02
7	575.00	4519.00	0.0	2.567E 02	2.502E-02	1.648E 00	6.455E 02	8.500E 01
8	577.00	4519.00	0.0	2.883E 02	2.903E-02	1.826E 00	7.158E 02	9.694E 01
9	578.00	4519.00	0.0	3.335E 02	4.259E-02	6.466E 00	1.537E 03	1.784E 02
10	580.00	4519.00	0.0	3.826E 02	4.229E-02	2.361E 00	9.437E 02	1.298E 02
11	575.00	4518.00	0.0	2.547E 02	2.533E-02	1.641E 00	6.439E 02	8.498E 01
12	577.00	4518.00	0.0	2.842E 02	2.878E-02	1.787E 00	7.115E 02	9.591E 01
13	578.00	4518.00	0.0	3.067E 02	3.109E-02	1.857E 00	7.479E 02	1.020E 02
14	580.00	4518.00	0.0	3.583E 02	3.848E-02	2.157E 00	8.947E 02	1.199E 02
15	576.00	4517.00	0.0	2.740E 02	2.729E-02	1.713E 00	6.870E 02	9.318E 01
16	579.00	4517.00	0.0	3.160E 02	3.076E-02	2.062E 00	7.843E 02	1.087E 02
17	575.00	4516.00	0.0	2.567E 02	2.752E-02	1.635E 00	6.509E 02	8.748E 01
18	577.00	4516.00	0.0	2.904E 02	2.976E-02	1.862E 00	7.246E 02	9.954E 01
19	578.00	4516.00	0.0	3.057E 02	3.087E-02	2.109E 00	7.568E 02	1.063E 02
20	580.00	4516.00	0.0	4.111E 02	5.052E-02	2.173E 00	1.008E 03	1.353E 02
21	577.50	4519.50	0.0	3.003E 02	3.652E-02	2.292E 00	8.140E 02	1.081E 02
22	576.50	4518.50	0.0	2.788E 02	2.802E-02	1.746E 00	6.974E 02	9.364E 01
23	577.50	4518.50	0.0	3.199E 02	3.538E-02	4.820E 00	1.249E 03	1.513E 02
24	578.50	4518.50	0.0	3.316E 02	4.014E-02	2.829E 00	8.486E 02	1.206E 02
25	577.50	4517.50	0.0	3.020E 02	2.947E-02	1.808E 00	7.330E 02	1.006E 02

END OF PROGRAM.

Figure A-24 Met 8/Case D

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	6.615E 01	6.509E-03	8.514E-01	6.573E 02	8.627E 01
2	577.00	4521.00	0.0	7.389E 01	8.193E-03	1.055E 00	7.205E 02	9.944E 01
3	578.00	4521.00	0.0	7.785E 01	7.950E-03	1.047E 00	7.574E 02	1.045E 02
4	580.00	4521.00	0.0	1.027E 02	1.213E-02	1.382E 00	1.067E 03	1.389E 02
5	576.00	4520.00	0.0	6.837E 01	5.873E-03	8.764E-01	6.847E 02	9.016E 01
6	579.00	4520.00	0.0	9.125E 01	1.037E-02	2.357E 00	1.015E 03	1.293E 02
7	575.00	4519.00	0.0	6.418E 01	5.256E-03	8.241E-01	6.455E 02	8.500E 01
8	577.00	4519.00	0.0	7.423E 01	7.275E-03	9.153E-01	7.158E 02	9.694E 01
9	578.00	4519.00	0.0	1.120E 02	1.691E-02	5.566E 00	1.537E 03	1.776E 02
10	580.00	4519.00	0.0	9.665E 01	1.073E-02	1.200E 00	9.428E 02	1.277E 02
11	575.00	4518.00	0.0	6.367E 01	5.332E-03	8.203E-01	6.439E 02	8.498E 01
12	577.00	4518.00	0.0	7.105E 01	7.196E-03	9.935E-01	7.115E 02	9.591E 01
13	578.00	4518.00	0.0	7.692E 01	7.800E-03	9.314E-01	7.479E 02	1.020E 02
14	580.00	4518.00	0.0	9.014E 01	9.735E-03	1.085E 00	8.947E 02	1.199E 02
15	576.00	4517.00	0.0	6.849E 01	6.824E-03	8.564E-01	6.870E 02	9.318E 01
16	579.00	4517.00	0.0	7.908E 01	7.698E-03	1.032E 00	7.843E 02	1.087E 02
17	575.00	4516.00	0.0	6.416E 01	6.879E-03	3.176E-01	6.509E 02	8.748E 01
18	577.00	4516.00	0.0	7.260E 01	7.440E-03	9.306E-01	7.246E 02	9.954E 01
19	578.00	4516.00	0.0	7.643E 01	7.719E-03	1.054E 00	7.568E 02	1.063E 02
20	580.00	4516.00	0.0	1.028E 02	1.263E-02	1.087E 00	1.008E 03	1.353E 02
21	577.50	4519.50	0.0	7.953E 01	9.908E-03	1.378E 00	8.140E 02	1.081E 02
22	576.50	4519.50	0.0	6.998E 01	7.036E-03	8.774E-01	6.974E 02	9.364E 01
23	577.50	4518.50	0.0	9.926E 01	1.306E-02	3.897E 00	1.249E 03	1.511E 02
24	578.50	4518.50	0.0	8.580E 01	1.066E-02	1.626E 00	8.486E 02	1.206E 02
25	577.50	4517.50	0.0	7.551E 01	7.368E-03	9.039E-01	7.330E 02	1.006E 02

END OF PROGRAM.

Figure A-25 Met 8/Case F

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.323E 02	1.302E-02	5.676E-01	6.573E 02	8.627E 01
2	577.00	4521.00	0.0	1.476E 02	1.637E-02	7.033E-01	7.204E 02	9.940E 01
3	578.00	4521.00	0.0	1.551E 02	1.584E-02	6.983E-01	7.563E 02	1.044E 02
4	580.00	4521.00	0.0	1.970E 02	2.272E-02	1.261E 00	1.026E 03	1.349E 02
5	576.00	4520.00	0.0	1.367E 02	1.375E-02	5.842E-01	6.847E 02	9.016E 01
6	579.00	4520.00	0.0	1.672E 02	1.767E-02	1.583E 00	9.376E 02	1.216E 02
7	575.00	4519.00	0.0	1.284E 02	1.251E-02	5.494E-01	6.455E 02	8.500E 01
8	577.00	4519.00	0.0	1.442E 02	1.452E-02	6.103E-01	7.156E 02	9.686E 01
9	578.00	4519.00	0.0	1.733E 02	2.275E-02	3.747E 00	1.273E 03	1.518E 02
10	580.00	4519.00	0.0	1.912E 02	2.110E-02	8.003E-01	9.414E 02	1.276E 02
11	575.00	4518.00	0.0	1.273E 02	1.266E-02	5.469E-01	6.439E 02	8.498E 01
12	577.00	4518.00	0.0	1.421E 02	1.439E-02	5.957E-01	7.115E 02	9.591E 01
13	578.00	4518.00	0.0	1.534E 02	1.555E-02	6.210E-01	7.477E 02	1.019E 02
14	580.00	4518.00	0.0	1.792E 02	1.923E-02	7.230E-01	8.942E 02	1.197E 02
15	576.00	4517.00	0.0	1.370E 02	1.365E-02	5.709E-01	6.870E 02	9.318E 01
16	579.00	4517.00	0.0	1.580E 02	1.538E-02	6.879E-01	7.842E 02	1.086E 02
17	575.00	4516.00	0.0	1.283E 02	1.376E-02	5.451E-01	6.509E 02	8.748E 01
18	577.00	4516.00	0.0	1.452E 02	1.488E-02	6.205E-01	7.246E 02	9.954E 01
19	578.00	4516.00	0.0	1.529E 02	1.544E-02	7.028E-01	7.568E 02	1.063E 02
20	580.00	4516.00	0.0	2.055E 02	2.526E-02	7.243E-01	1.008E 03	1.353E 02
21	577.50	4519.50	0.0	1.512E 02	1.844E-02	9.228E-01	7.864E 02	1.048E 02
22	576.50	4516.50	0.0	1.395E 02	1.402E-02	5.850E-01	6.971E 02	9.350E 01
23	577.50	4518.50	0.0	1.644E 02	1.868E-02	2.624E 00	1.081E 03	1.342E 02
24	578.50	4518.50	0.0	1.664E 02	2.020E-02	1.088E 00	8.246E 02	1.181E 02
25	577.50	4517.50	0.0	1.510E 02	1.474E-02	6.026E-01	7.330E 02	1.006E 02

END OF PROGRAM,

Figure A-26 Met 8/Case G

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE 1	Y-COORD SCALE 0	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	6.613E 01	6.509E-03	8.514E-01	6.573E 02	8.627E 01
2	577.00	4521.00	0.0	7.398E 01	8.202E-03	1.057E 00	7.207E 02	9.954E 01
3	579.00	4521.00	0.0	7.815E 01	7.982E-03	1.053E 00	7.596E 02	1.049E 02
4	580.00	4521.00	0.0	1.088E 02	1.293E-02	2.374E 00	1.153E 03	1.495E 02
5	576.00	4520.00	0.0	6.837E 01	6.873E-03	8.764E-01	6.847E 02	9.016E 01
6	574.00	4520.00	0.0	1.025E 02	1.195E-02	2.092E 00	1.177E 03	1.490E 02
7	575.00	4519.00	0.0	6.418E 01	6.256E-03	8.241E-01	6.455E 02	8.500E 01
8	577.00	4519.00	0.0	7.238E 01	7.292E-03	9.182E-01	7.161E 02	9.710E 01
9	579.00	4519.00	0.0	1.494E 02	2.253E-02	3.703E 00	2.086E 03	2.437E 02
10	580.00	4519.00	0.0	9.807E 01	1.090E-02	1.227E 00	9.462E 02	1.292E 02
11	575.00	4518.00	0.0	6.367E 01	6.332E-03	8.203E-01	6.439E 02	8.498E 01
12	577.00	4518.00	0.0	7.105E 01	7.195E-03	8.935E-01	7.115E 02	9.591E 01
13	578.00	4518.00	0.0	7.714E 01	7.825E-03	9.350E-01	7.485E 02	1.023E 02
14	580.00	4518.00	0.0	9.060E 01	9.806E-03	1.093E 00	8.958E 02	1.204E 02
15	576.00	4517.00	0.0	6.849E 01	6.821E-03	8.564E-01	6.870E 02	9.318E 01
16	579.00	4517.00	0.0	7.911E 01	7.705E-03	1.035E 00	7.844E 02	1.087E 02
17	575.00	4516.00	0.0	6.416E 01	6.879E-03	8.170E-01	6.509E 02	8.748E 01
18	577.00	4516.00	0.0	7.260E 01	7.440E-03	9.308E-01	7.246E 02	9.954E 01
19	578.00	4516.00	0.0	7.643E 01	7.718E-03	1.054E 00	7.568E 02	1.063E 02
20	580.00	4516.00	0.0	1.028E 02	1.263E-02	1.087E 00	1.008E 03	1.353E 02
21	577.50	4519.50	0.0	8.455E 01	1.061E-02	1.692E 00	8.714E 02	1.158E 02
22	576.50	4518.50	0.0	7.023E 01	7.065E-03	8.823E-01	6.981E 02	9.392E 01
23	577.50	4518.50	0.0	1.238E 02	1.690E-02	5.906E 00	1.599E 03	1.940E 02
24	576.50	4516.50	0.0	8.940E 01	1.121E-02	1.913E 00	8.984E 02	1.268E 02
25	577.50	4517.50	0.0	7.551E 01	7.368E-03	9.039E-01	7.330E 02	1.006E 02

END OF PROGRAM.

Figure A-27 Met 8/Case H

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.031E 02	9.824E-03	6.327E-01	4.796E 02	6.277E 01
2	577.00	4521.00	0.0	1.207E 02	1.262E-02	8.799E-01	5.451E 02	7.693E 01
3	578.00	4521.00	0.0	1.208E 02	1.204E-02	7.704E-01	5.542E 02	7.500E 01
4	580.00	4521.00	0.0	1.437E 02	1.680E-02	8.912E-01	6.670E 02	8.827E 01
5	576.00	4520.00	0.0	1.089E 02	1.046E-02	6.595E-01	5.075E 02	6.631E 01
6	579.00	4520.00	0.0	1.306E 02	1.339E-02	8.829E-01	5.878E 02	8.277E 01
7	575.00	4519.00	0.0	1.049E 02	1.002E-02	6.595E-01	4.875E 02	6.427E 01
8	577.00	4519.00	0.0	1.166E 02	1.145E-02	7.296E-01	5.373E 02	7.186E 01
9	578.00	4519.00	0.0	1.617E 02	2.085E-02	5.692E 00	1.416E 03	1.580E 02
10	580.00	4519.00	0.0	1.578E 02	1.759E-02	2.419E 00	9.484E 02	1.157E 02
11	575.00	4518.00	0.0	1.047E 02	9.880E-03	6.445E-01	4.887E 02	6.386E 01
12	577.00	4518.00	0.0	1.307E 02	1.305E-02	7.874E-01	5.728E 02	8.724E 01
13	578.00	4518.00	0.0	1.654E 02	2.123E-02	5.652E 00	1.417E 03	1.617E 02
14	580.00	4518.00	0.0	1.714E 02	1.964E-02	2.664E 00	9.762E 02	1.296E 02
15	576.00	4517.00	0.0	1.128E 02	1.100E-02	6.856E-01	5.219E 02	7.001E 01
16	579.00	4517.00	0.0	1.368E 02	1.414E-02	9.473E-01	6.079E 02	8.886E 01
17	575.00	4516.00	0.0	1.078E 02	1.043E-02	6.413E-01	5.006E 02	6.718E 01
18	577.00	4516.00	0.0	1.339E 02	1.373E-02	6.900E-01	5.575E 02	7.819E 01
19	578.00	4516.00	0.0	1.397E 02	1.458E-02	8.709E-01	5.920E 02	8.661E 01
20	580.00	4516.00	0.0	1.600E 02	1.709E-02	8.668E-01	7.276E 02	9.842E 01
21	577.50	4519.50	0.0	1.226E 02	1.229E-02	8.276E-01	5.657E 02	7.735E 01
22	576.50	4518.50	0.0	1.151E 02	1.132E-02	7.431E-01	5.297E 02	7.139E 01
23	577.50	4518.50	0.0	1.732E 02	2.365E-02	7.287E 00	1.694E 03	1.856E 02
24	576.50	4518.50	0.0	1.697E 02	2.206E-02	6.181E 00	1.519E 03	1.692E 02
25	577.50	4517.50	0.0	1.239E 02	1.253E-02	8.230E-01	5.615E 02	7.813E 01

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29550020

END OF PROGRAM.

Figure A-28 Met 9/Case A

PROPERTY OF
NEW JERSEY STATE LIBRARY
186 W. STATE ST. PO BOX 520
TRENTON, NJ 08625-0520

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	1.031E 02	9.824E-03	4.218E-01	4.796E 02	6.277E 01
2	577.00	4521.00	0.0	1.207E 02	1.262E-02	5.866E-01	5.451E 02	7.693E 01
3	578.00	4521.00	0.0	1.204E 02	1.200E-02	5.094E-01	5.532E 02	7.453E 01
4	580.00	4521.00	0.0	1.434E 02	1.677E-02	5.911E-01	6.663E 02	8.793E 01
5	576.00	4520.00	0.0	1.089E 02	1.046E-02	4.397E-01	5.075E 02	6.631E 01
6	579.00	4520.00	0.0	1.300E 02	1.332E-02	5.571E-01	5.855E 02	8.205E 01
7	575.00	4519.00	0.0	1.049E 02	1.002E-02	4.395E-01	4.875E 02	6.427E 01
8	577.00	4519.00	0.0	1.166E 02	1.145E-02	4.864E-01	5.373E 02	7.186E 01
9	578.00	4519.00	0.0	1.335E 02	1.462E-02	1.927E 00	8.111E 02	9.921E 01
10	580.00	4519.00	0.0	1.482E 02	1.572E-02	1.022E 00	7.507E 02	9.621E 01
11	575.00	4518.00	0.0	1.047E 02	9.880E-03	4.297E-01	4.887E 02	6.386E 01
12	577.00	4518.00	0.0	1.216E 02	1.201E-02	5.665E-01	5.506E 02	7.714E 01
13	578.00	4518.00	0.0	1.353E 02	1.480E-02	1.943E 00	8.136E 02	1.009E 02
14	580.00	4518.00	0.0	1.563E 02	1.683E-02	1.134E 00	7.686E 02	1.045E 02
15	576.00	4517.00	0.0	1.128E 02	1.100E-02	4.570E-01	5.219E 02	7.001E 01
16	579.00	4517.00	0.0	1.342E 02	1.375E-02	6.067E-01	6.020E 02	8.611E 01
17	575.00	4516.00	0.0	1.078E 02	1.043E-02	4.275E-01	5.006E 02	6.718E 01
18	577.00	4516.00	0.0	1.339E 02	1.373E-02	4.600E-01	5.575E 02	7.819E 01
19	578.00	4516.00	0.0	1.389E 02	1.444E-02	5.737E-01	5.903E 02	8.584E 01
20	580.00	4516.00	0.0	1.597E 02	1.704E-02	5.747E-01	7.268E 02	9.807E 01
21	577.50	4519.50	0.0	1.215E 02	1.217E-02	5.414E-01	5.564E 02	7.622E 01
22	576.50	4518.50	0.0	1.149E 02	1.130E-02	4.938E-01	5.293E 02	7.121E 01
23	577.50	4518.50	0.0	1.356E 02	1.531E-02	2.424E 00	8.876E 02	1.068E 02
24	578.50	4518.50	0.0	1.383E 02	1.528E-02	2.103E 00	8.500E 02	1.036E 02
25	577.50	4517.50	0.0	1.238E 02	1.253E-02	5.481E-01	5.613E 02	7.807E 01

END OF PROGRAM.

Figure A-29 Met 9/Case G

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	5.973E 02	4.345E-02	2.854E 00	3.999E 03	3.976E 02
2	577.00	4521.00	0.0	6.054E 02	4.369E-02	2.627E 00	3.471E 03	3.588E 02
3	578.00	4521.00	0.0	6.143E 02	4.612E-02	2.464E 00	3.433E 03	3.585E 02
4	580.00	4521.00	0.0	6.797E 02	6.204E-02	2.757E 00	3.642E 03	3.967E 02
5	576.00	4520.00	0.0	6.055E 02	4.884E-02	2.808E 00	4.466E 03	4.398E 02
6	579.00	4520.00	0.0	6.518E 02	5.797E-02	2.571E 00	3.620E 03	3.783E 02
7	575.00	4519.00	0.0	5.863E 02	3.577E-02	2.354E 00	3.172E 03	3.075E 02
8	577.00	4519.00	0.0	7.369E 02	7.870E-02	2.398E 01	7.109E 03	7.011E 02
9	578.00	4519.00	0.0	5.732E 02	4.342E-02	2.574E 00	3.407E 03	3.434E 02
10	580.00	4519.00	0.0	6.175E 02	7.577E-02	2.518E 00	3.423E 03	3.598E 02
11	575.00	4518.00	0.0	4.712E 02	3.456E-02	2.030E 00	3.029E 03	2.815E 02
12	577.00	4518.00	0.0	5.533E 02	4.335E-02	2.792E 00	3.348E 03	3.417E 02
13	578.00	4518.00	0.0	5.677E 02	4.489E-02	2.598E 00	3.410E 03	3.414E 02
14	580.00	4518.00	0.0	5.719E 02	5.158E-02	2.248E 00	3.417E 03	3.331E 02
15	576.00	4517.00	0.0	4.629E 02	3.688E-02	1.975E 00	3.017E 03	2.788E 02
16	579.00	4517.00	0.0	5.954E 02	4.953E-02	2.531E 00	3.570E 03	3.553E 02
17	575.00	4516.00	0.0	4.315E 02	3.608E-02	1.751E 00	2.860E 03	2.583E 02
18	577.00	4516.00	0.0	4.501E 02	4.784E-02	1.903E 00	2.942E 03	2.708E 02
19	578.00	4516.00	0.0	4.628E 02	4.228E-02	2.098E 00	3.074E 03	2.911E 02
20	580.00	4516.00	0.0	5.504E 02	5.012E-02	2.251E 00	3.378E 03	3.265E 02
21	577.50	4519.50	0.0	5.929E 02	4.673E-02	4.521E 00	3.751E 03	3.781E 02
22	576.50	4518.50	0.0	5.623E 02	4.470E-02	4.597E 00	3.643E 03	3.685E 02
23	577.50	4518.50	0.0	6.812E 02	6.934E-02	1.623E 01	5.780E 03	5.758E 02
24	578.50	4518.50	0.0	6.385E 02	6.004E-02	2.884E 00	3.722E 03	3.831E 02
25	577.50	4517.50	0.0	5.701E 02	5.036E-02	2.881E 00	3.405E 03	3.524E 02

RECEPTOR CONCENTRATIONS OUTPUT TO UNIT13 BEGINNINGSEQUENCE NUMBER 29570020

END OF PROGRAM.

Figure A-30 Met 10/Case A

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE D	Y-COORD SCALE D	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	579.00	4521.00	0.0	1.145E 03	7.905E-02	5.42[illegible] 00	3.663E 03	3.644E 02
2	577.00	4521.00	0.0	1.208E 03	8.703E-02	5.17[illegible] 00	3.468E 03	3.581E 02
3	578.00	4521.00	0.0	1.228E 03	9.213E-02	4.91[illegible] 00	3.432E 03	3.582E 02
4	580.00	4521.00	0.0	1.359E 03	1.241E-01	5.51[illegible] 00	3.642E 03	3.967E 02
5	576.00	4521.00	0.0	1.121E 03	8.151E-02	7.69[illegible] 00	3.818E 03	3.773E 02
6	579.00	4520.00	0.0	1.303E 03	1.158E-01	5.129E 00	3.619E 03	3.781E 02
7	578.00	4519.00	0.0	1.066E 03	7.064E-02	4.58[illegible] 00	3.167E 03	3.049E 02
8	577.00	4519.00	0.0	1.196E 03	9.784E-02	1.43[illegible] 01	3.007E 03	4.952E 02
9	578.00	4519.00	0.0	1.133E 03	8.482E-02	4.911E 00	3.396E 03	3.391E 02
10	580.00	4519.00	0.0	1.235E 03	1.515E-01	5.037E 00	3.423E 03	3.598E 02
11	575.00	4518.00	0.0	9.418E 02	6.904E-02	4.032E 00	3.028E 03	2.813E 02
12	577.00	4518.00	0.0	1.063E 03	8.296E-02	5.171E 00	3.329E 03	3.329E 02
13	578.00	4518.00	0.0	1.133E 03	8.896E-02	5.157E 00	3.408E 03	3.406E 02
14	580.00	4518.00	0.0	1.144E 03	1.032E-01	4.496E 00	3.417E 03	3.331E 02
15	576.00	4517.00	0.0	9.258E 02	7.375E-02	3.951E 00	3.017E 03	2.788E 02
16	579.00	4517.00	0.0	1.189E 03	9.831E-02	5.031E 00	3.568E 03	3.546E 02
17	575.00	4516.00	0.0	8.631E 02	7.216E-02	3.503E 00	2.860E 03	2.583E 02
18	577.00	4516.00	0.0	9.002E 02	9.567E-02	3.805E 00	2.942E 03	2.708E 02
19	578.00	4516.00	0.0	9.655E 02	8.457E-02	4.195E 00	3.074E 03	2.911E 02
20	580.00	4516.00	0.0	1.101E 03	1.002E-01	4.502E 00	3.378E 03	3.265E 02
21	577.50	4519.50	0.0	1.153E 03	8.706E-02	5.694E 00	3.556E 03	3.580E 02
22	576.50	4518.50	0.0	1.080E 03	8.116E-02	5.852E 00	3.438E 03	3.425E 02
23	577.50	4518.50	0.0	1.183E 03	9.700E-02	1.127E 01	4.446E 03	4.439E 02
24	578.50	4518.50	0.0	1.257E 03	1.169E-01	5.408E 00	3.705E 03	3.754E 02
25	577.50	4517.50	0.0	1.127E 03	9.767E-02	5.559E 00	3.396E 03	3.479E 02

END OF PROGRAM.

Figure A-31 Met 10/Case D

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	2.961E 02	2.131E-02	3.950E 00	3.662E 03	3.624E 02
2	577.00	4521.00	0.0	3.024E 02	2.180E-02	2.606E 00	3.468E 03	3.574E 02
3	576.00	4521.00	0.0	3.071E 02	2.305E-02	2.450E 00	3.432E 03	3.582E 02
4	580.00	4521.00	0.0	3.398E 02	3.102E-02	2.757E 00	3.642E 03	3.967E 02
5	576.00	4520.00	0.0	2.984E 02	2.301E-02	5.217E 00	3.817E 03	3.748E 02
6	579.00	4520.00	0.0	3.259E 02	2.898E-02	2.566E 00	3.619E 03	3.781E 02
7	575.00	4519.00	0.0	2.528E 02	1.782E-02	2.309E 00	3.167E 03	3.049E 02
8	577.00	4519.00	0.0	3.565E 02	3.670E-02	1.185E 01	5.006E 03	4.934E 02
9	578.00	4519.00	0.0	2.856E 02	2.150E-02	2.490E 00	3.396E 03	3.375E 02
10	580.00	4519.00	0.0	3.087E 02	3.788E-02	2.518E 00	3.423E 03	3.598E 02
11	575.00	4518.00	0.0	2.356E 02	1.727E-02	2.027E 00	3.028E 03	2.813E 02
12	577.00	4518.00	0.0	2.755E 02	2.137E-02	2.643E 00	3.329E 03	3.329E 02
13	578.00	4518.00	0.0	2.836E 02	2.234E-02	2.584E 00	3.408E 03	3.406E 02
14	580.00	4518.00	0.0	2.860E 02	2.579E-02	2.248E 00	3.417E 03	3.331E 02
15	576.00	4517.00	0.0	2.314E 02	1.844E-02	1.975E 00	3.017E 03	2.788E 02
16	579.00	4517.00	0.0	2.975E 02	2.467E-02	2.520E 00	3.568E 03	3.546E 02
17	575.00	4516.00	0.0	2.158E 02	1.804E-02	1.751E 00	2.860E 03	2.583E 02
18	577.00	4516.00	0.0	2.251E 02	2.392E-02	1.903E 00	2.942E 03	2.708E 02
19	578.00	4516.00	0.0	2.414E 02	2.114E-02	2.098E 00	3.074E 03	2.911E 02
20	580.00	4516.00	0.0	2.752E 02	2.506E-02	2.251E 00	3.378E 03	3.265E 02
21	577.50	4519.50	0.0	2.944E 02	2.298E-02	3.386E 00	3.555E 03	3.554E 02
22	576.50	4518.50	0.0	2.791E 02	2.190E-02	3.392E 00	3.438E 03	3.425E 02
23	577.50	4518.50	0.0	3.329E 02	3.273E-02	8.589E 00	4.446E 03	4.437E 02
24	578.50	4518.50	0.0	3.182E 02	2.977E-02	2.754E 00	3.705E 03	3.754E 02
25	577.50	4517.50	0.0	2.842E 02	2.485E-02	2.807E 00	3.396E 03	3.479E 02

END OF PROGRAM.

Figure A-32 Met 10/Case F

ARITHMETIC YEAR POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE U	Y-COORD SCALE U	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	5.747E 02	3.983E-02	2.644E 00	3.578E 03	3.244E 02
2	577.00	4521.00	0.0	6.040E 02	4.351E-02	1.738E 00	3.458E 03	3.573E 02
3	579.00	4521.00	0.0	6.139E 02	4.607E-02	1.639E 00	3.432E 03	3.581E 02
4	581.00	4521.00	0.0	5.797E 02	6.204E-02	1.838E 00	3.642E 03	3.967E 02
5	583.00	4521.00	0.0	5.645E 02	4.143E-02	1.502E 00	3.635E 03	3.595E 02
6	575.00	4519.00	0.0	6.515E 02	5.792E-02	1.711E 00	3.619E 03	3.780E 02
7	577.00	4519.00	0.0	6.031E 02	4.535E-02	1.539E 00	3.165E 03	3.042E 02
8	579.00	4519.00	0.0	6.110E 02	5.167E-02	1.777E 00	4.479E 03	4.416E 02
9	581.00	4519.00	0.0	5.668E 02	4.241E-02	1.650E 00	3.393E 03	3.367E 02
10	583.00	4519.00	0.0	6.175E 02	7.577E-02	1.579E 00	3.423E 03	3.598E 02
11	575.00	4517.00	0.0	4.709E 02	3.452E-02	1.351E 00	3.029E 03	2.813E 02
12	577.00	4517.00	0.0	5.425E 02	4.135E-02	1.762E 00	3.324E 03	3.307E 02
13	579.00	4517.00	0.0	5.663E 02	4.447E-02	1.722E 00	3.408E 03	3.403E 02
14	581.00	4517.00	0.0	5.719E 02	5.139E-02	1.499E 00	3.417E 03	3.331E 02
15	583.00	4517.00	0.0	4.629E 02	3.633E-02	1.317E 00	3.017E 03	2.788E 02
16	579.00	4515.00	0.0	5.944E 02	4.915E-02	1.680E 00	3.568E 03	3.544E 02
17	579.00	4515.00	0.0	4.315E 02	3.608E-02	1.166E 00	2.860E 03	2.583E 02
18	577.00	4513.00	0.0	4.501E 02	4.784E-02	1.268E 00	2.942E 03	2.708E 02
19	579.00	4513.00	0.0	4.828E 02	4.228E-02	1.398E 00	3.074E 03	2.911E 02
20	581.00	4513.00	0.0	5.504E 02	5.012E-02	1.501E 00	3.378E 03	3.265E 02
21	577.00	4511.00	0.0	5.776E 02	4.374E-02	2.265E 00	3.506E 03	3.508E 02
22	579.00	4511.00	0.0	5.419E 02	4.089E-02	2.269E 00	3.387E 03	3.359E 02
23	577.00	4509.00	0.0	5.999E 02	5.037E-02	5.777E 00	4.111E 03	4.105E 02
24	579.00	4509.00	0.0	6.292E 02	5.850E-02	1.836E 00	3.701E 03	3.735E 02
25	577.00	4507.00	0.0	5.639E 02	4.883E-02	1.671E 00	3.394E 03	3.468E 02

END OF PROGRAM.

Figure A-33 Met 10/Case G

ARITHMETIC MEAN POLLUTANT CONCENTRATIONS

RECEPTOR COORDINATE SCALE UNIT(METERS)= 1000.00

RECEPTOR NUMBER	X-COORD SCALE 0	Y-COORD SCALE 0	HEIGHT METERS	TSP UG/M**3	SOX PPM	CO PPM	HC UG/M**3	NOX UG/M**3
1	575.00	4521.00	0.0	3.088E 02	2.273E-02	4.944E 00	3.838E 03	3.841E 02
2	577.00	4521.00	0.0	3.030E 02	2.135E-02	2.617E 00	3.469E 03	3.580E 02
3	579.00	4521.00	0.0	3.073E 02	2.307E-02	2.461E 00	3.432E 03	3.584E 02
4	580.00	4521.00	0.0	3.398E 02	3.102E-02	2.757E 00	3.642E 03	3.967E 02
5	576.00	4520.00	0.0	3.218E 02	2.655E-02	7.092E 00	4.155E 03	4.153E 02
6	574.00	4520.00	0.0	3.260E 02	2.899E-02	2.96[illegible] 00	3.620E 03	3.782E 02
7	575.00	4519.00	0.0	2.540E 02	1.794E-02	2.[illegible] 00	3.169E 03	3.062E 02
8	577.00	4520.00	0.0	4.312E 02	4.771E-02	1.81[illegible] 01	5.104E 03	6.256E 02
9	578.00	4520.00	0.0	2.881E 02	2.179E-02	2.05[illegible] 00	3.4[illegible]E 03	3.402E 02
10	580.00	4520.00	0.0	3.067E 02	2.788E-02	2.51[illegible] 00	3.423E 03	3.598E 02
11	575.00	4518.00	0.0	2.357E 02	1.728E-02	2.029E 00	3.029E 03	2.814E 02
12	577.00	4518.00	0.0	2.795E 02	2.137E-02	2.719E 00	3.339E 03	3.374E 02
13	578.00	4518.00	0.0	2.840E 02	2.240E-02	2.590E 00	3.409E 03	3.409E 02
14	580.00	4518.00	0.0	2.860E 02	2.579E-02	2.248E 00	3.417E 03	3.331E 02
15	576.00	4517.00	0.0	2.314E 02	1.844E-02	1.975E 00	3.017E 03	2.788E 02
16	574.00	4517.00	0.0	2.978E 02	2.473E-02	2.525E 00	3.569E 03	3.549E 02
17	575.00	4516.00	0.0	2.158E 02	1.804E-02	1.751E 00	2.860E 03	2.583E 02
18	577.00	4516.00	0.0	2.251E 02	1.892E-02	1.903E 00	2.942E 03	2.708E 02
19	578.00	4516.00	0.0	2.414E 02	2.114E-02	2.098E 00	3.074E 03	2.911E 02
20	580.00	4516.00	0.0	2.752E 02	2.506E-02	2.251E 00	3.378E 03	3.265E 02
21	577.00	4519.00	0.0	3.027E 02	2.413E-02	3.970E 00	3.657E 03	3.689E 02
22	575.00	4513.00	0.0	2.893E 02	2.329E-02	4.020E 00	3.545E 03	3.581E 02
23	577.00	4516.00	0.0	3.805E 02	4.026E-02	1.258E 01	5.143E 03	5.278E 02
24	578.00	4515.00	0.0	3.218E 02	3.021E-02	2.820E 00	3.714E 03	3.793E 02
25	577.00	4517.00	0.0	2.862E 02	2.514E-02	2.845E 00	3.401E 03	3.501E 02

END OF PROGRAM.

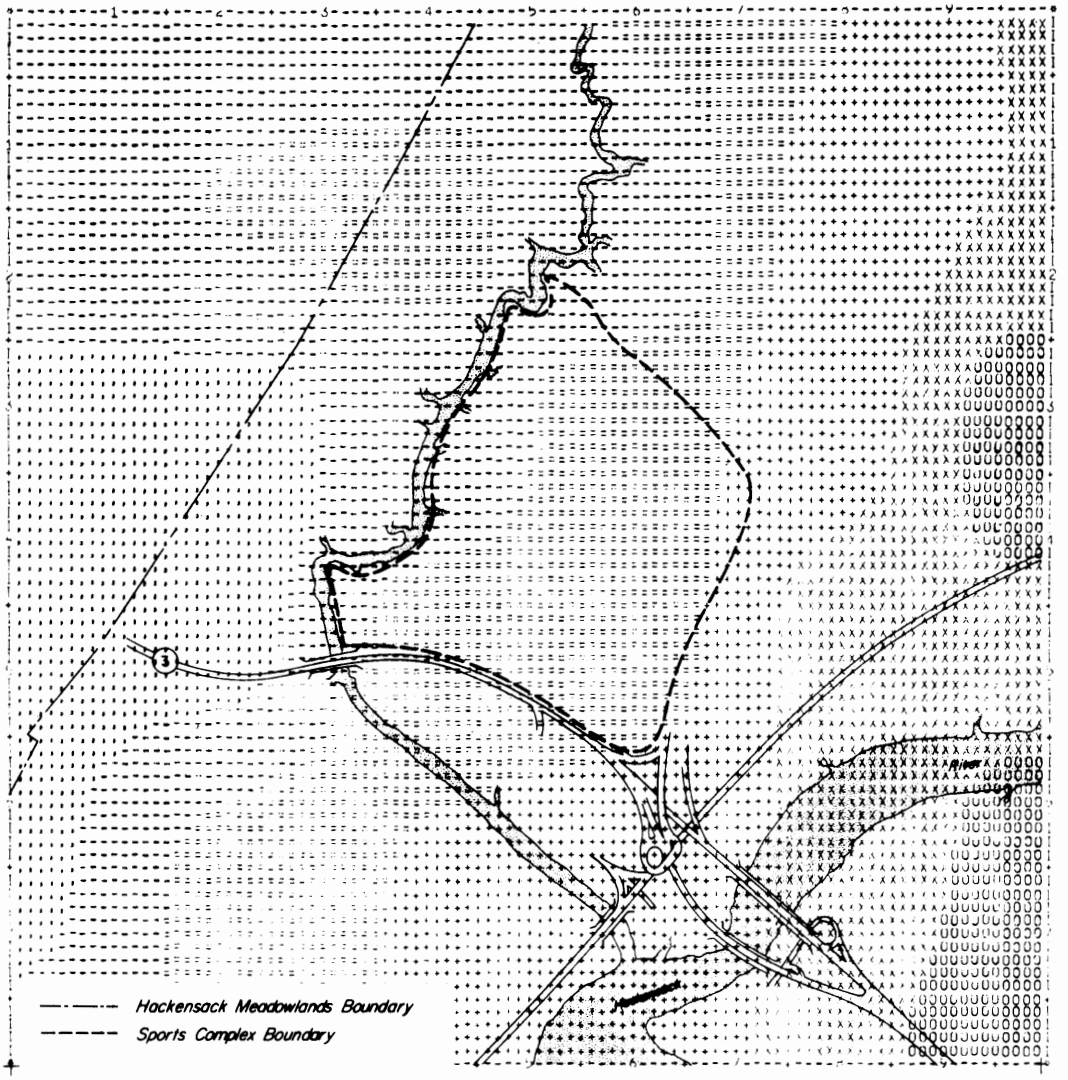
Figure A-34 Met 10/Case H

APPENDIX B

Air Quality Contour Maps

LIST OF MAPS OF AIR QUALITY

Figure No.	Meteorological Condition	Facility Case	Pollutant
B-1	Annual	Average	Particulates
B-2	Annual	Average	SO_2
B-3	Annual	Average	CO
B-4	Annual	Average	HC
B-5	Annual	Average	NO_2
B-6	Annual	Football (Exit)	CO
B-7	Annual	Football (Exit)	NO_2
B-8	Annual	Football (Enter)	CO
B-9	Annual	Winter Racing (Enter)	CO
B-10	Annual	Winter Racing (Exit)	CO
B-11	Annual	Summer Racing (Enter)	CO
B-12	Annual	Summer Racing (Exit)	CO
B-13	Annual	Arena	CO
B-14	Annual	Combined	CO
B-15	S, Neutral (200 m.)	Football (Enter)	CO
B-16	S, Neutral (100 m.)	Football (Enter)	CO
B-17	WSW, Neutral (100 m.)	Football (Exit)	CO
B-18	E, Neutral	Football (Exit)	CO
B-19	SE, Neutral	Football (Enter)	CO
B-20	S, Stable	Football (Exit)	CO
B-21	SW, Stable	Football (Exit)	CO
B-22	W, Stable	Football (Exit)	CO
B-23	SE, Stable	Football (Exit)	Particulates
B-24	SE, Stable	Football (Exit)	SO_2
B-25	SE, Stable	Football (Exit)	CO
B-26	SE, Stable	Football (Exit)	HC
B-27	SE, Stable	Football (Exit)	NO_2



I-11
PARTICULATES

DATA VALUE EXTREMES ARE 97.99 124.68

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	90.00	95.00	100.00	105.00	110.00	115.00	120.00	125.00	130.00	135.00
MAXIMUM	95.00	100.00	105.00	110.00	115.00	120.00	125.00	130.00	135.00	140.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

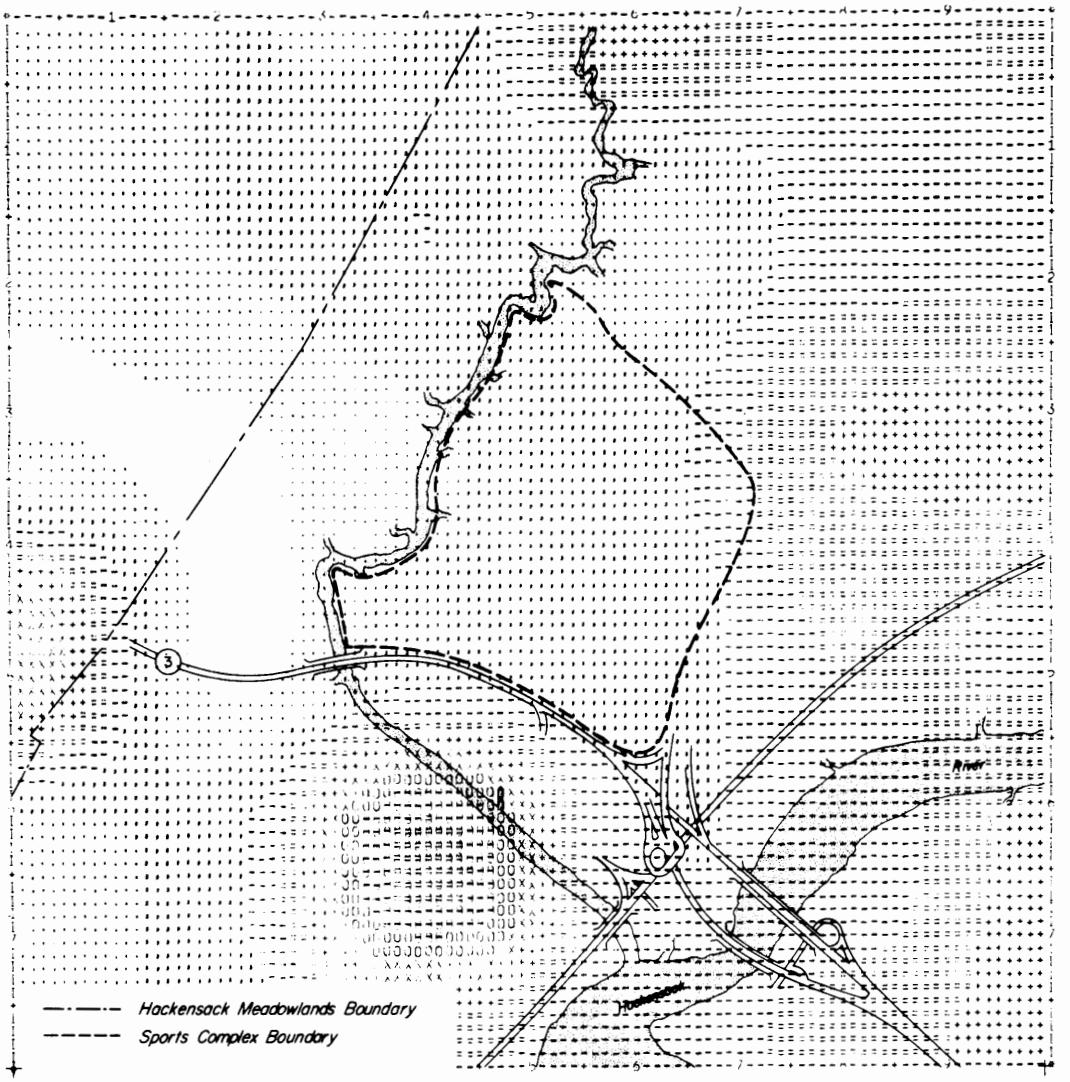
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.....	.....	-----	=====	+++++	XXXXX	00000	@@@@@	#####	#####
FREQ.	0	6	7	8	6	6	3	0	0	0

MARTIK RUN 2002 DATE JUN. 08/72
TSP SOX CO HC NOX

Figure B-1 Annual, Average - Particulates



I-11
SOX

DATA VALUE EXTREMES ARE 0.59 1.02

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05
MAXIMUM	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

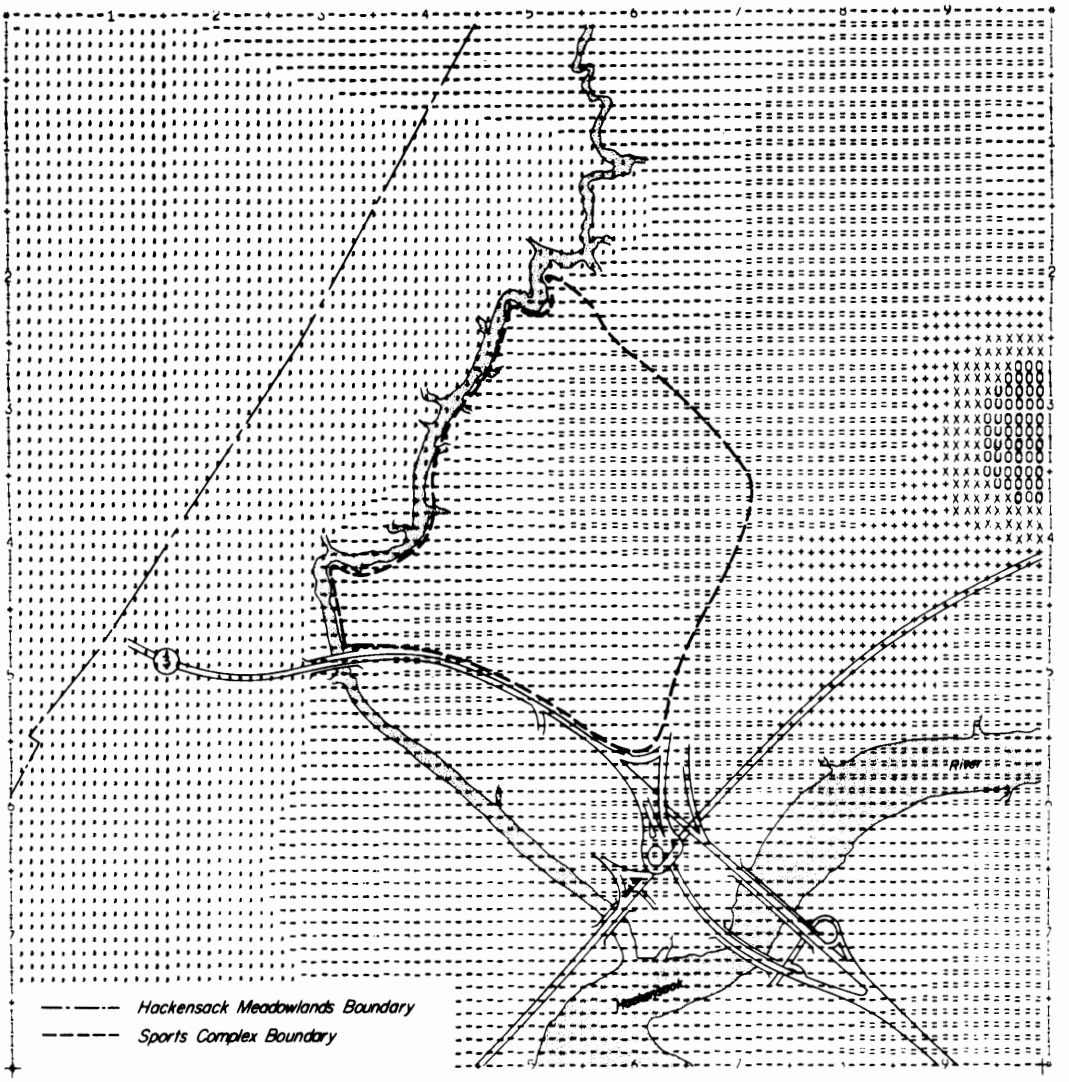
10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	L	1	2	3	4	5	6	7	8	9	10
SYMBOLS							XXXXXXXXX	000000000	#########	#########	#########
FREQ.	2	7	8	8	4	5	0	1	0	1	0

MARTIK RUN 2002 DATE JUN. 08/79
TSP SOX CO HC NOX

Figure B-2 Annual Average CO_2



I-11
CO

DATA VALUE EXTREMES ARE 0.65 0.94

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05
MAXIMUM	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

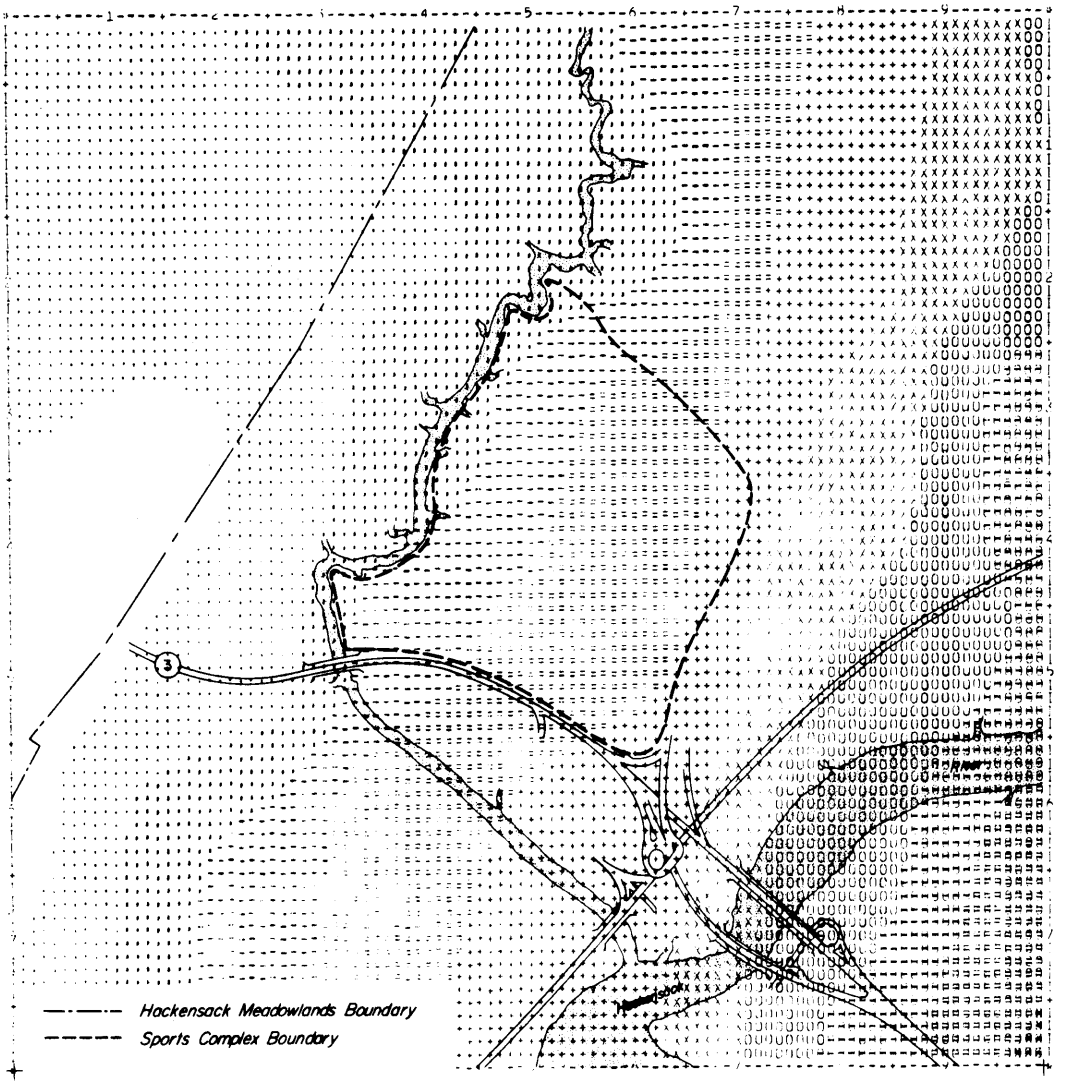
10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	-	=	+	X	0	@			
FREQ.	0	13	12	9	1	0	1	0	0	0

MARTIK RUN 2005 DATE JUN. 08/72
TSP SOX CO HC NOx

Figure B-3 Annual Average CO



1-11
HC

DATA VALUE EXTREMES ARE 1241.10 1761.40

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	1300.00	1350.00	1400.00	1450.00	1500.00	1550.00	1600.00	1650.00	1700.00	1750.00
MAXIMUM	1300.00	1350.00	1400.00	1450.00	1500.00	1550.00	1600.00	1650.00	1700.00	1750.00	1800.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

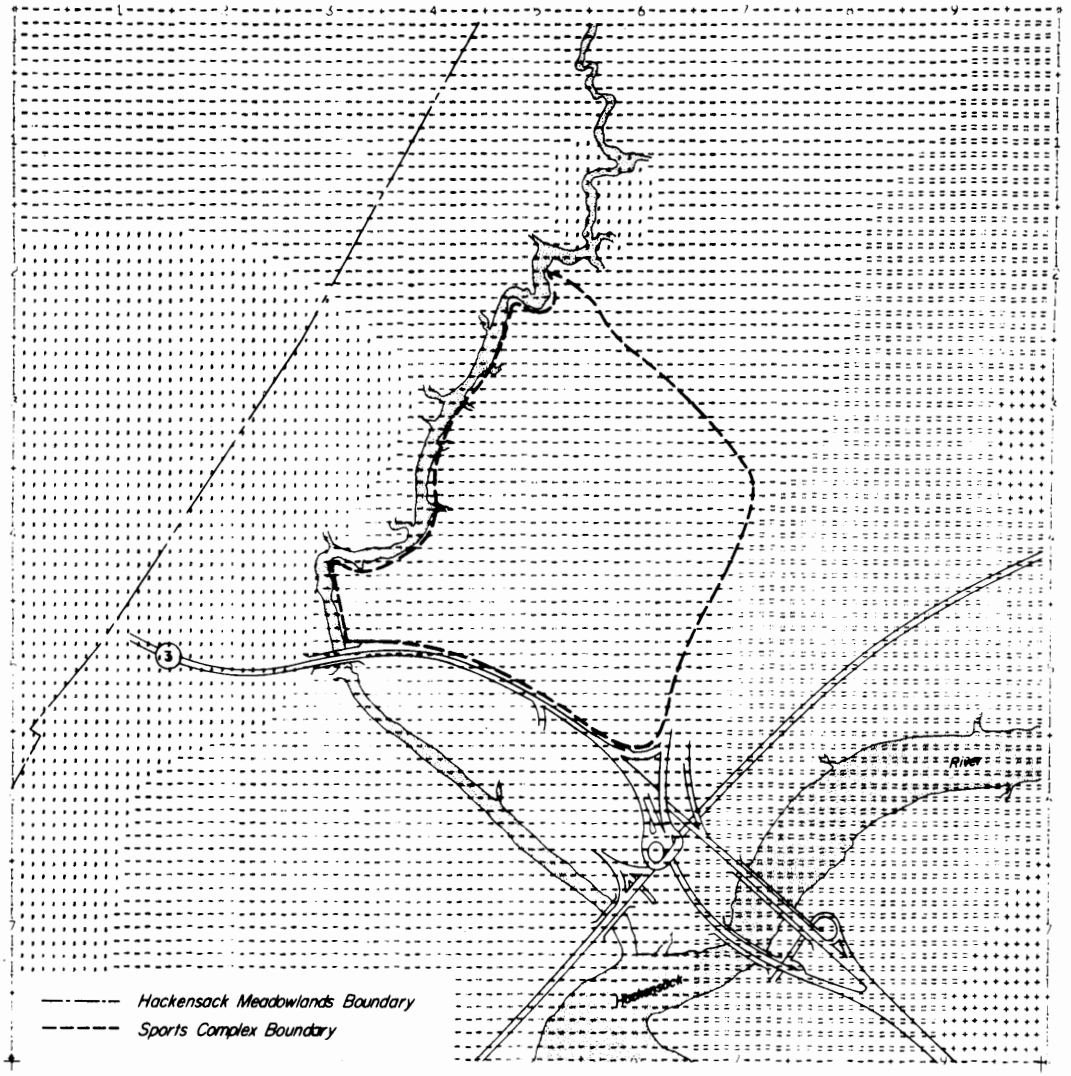
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	:	-	=	+	X	0	@	&	N
FREQ.	3	6	5	4	4	1	4	5	1	1

MARTIK RUN 2002 DATE JUN. 08/72
TSP SOX CO HC NOX

Figure B-4 Annual, Average - HC



I-11
NOX

DATA VALUE EXTREMES ARE 30.00 51.72

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL'S RANGE)

MINIMUM	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00
MAXIMUM	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

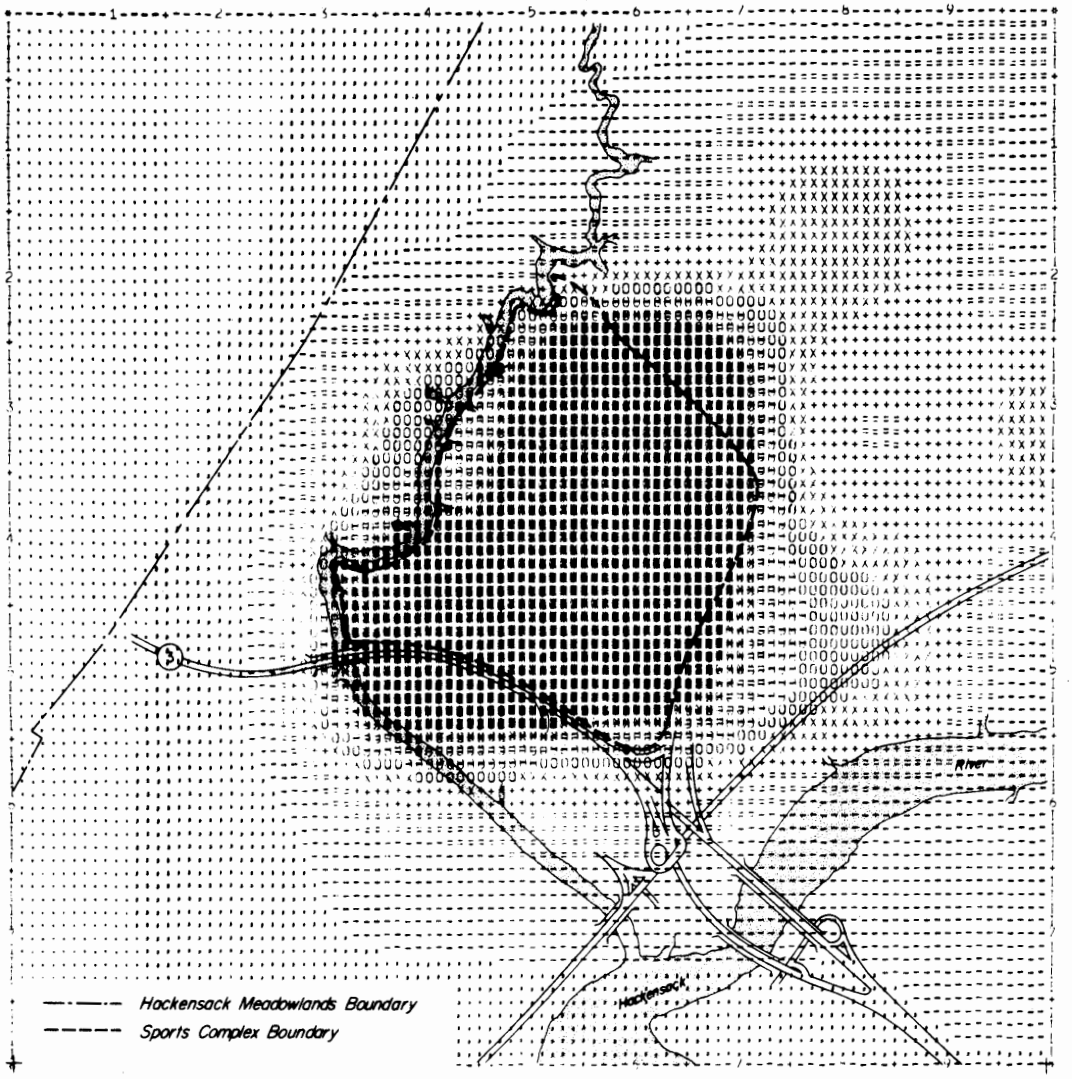
	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	*	-	=	+	X	O	H	@	#
FREQ.	0	7	19	8	2	0	0	0	0	0

MARTIN RUN 2005 DATE JUN. 08/72

Figure B-5 Annual, Average - NO_2



4-11
CO

DATA VALUE EXTREMES ARE 1.08 2.81

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

											ABOVE
MINIMUM	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
MAXIMUM	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

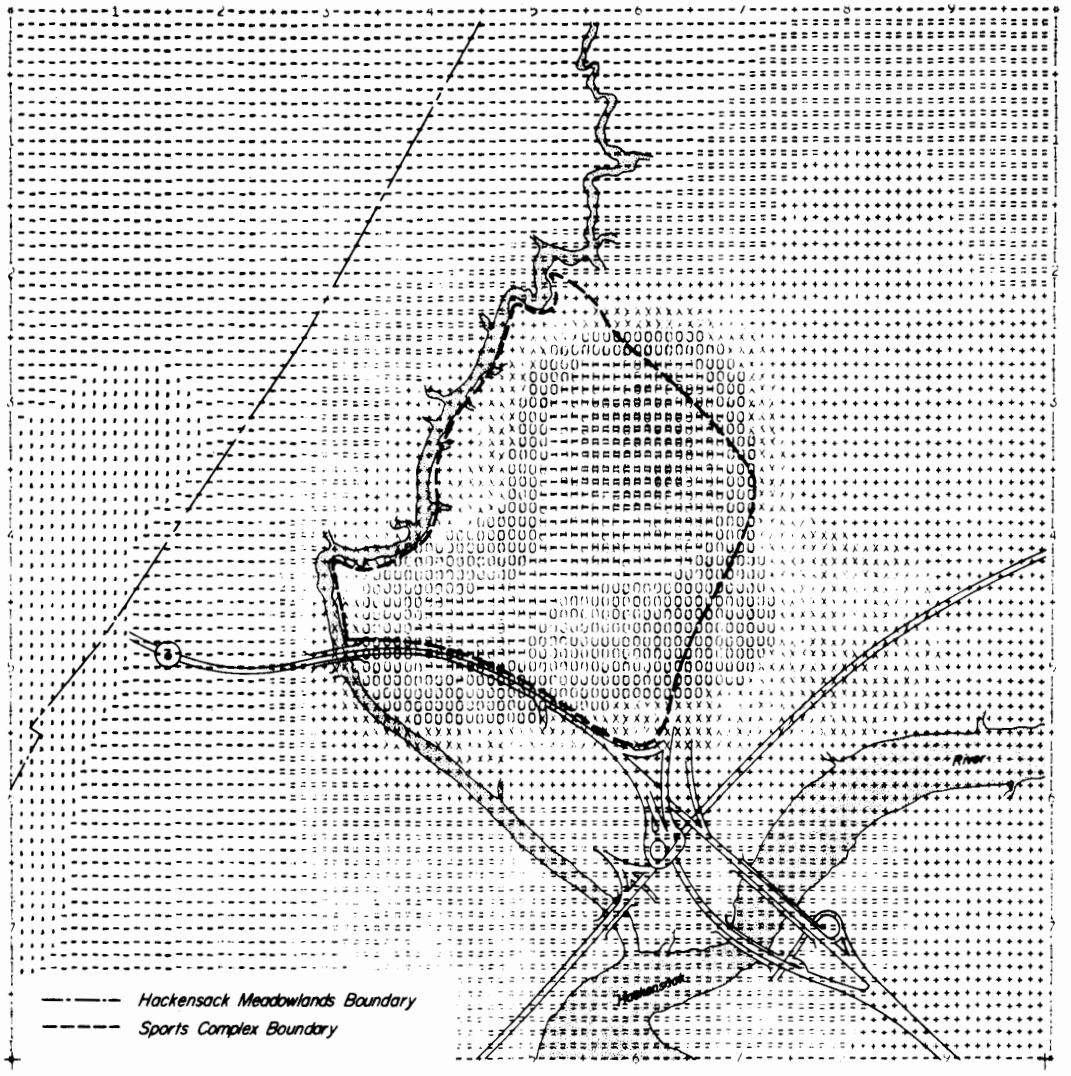
10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	H
SYMBOLS	.	-	=	+	X	0	@	#	%	&	
FREQ.	8	11	6	1	1	2	2	0	0	0	3

BASTIK RUN 2002 DATE JUN. 08/72
TSP SOX CO HC NOX

Figure B-6 Annual, Football (Exit) - CO



A-11
NOx

DATA VALUE EXTREMES ARE 39.11 71.68

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00
MAXIMUM	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	#	-	=	+	X	0	@	*	M
FREQ.	0	3	12	10	7	1	1	1	1	0

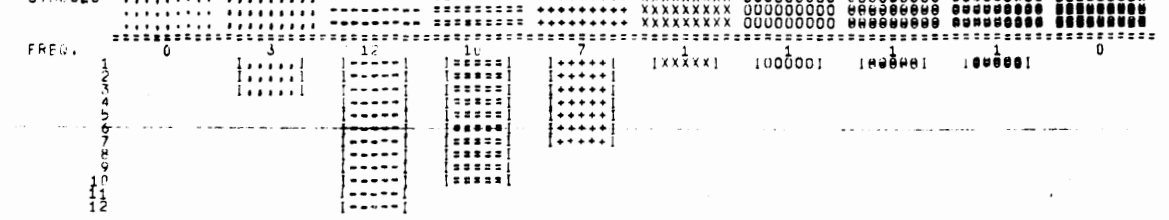
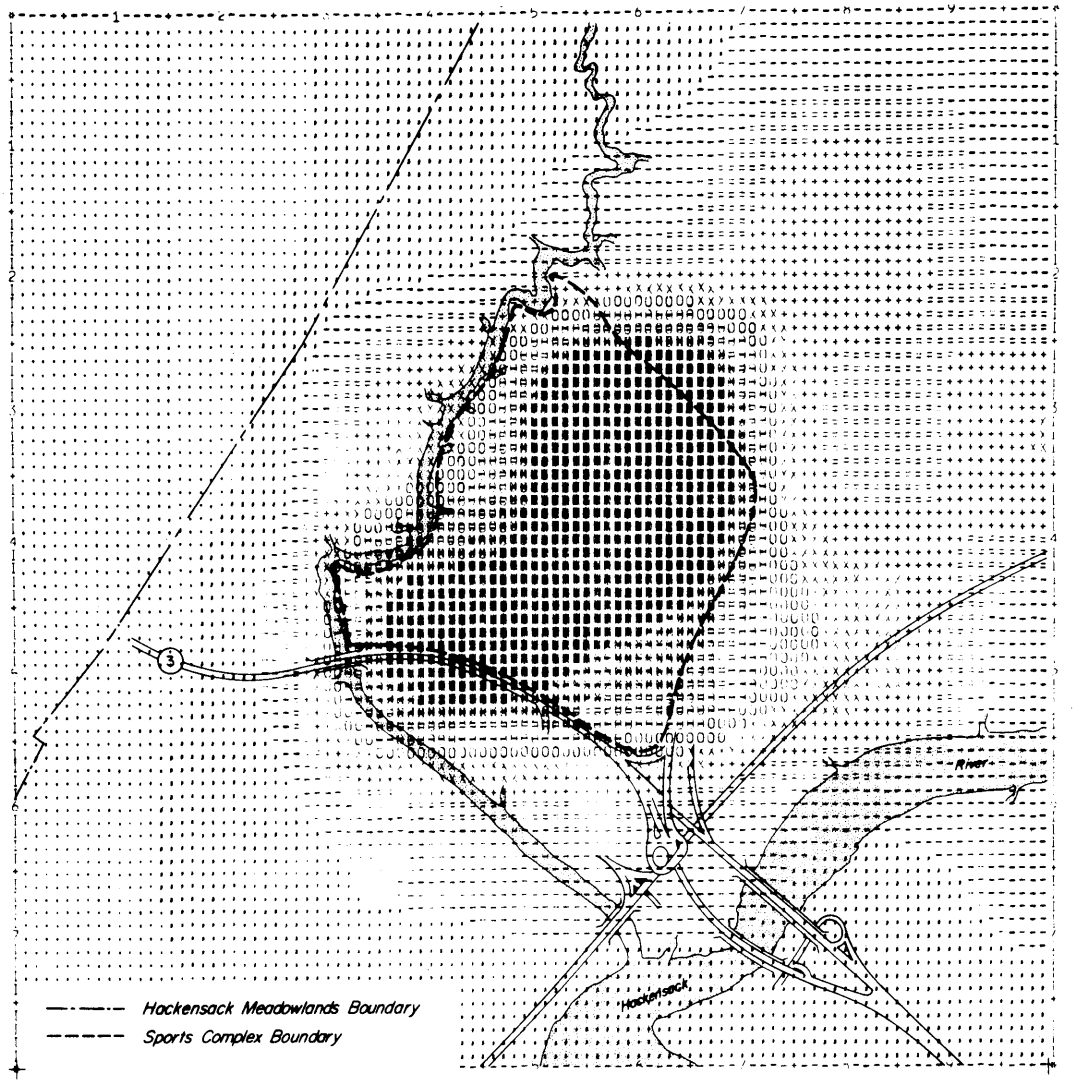


Figure B-7 Annual, Football (Exit) - NO_2



B-11
CO

DATA VALUE EXTREMES ARE 1.02 2.47

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(MAXIMUM INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	ABOVE 2.00
MAXIMUM	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

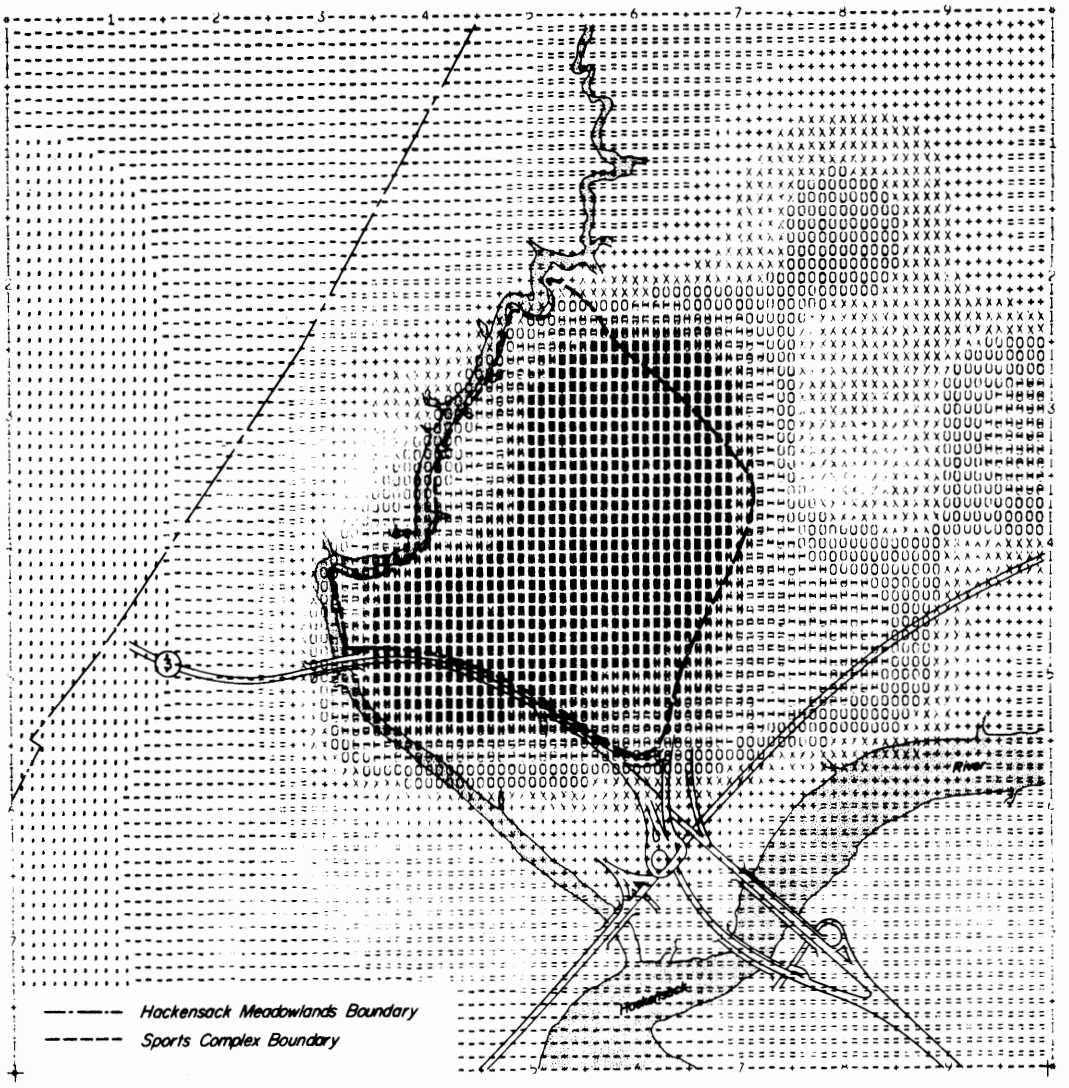
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	H
SYMBOLS	.	/	-	=	+	X	0	#	@		
FREQ.	10	10	8	1	1	5	0	0	0	1	2

MANTIK RUN 2965 DATE JUN. 07/72
TSP SOX CO HC NOX

Figure B-8 Annual, Football (Enter) - CO



C-11
CO

DATA VALUE EXTREMES ARE 0.67 1.33

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

										ABOVE
MINIMUM	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10
MAXIMUM	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

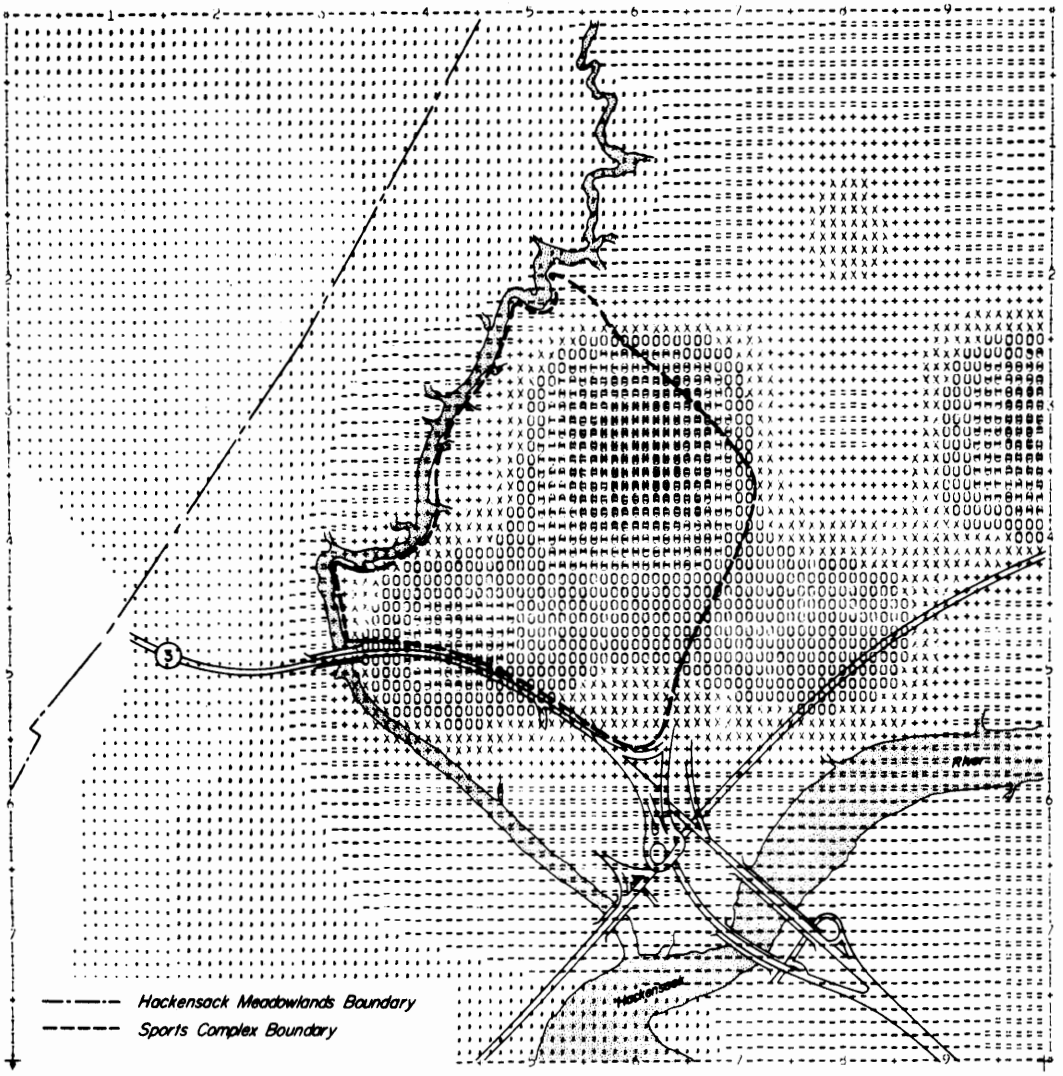
10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	H
SYMBOLS	.	,	-	=	+	X	0	@	@	@	@
FREQ.	0	5	11	10	2	1	2	2	0	0	3

MARTIK RUN 2966 DATE JUN. 07/72
TSP SOX CO HC NOX

Figure B-9 Annual, Winter Racing (Enter) - CO



D-11
CO

DATA VALUE EXTREMES ARE 1.97 2.94

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90
MAXIMUM	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

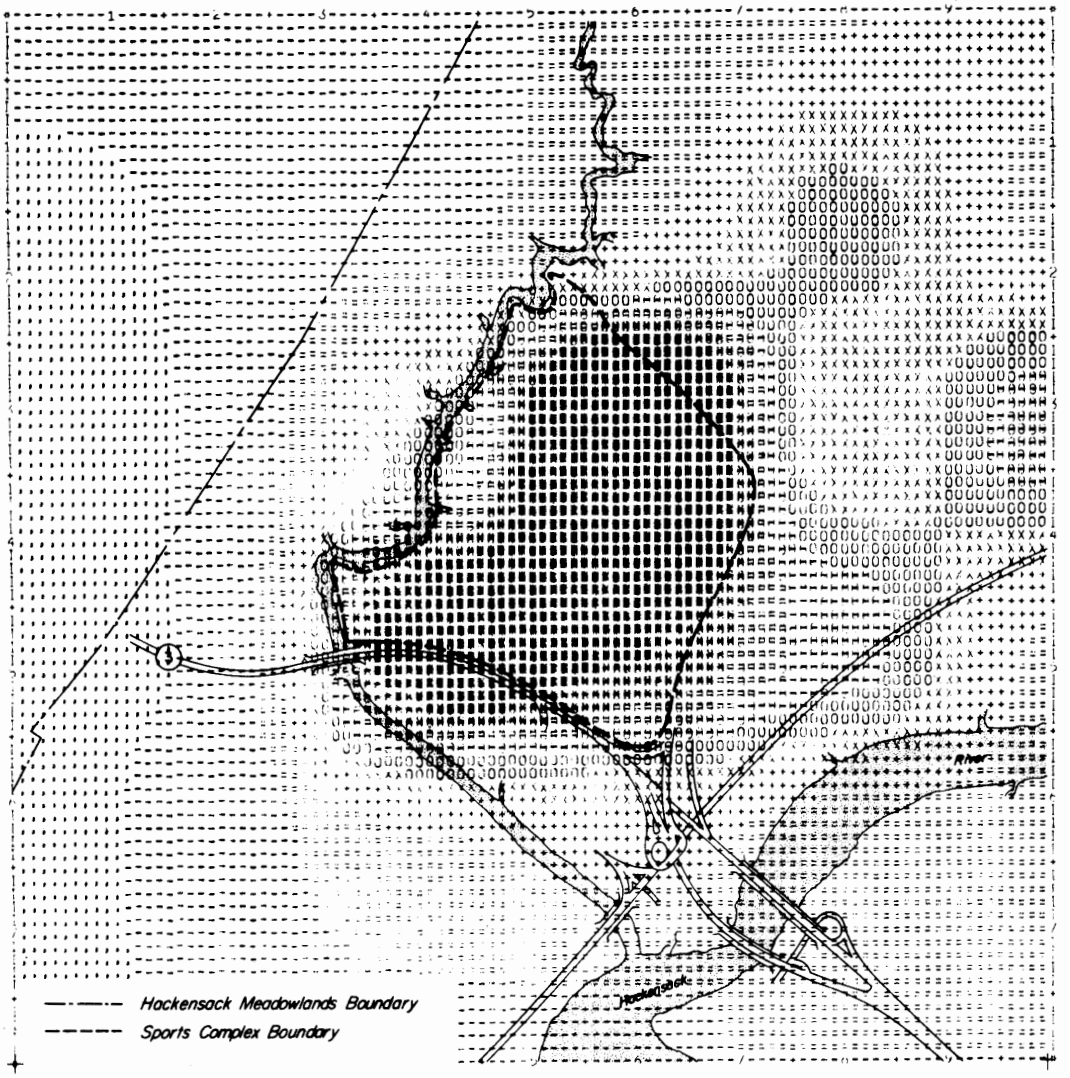
	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	L	1	2	3	4	5	6	7	8	9	10
SYMBOLS		.	:	-	=	+	X	0	@	#	*
FREQ.	3	6	8	7	6	0	1	2	1	1	1

MANTIK RUN 2967 DATE JUN. 07/72
TSP SOX CO HC NOX

Figure B-10 Annual, Winter Racing (Exit) - CO



E-11
CO

DATA VALUE EXTREMES ARE 1.07 1.33

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

											ABOVE
MINIMUM	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10
MAXIMUM	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

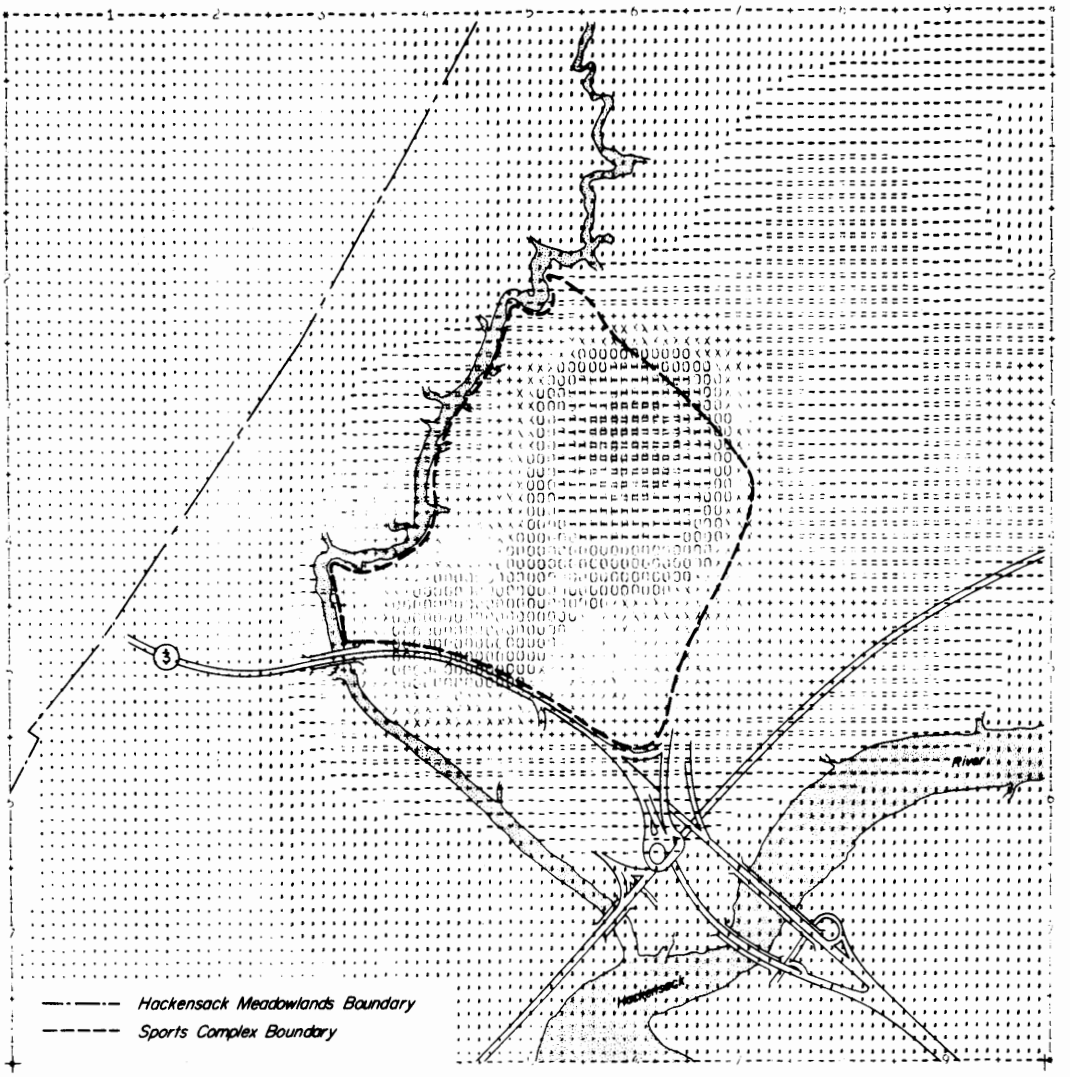
10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	M
SYMBOLS	.	#	-	=	+	X	0	@	&	$	
FREQ.	0	5	11	10	2	1	2	2	0	0	3

MARTIK RUN 2968 DATE JUN, 07/72
TSP SOX CO HC NOX

Figure B-11 Annual, Summer Racing (Enter) - CO



F-11
CO

DATA VALUE EXTREMES ARE 1.00 1.84

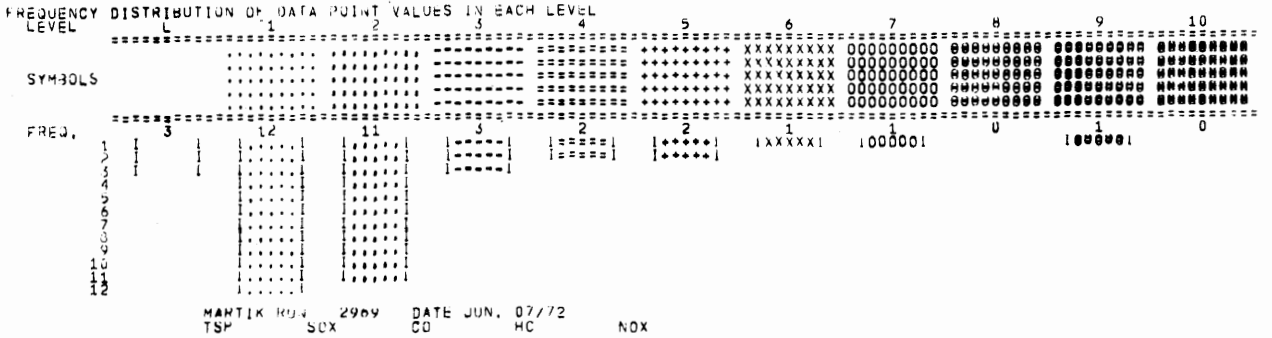
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90
MAXIMUM	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

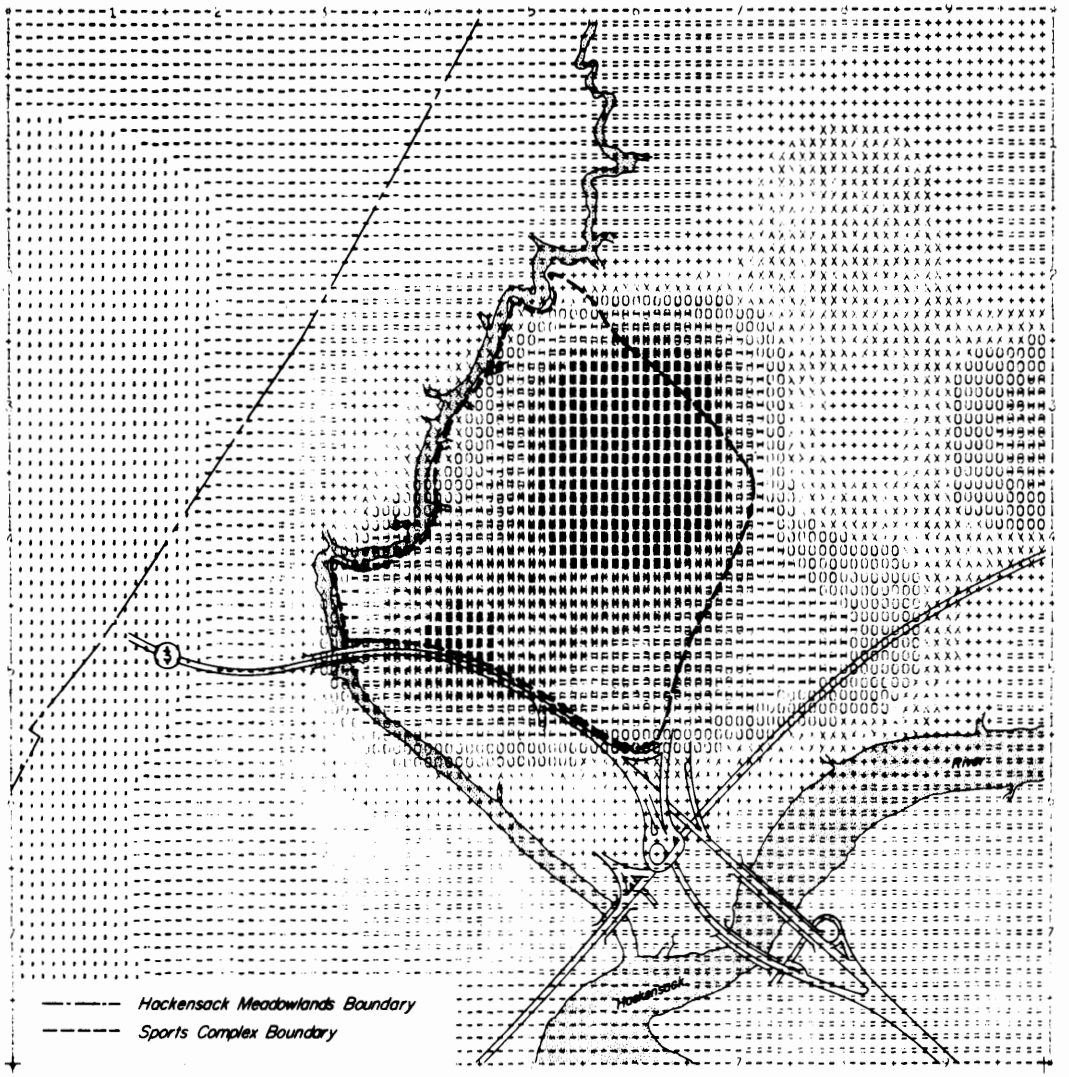
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL



MANTIK RUN 2969 DATE JUN. 07/72
TSP SOX CO HC NOX

Figure B-12 Annual, Summer Racing (Exit) - CO



G-11
CO

DATA VALUE EXTREMES ARE 0.60 1.24

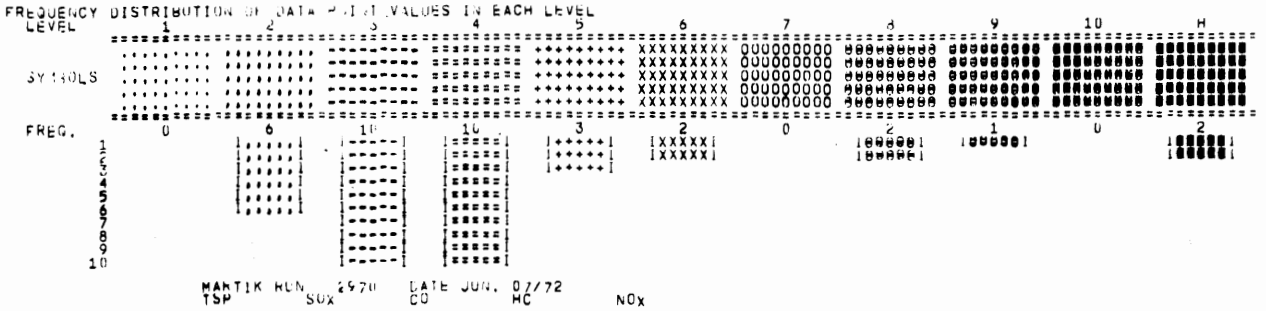
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(MAXIMUM INCLUDED IN HIGHEST LEVEL ONLY)

											ABOVE
MINIMUM	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10
MAXIMUM	0.65	0.70	0.75	1.80	0.85	0.90	0.95	1.00	1.05	1.10	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

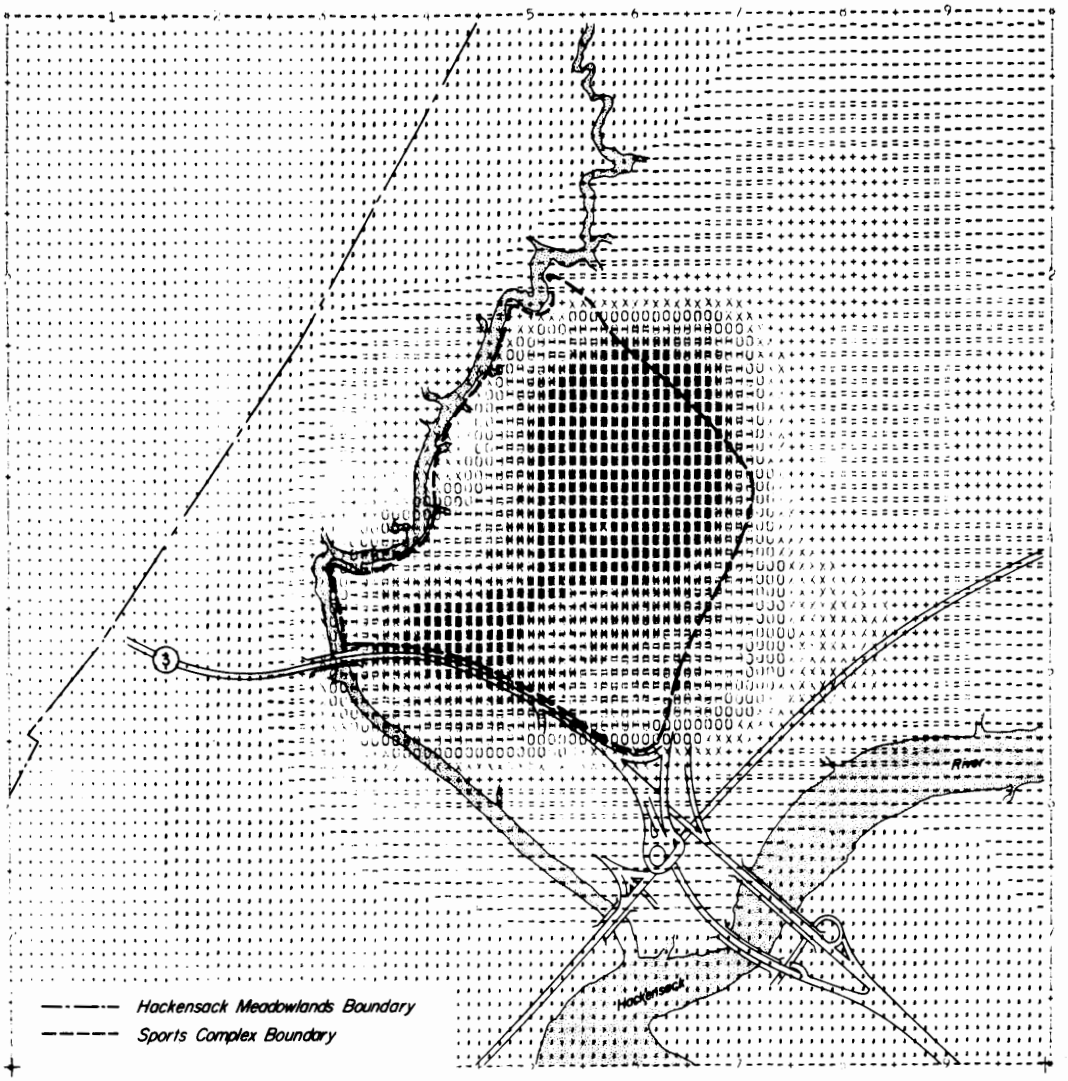
10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL



MARTIK RUN 2970 DATE JUN. 07/72
TSP SOx CO HC NOx

Figure B-13 Annual, Arena - CO



H=11
CO

DATA VALUE EXTREMES ARE 1.11 2.55

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

										ABOVE
MINIMUM	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
MAXIMUM	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

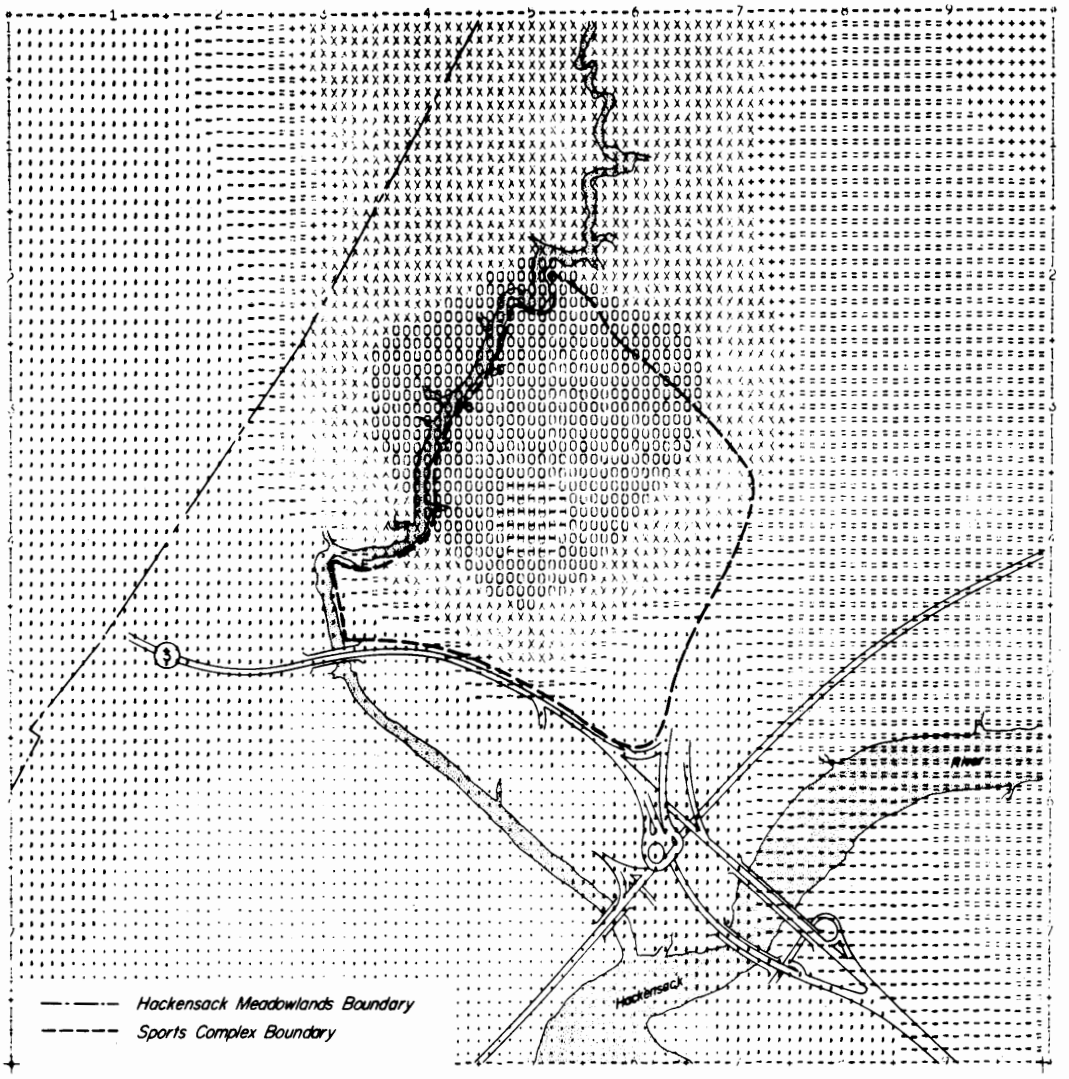
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	H
SYMBOLS	.	:	-	=	+	X	0	#	@		
FREQ.	10	10	8	1	3	1	0	0	0	1	2

PROPERTY OF
NEW JERSEY STATE LIBRARY
186 W. STATE ST. PO BOX 520
TRENTON, NJ 08625-0520

Figure B-14 Annual, Combined - CO



B-1

DATA VALUE EXTREMES ARE 0.54 5.21

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00
MAXIMUM	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

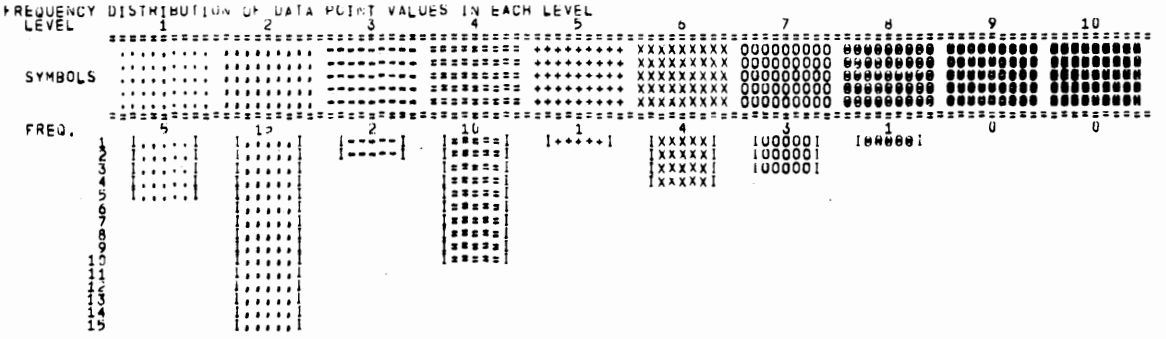
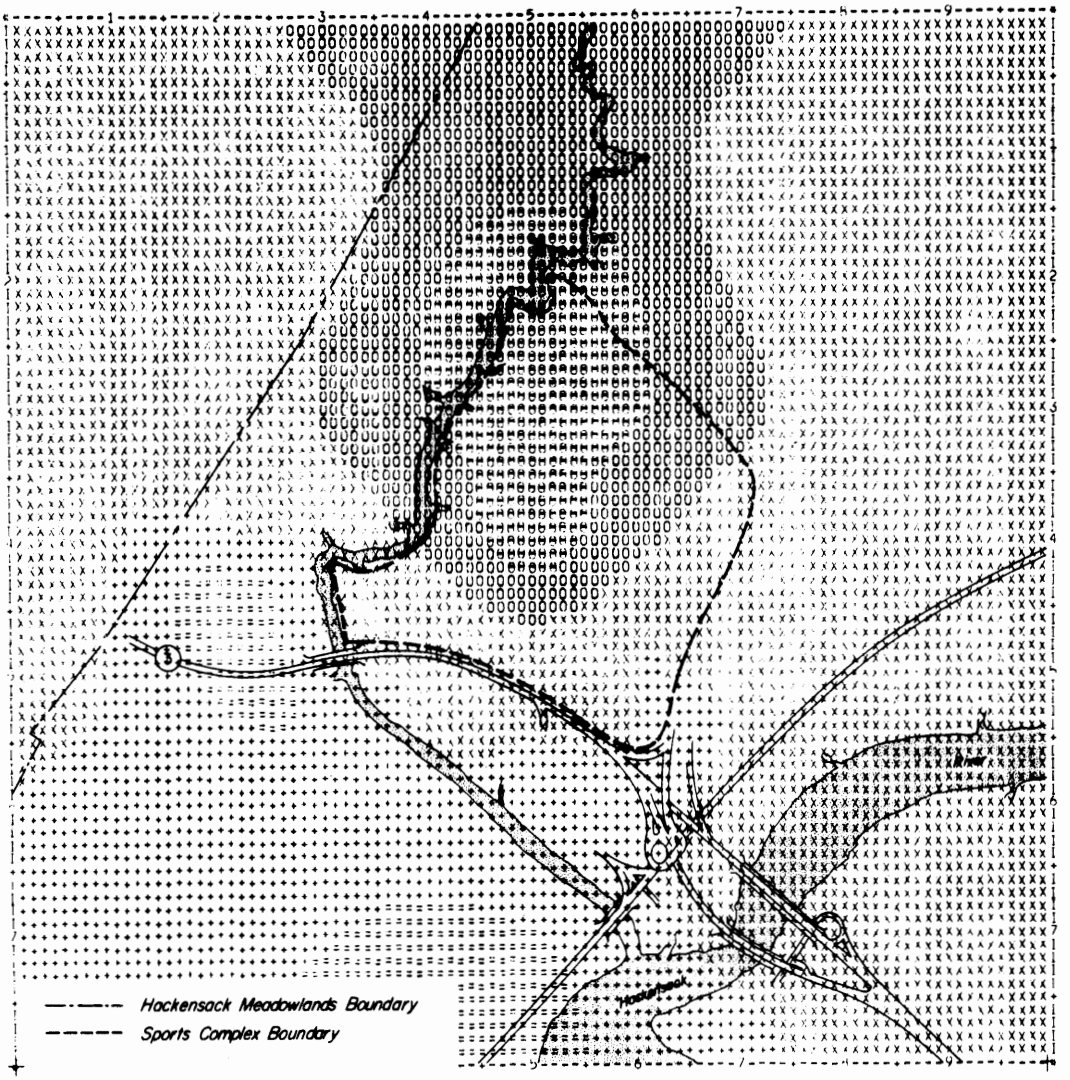


Figure B-15 S, Neutral (200 m.), Football (Enter) - CO



B-2

DATA VALUE EXTREMES ARE 0.56 3.61

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00
MAXIMUM	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

	1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18

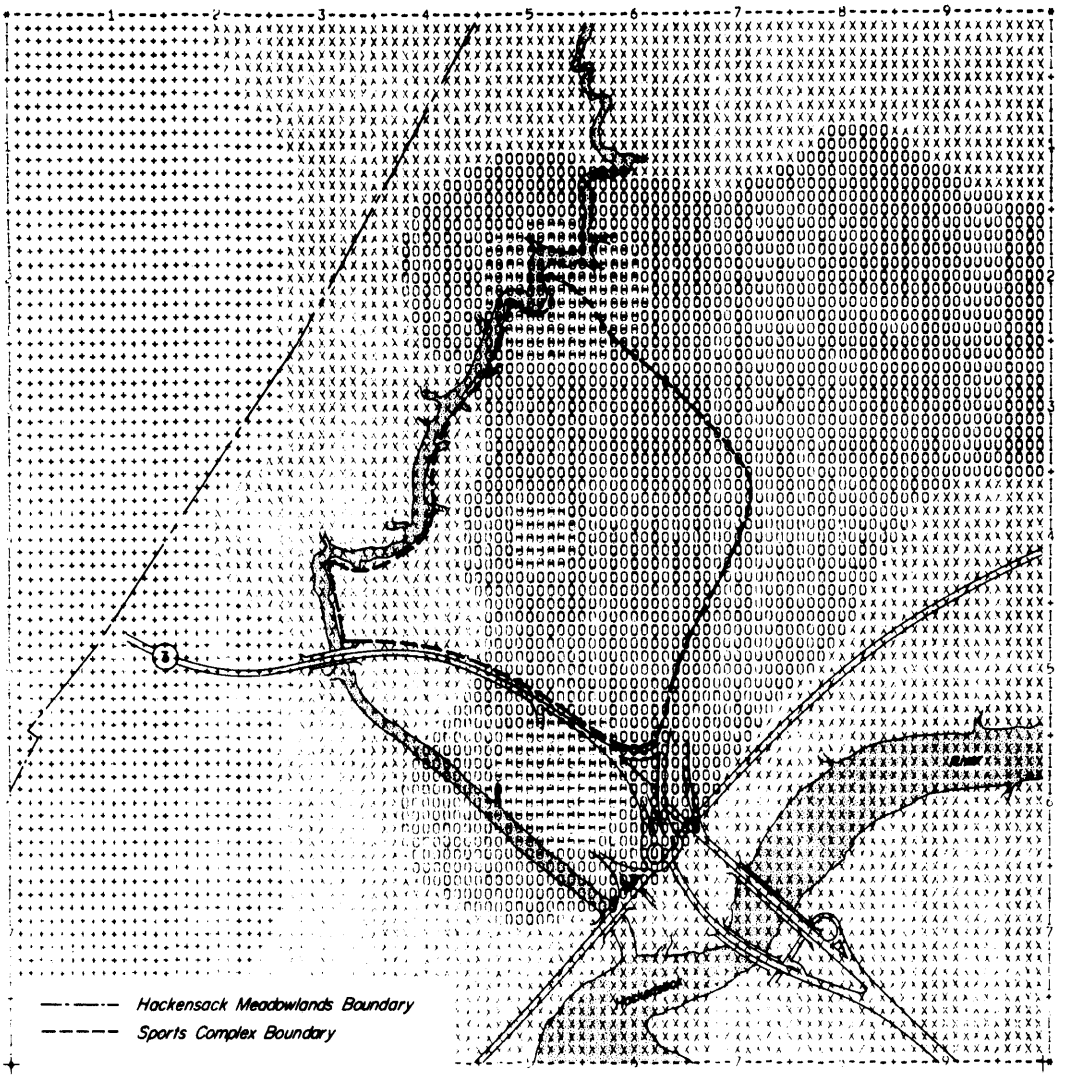
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	.	-	=	+	X	0	H	#	#
FREQ.	0	0	0	1	4	14	4	2	0	0



MANTIK RUN 2950 DATE JUN. 07/72
TSP SOX CO HC NOX

Figure B-16 S, Neutral (100 m.), Football (Enter) - CO



A-4

DATA VALUE EXTREMES ARE 0.41 5.25

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00
MAXIMUM	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

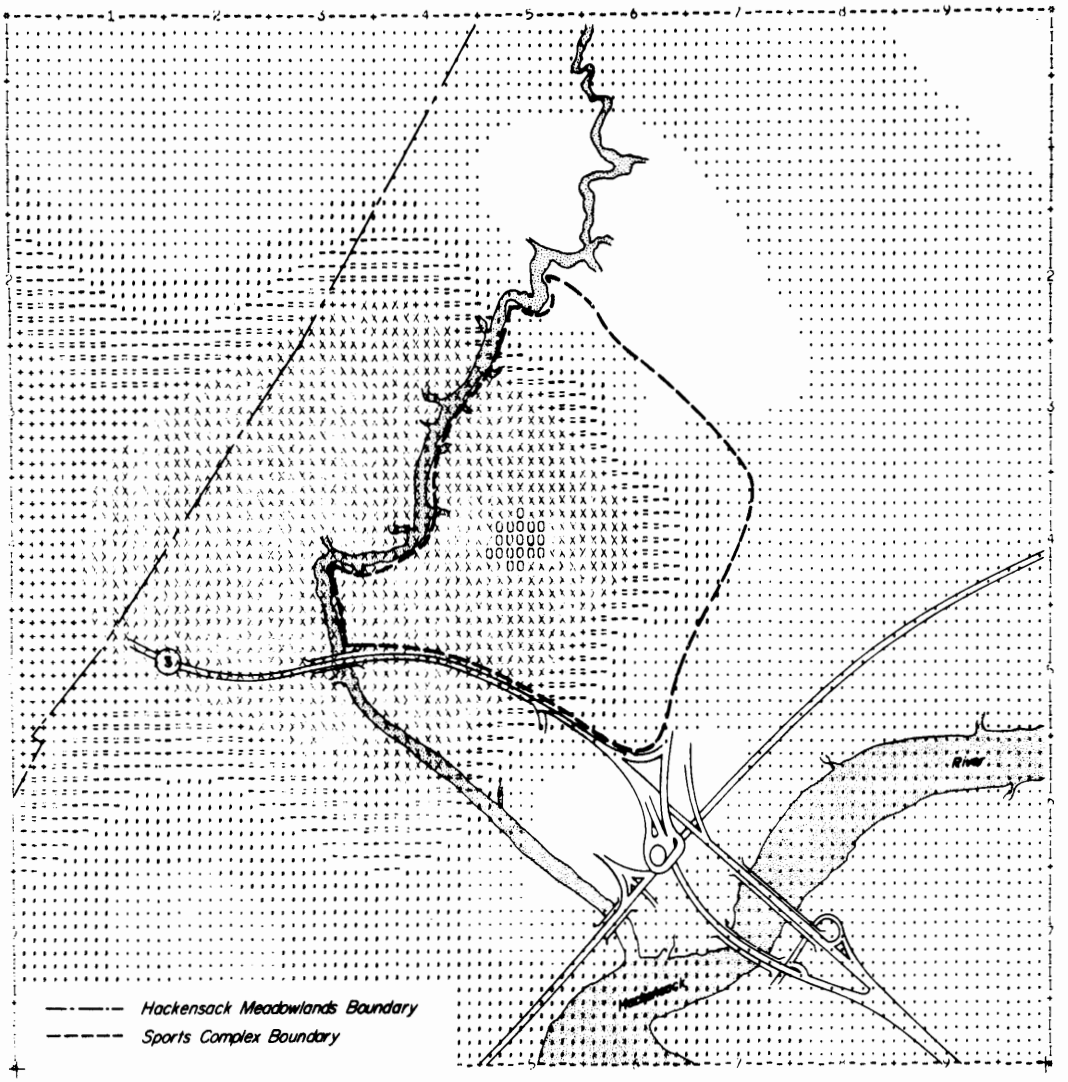
1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	*	-	=	+	X	0	#	@	W
FREQ.	0	0	0	0	6	11	5	3	0	0

MARTIK RUN 2952 DATE JUN. 07/72
TSP SOX CO HC NOX

Figure B-17 WSW, Neutral (100 m.), Football (Exit) - CO



A-5

DATA VALUE EXTREMES ARE 0.48 2.16

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00
MAXIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18

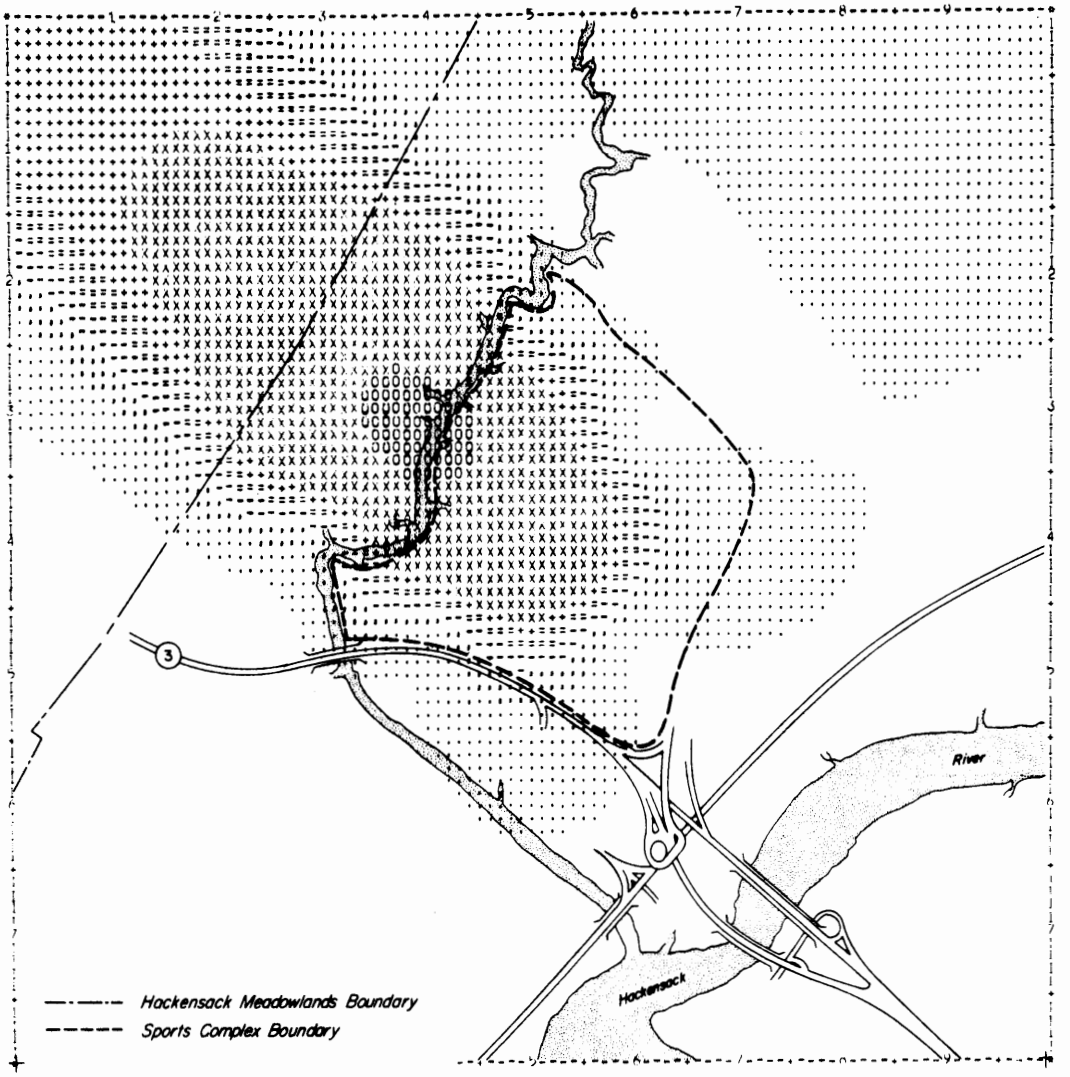
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	L	1	2	3	4	5	6	7	8	9	10
SYMBOLS		.	:	-	=	+	X	0	@	#	*
FREQ.	1	14	4	0	0	2	3	1	0	0	0

MANTIK RUN 2953 DATE JUN. 07/72
TSP SOX CO HC NOX

Figure B-18 E, Neutral, Football (Exit) - CO

PROPERTY OF
NEW JERSEY STATE LIBRARY
186 W. STATE ST. PO BOX
TRENTON, N.J. 08625



B-6

DATA VALUE EXTREMES ARE 0.37 2.45

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00
MAXIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

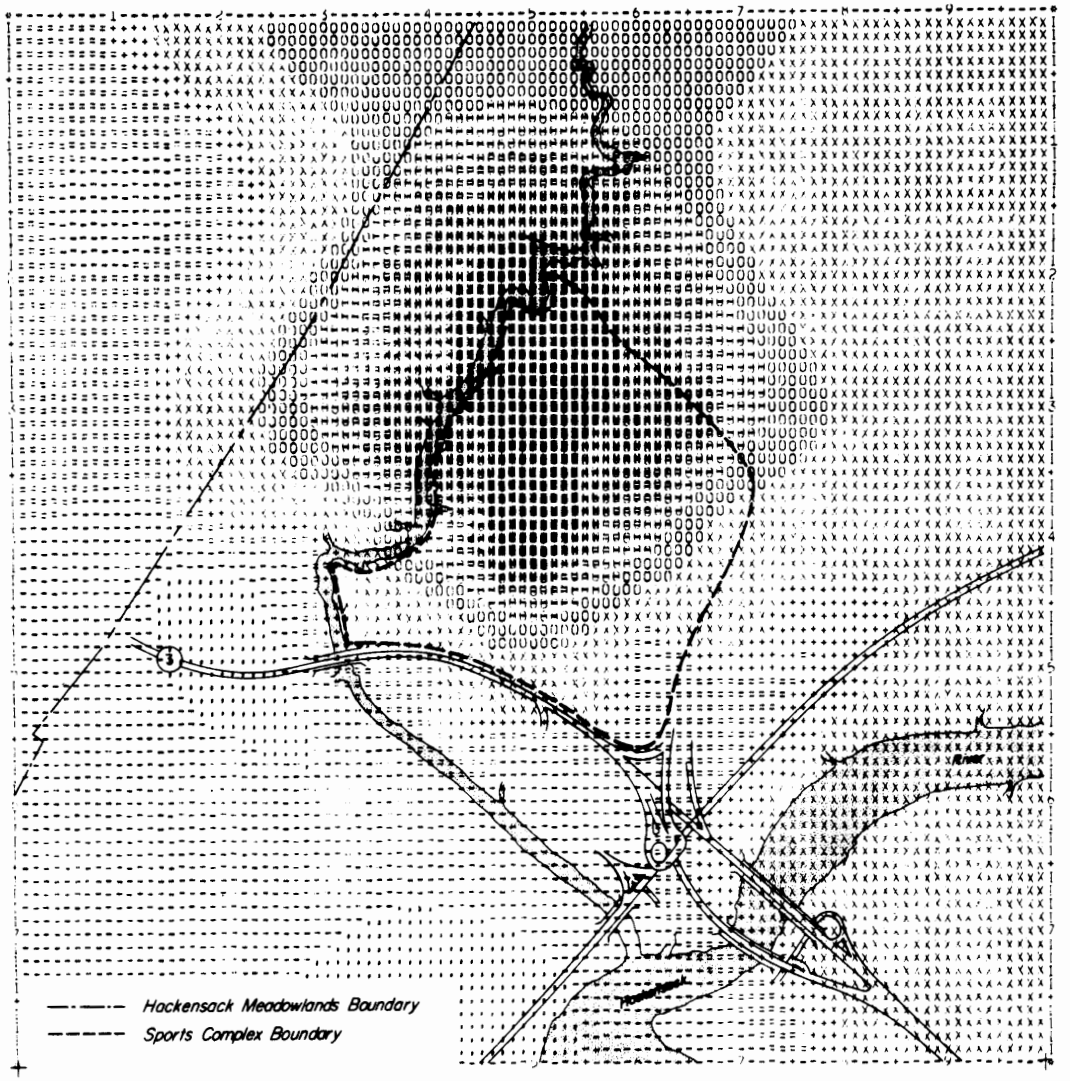
1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	L	1	2	3	4	5	6	7	8	9	10
SYMBOLS		.	#	-	=	+	X	0			
FREQ.	10	9	2	0	0	1	2	1	0	0	0

MANTIK RUN 2951 DATE JUN. 07/72
TSP SUX CO HC NOX

Figure B-19 SE, Neutral, Football (Enter) - CO



A-7

DATA VALUE EXTREMES ARE 0.07 7.35

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

											ABOVE
MINIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00
MAXIMUM	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

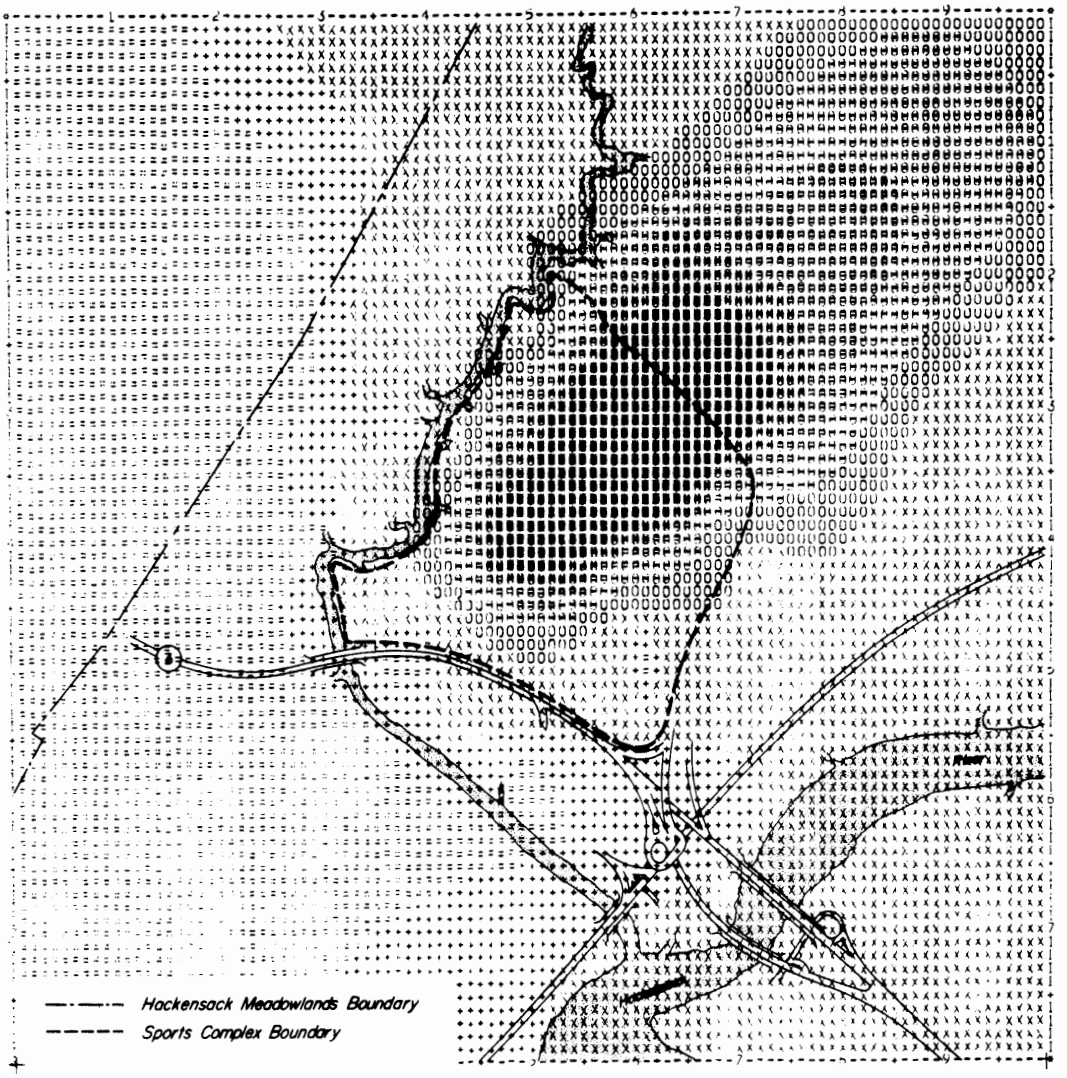
1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18	

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	H
SYMBOLS	.	*	-	=	+	X	0	&	@	#	
FREQ.	0	1	3	4	2	7	2	0	0	4	2

MARTIK RUN 2954 DATE JUN, 07/72
TSP SOX CO HC NOX

Figure B-20 S, Stable, Football (Exit) - CO



A=b

DATA VALUE EXTREMES ARE 0.82 11.98

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

											ABOVE
MINIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00
MAXIMUM	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

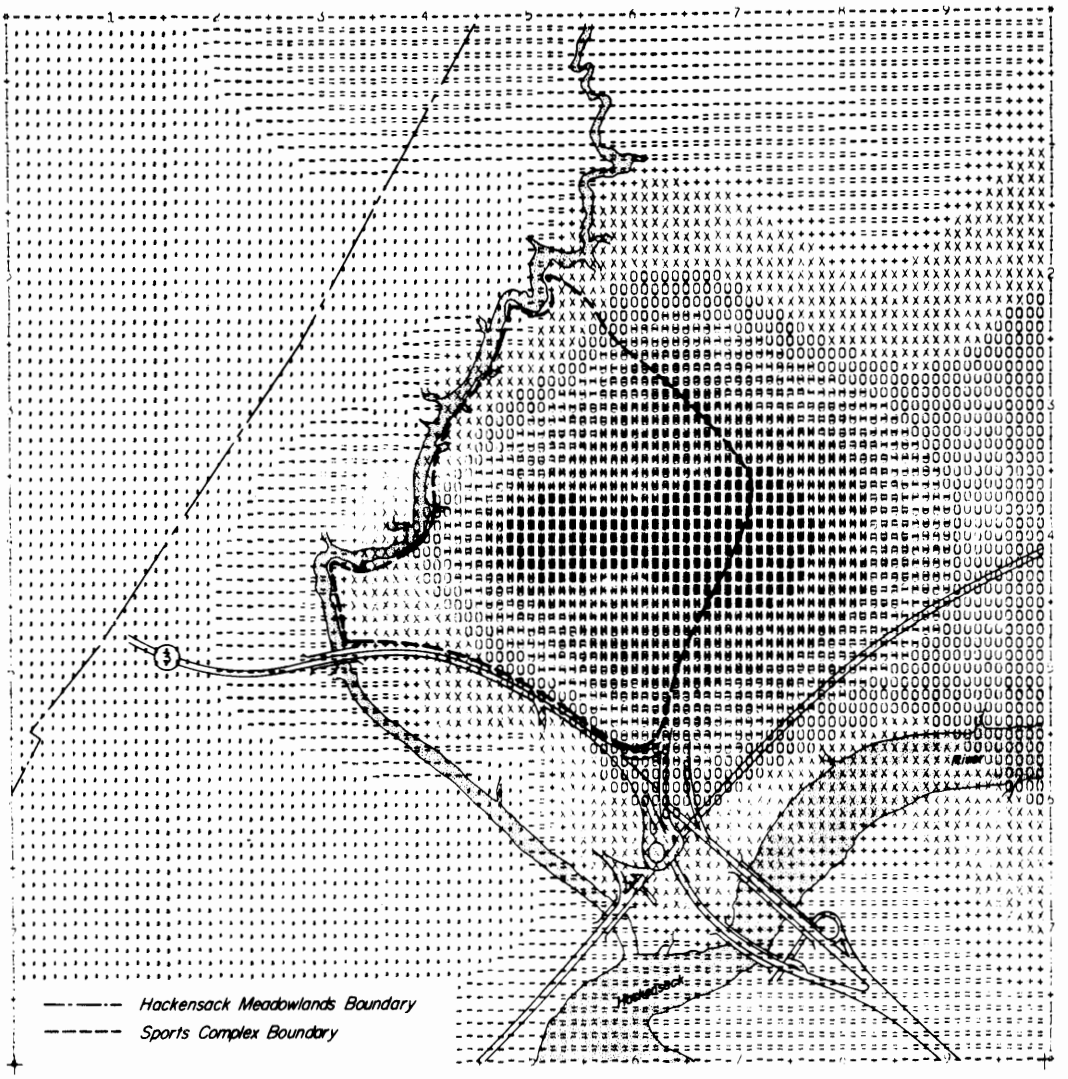
1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18	

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	H
SYMBOLS	.	#	-	=	+	X	0	@			
FREQ.	0	0	0	8	4	8	2	0	1	0	2

MARTIK RUN 2955 DATE JUN, 07/72
TSP SOX CO HC NOX

Figure B-21 SW, Stable, Football (Exit) - CO



A=7

DATA VALUE EXTREMES ARE 0.53 7.29

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

											ABOVE
MINIMUM	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00
MAXIMUM	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

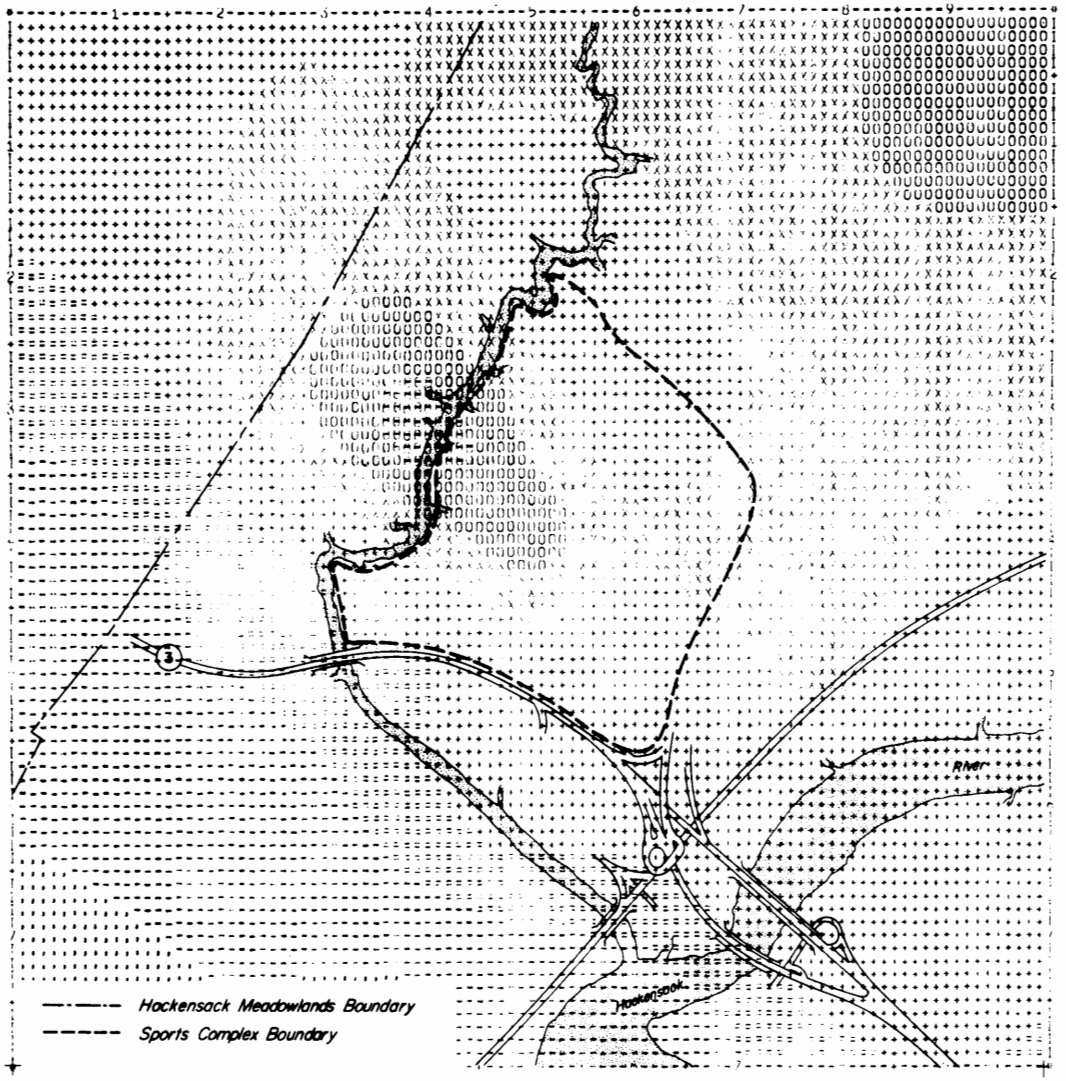
1.82	1.82	1.82	1.82	1.82	18.18	18.18	18.18	18.18	18.18	

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10	H
SYMBOLS	.	*	-	=	+	X	0	#			
FREQ.	0	7	3	7	2	0	2	0	0	2	2

HACKENSACK SPORTS COMPLEX

Figure B-22 W, Stable, Football (Exit) - CO



A-19

PARTICULATES

DATA VALUE EXTREMES ARE 175.00 365.67

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(MAXIMUM DOCUMENTED IN HIGHEST LEVEL ONLY)

MINIMUM	175.00	200.00	225.00	250.00	275.00	300.00	325.00	350.00	375.00	400.00
MAXIMUM	200.00	225.00	250.00	275.00	300.00	325.00	350.00	375.00	400.00	425.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

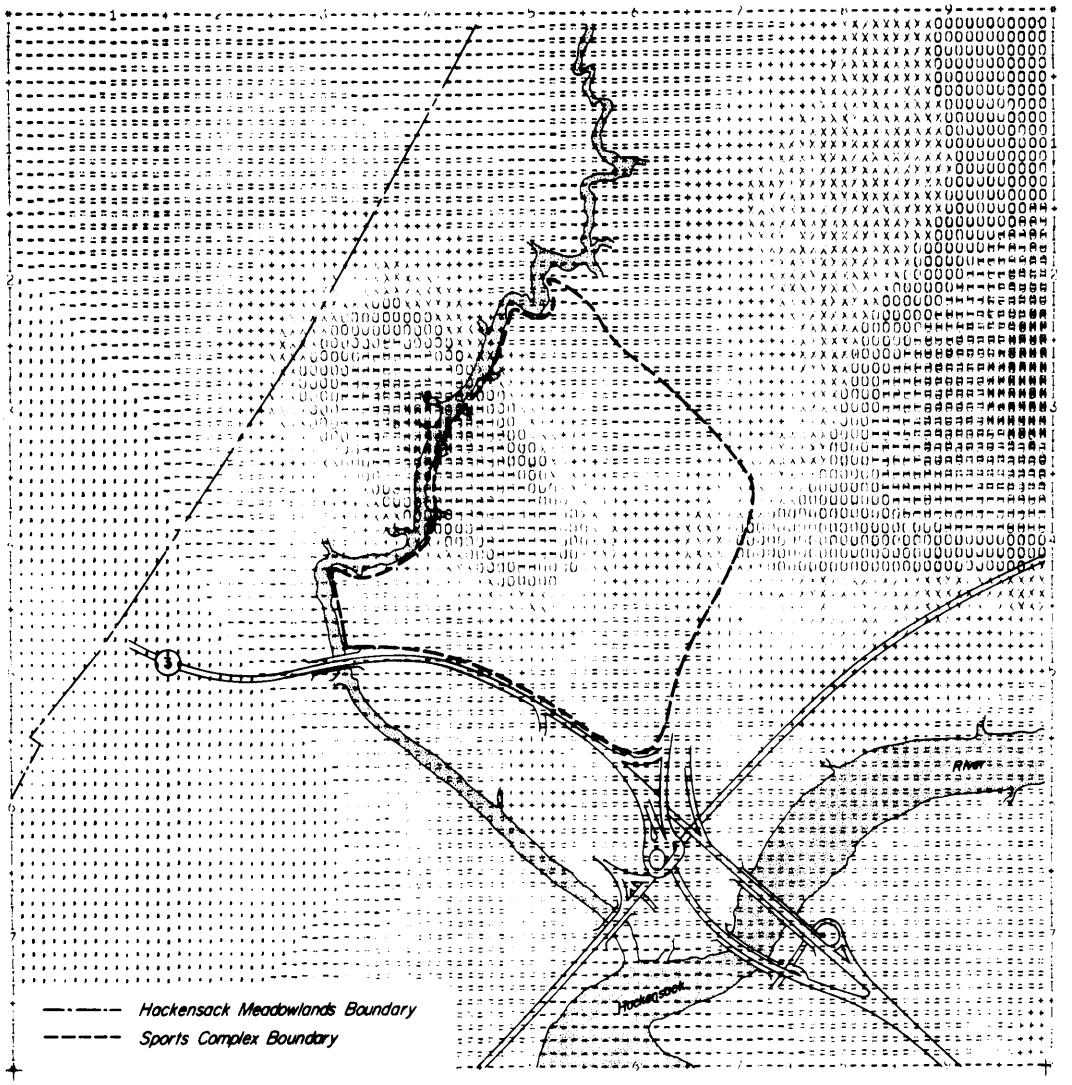
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS										
FREQ.	0	2	3	3	8	6	2	1	0	0

1
2
3
4
5
6
7
8

MARTIN RD. 2999 DATE JUL 08/72
TSP SOX CO HC NOX

Figure B-23 SE, Stable, Football (Exit) - Particulates



A-10
SOX

DATA VALUE EXTREMES ARE 1.75 3.94

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75
MAXIMUM	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

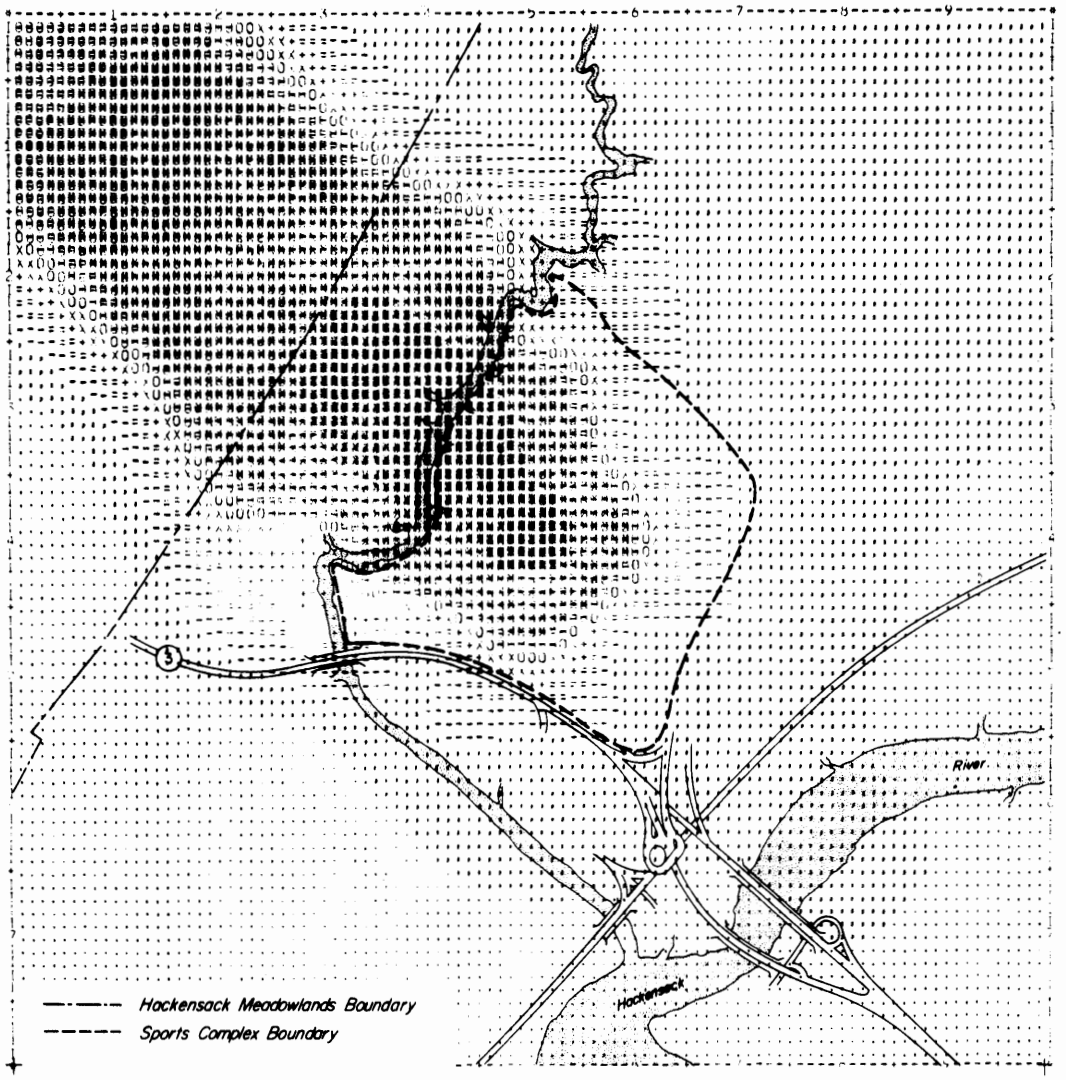
LEVEL 1 2 3 4 5 6 7 8 9 10

SYMBOLS

FREQ. 1 1 3 7 5 3 1 2 1 0 2

MANTIK RUN 2999 DATE JUN. 08/72
TSP SOX CO HC NOX

Figure B-24 SE, Stable, Football (Exit) - SO_2



A-10

CO

DATA VALUE EXTREMES ARE 11.94

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAX.OUT* IS MAXIMUM LEVEL ONLY)

MINIMUM	.0000	.7500	1.000	1.250	1.500	1.750	2.000	2.250	2.500	2.750	3.000	3.250
MAXIMUM	.7500	1.000	1.250	1.500	1.750	2.000	2.250	2.500	2.750	3.000	3.250	6.500

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

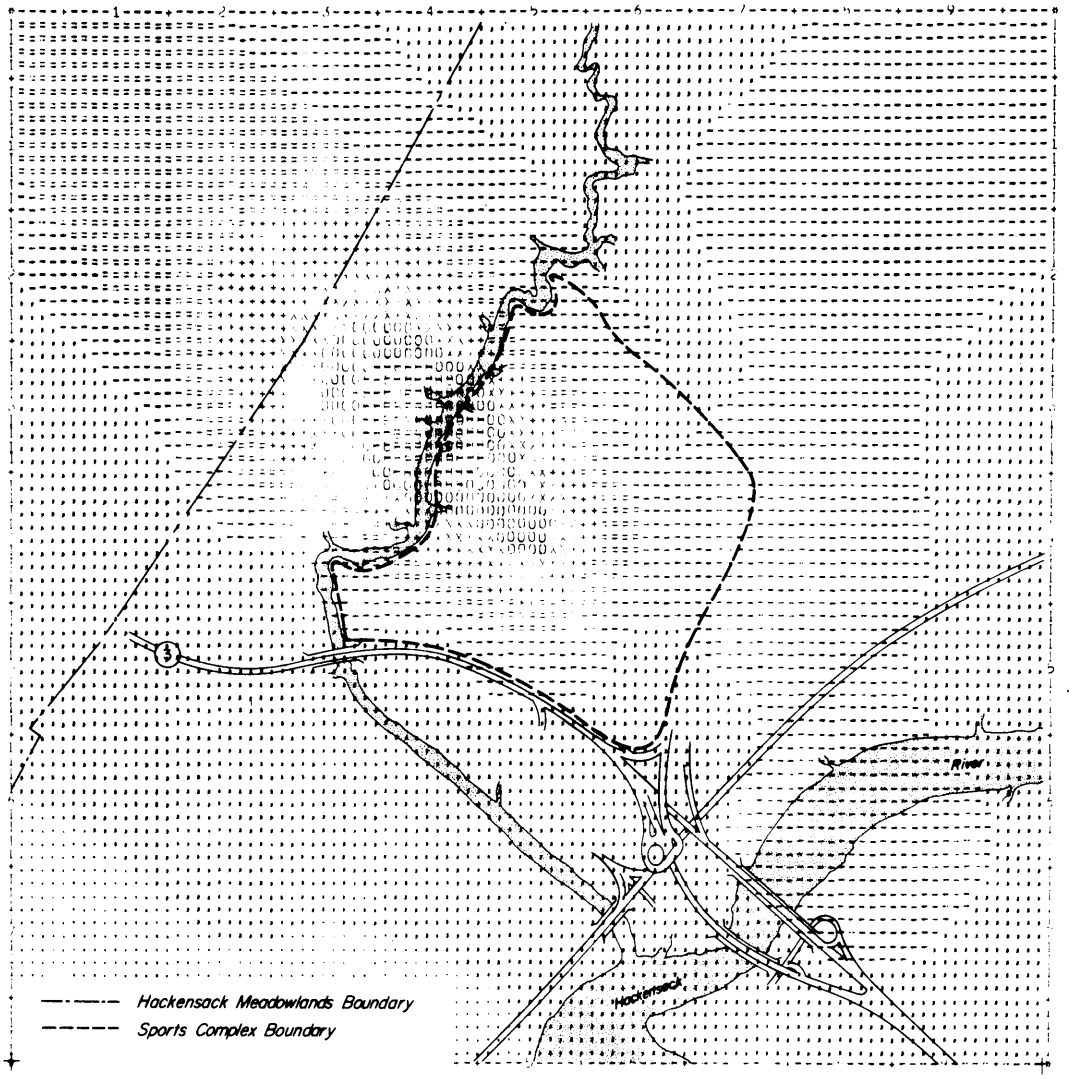
4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	59.09

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS						XXXXXXXXX	000000000	#########	@@@@@@@@@	&&&&&&&&&
FREQ.	3	3	10	0	0	0	2	0	1	0	1

MAKTIK RUN 2999 DATE JUN. 08/72
TSP SOx CO HC NOX

Figure B-25 SE, Stable, Football (Exit) - CO



A-10
HC

DATA VALUE EXTREMES ARE 1429.00 3554.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
("MAXIMUM" INCLUDED IN HIGHEST LEVEL ONLY)

	1	2	3	4	5	6	7	8	9	10
MINIMUM	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00
MAXIMUM	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

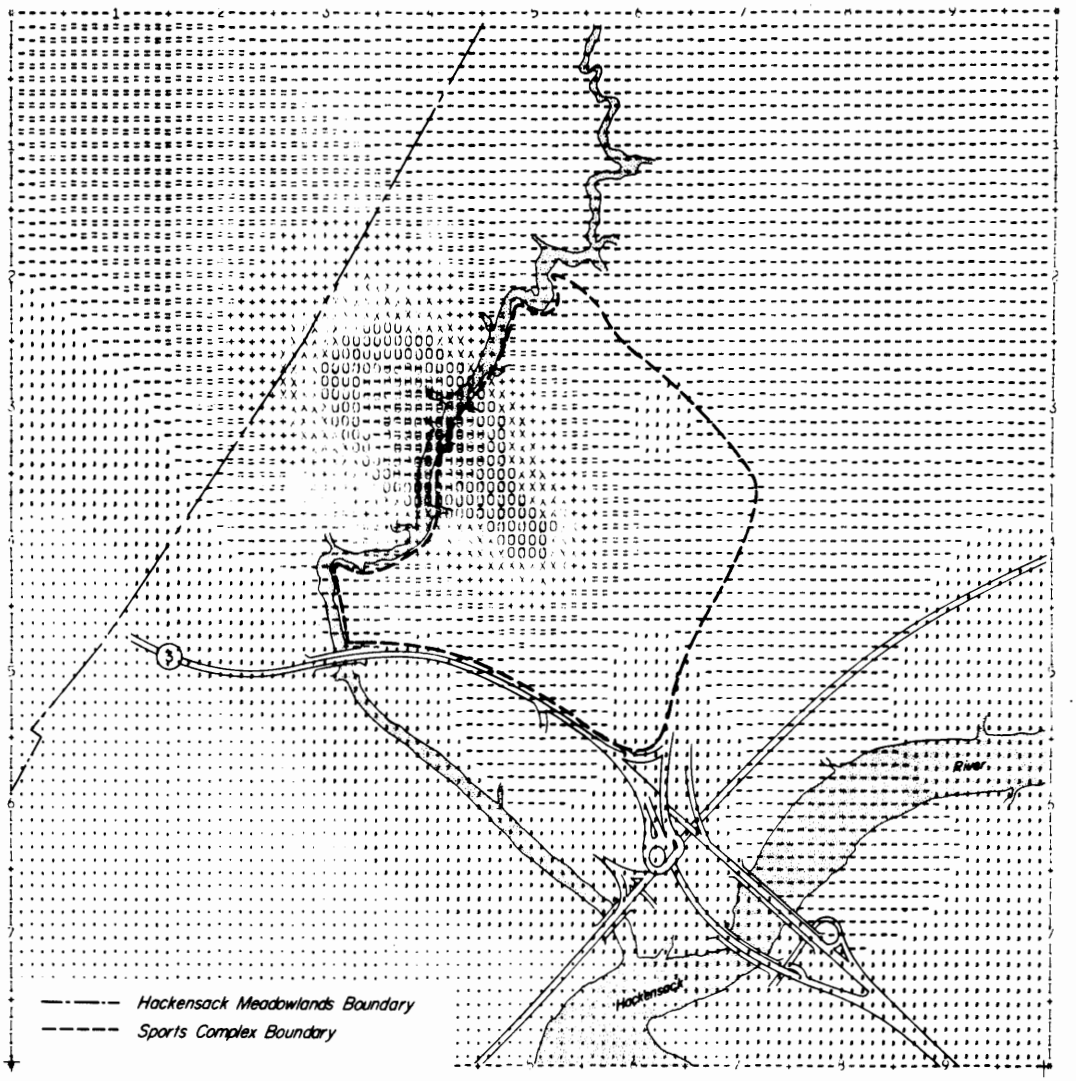
1	2	3	4	5	6	7	8	9	10
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	=	-	+	X	0	#	@	A	B
FREQ.	2	13	7	1	0	0	1	0	0	1

MARTIK RUN 2999 DATE JUN. 08/72
TSP SOX CO HC NOX

Figure B-26 SE, Stable, Football (Exit) - HC



A-10
NOX

DATA VALUE EXTREMES ARE 129.17 350.55

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	125.00	150.00	175.00	200.00	225.00	250.00	275.00	300.00	325.00	350.00
MAXIMUM	150.00	175.00	200.00	225.00	250.00	275.00	300.00	325.00	350.00	375.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.	,	-	=	+	X	0	@	#	M
FREQ.	5	6	11	1	0	0	1	0	0	1



Figure B-27 SE, Stable, Football (Exit) - NO_2

APPENDIX C

Supplementary Technical Data

C.1. GENERAL CONSIDERATIONS

The proposed site of the New Jersey Sports Complex is located within the Hackensack Meadowlands District at the heart of the New York Metropolitan Region. As shown in Figure C-1, the Sports Complex is close to the intersection of two major highways, N.J. Route 3 and the New Jersey Turnpike. Because the various sports activities contemplated for the complex will attract large groups of spectators and because a large number of these spectators will come to the activities in automobiles, the assessment of automotive pollution is of great importance.

The year 1990 was chosen for analysis because: 1) all facilities would be completed at that time and, therefore, a complete analysis of the complex could be made, and 2) sufficient information on surrounding background air quality was available from a current ERT study for the Hackensack Meadowlands area.

We were concerned in this analysis both with the regional and local impact of the facility. In terms of regional impact the concern is with the average annual contribution of the facility to ambient air quality levels. Since the facility is used only on a part time basis and the automotive pollution occurs only on entering and exiting from the facilities we would expect the annual average contribution of the facility to be quite small. The assessment of the microscale or local impact includes consideration of both the average situation and worst case situations. Our preliminary analysis showed that the major contribution to air pollution would result from the automotive pollutants arising from automobiles idling while waiting to enter or leave the parking lots. A characteristic situation

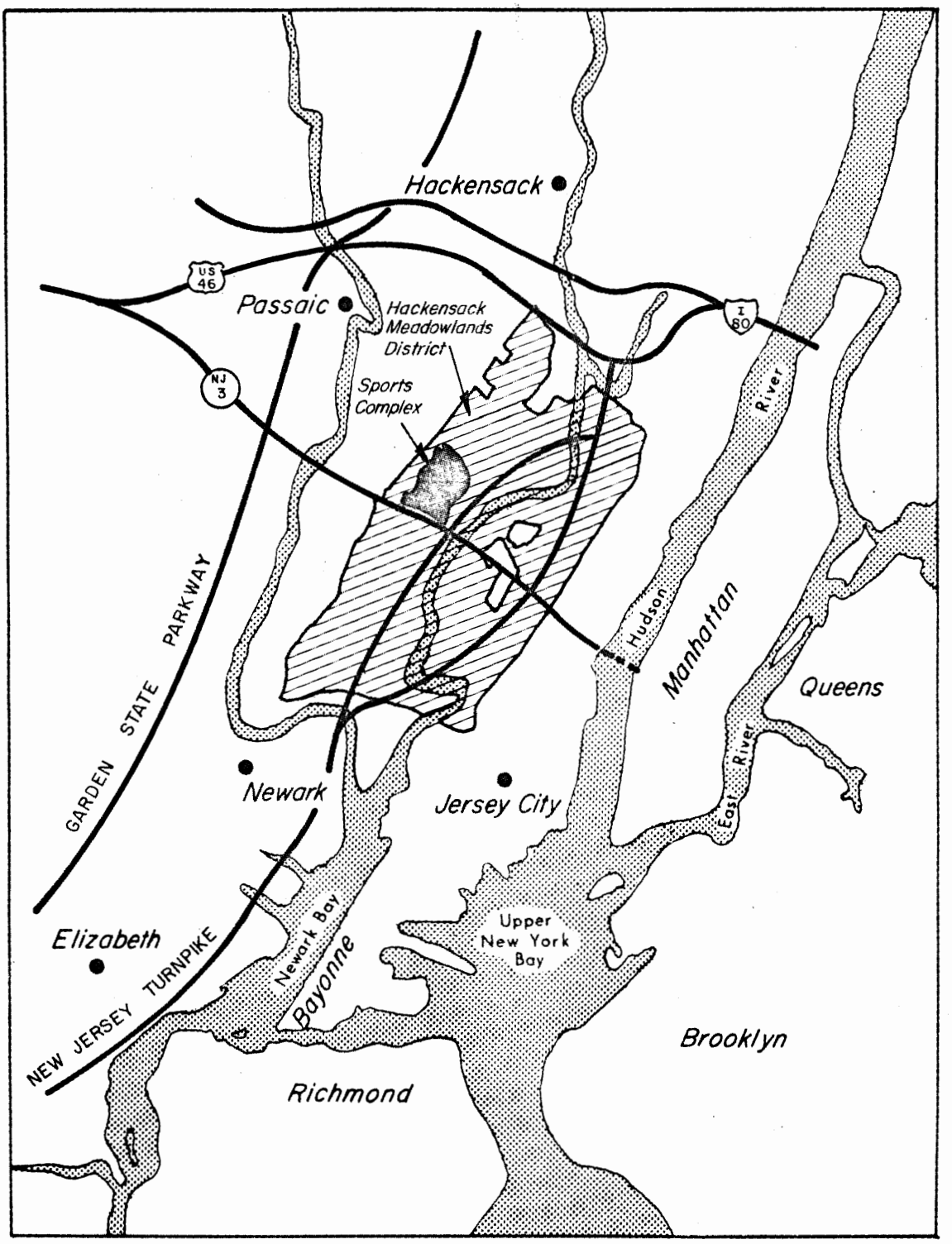


Figure C-1 Location of Sports Complex in New York Region

occurs during a one hour period immediately preceding and following each sports event. In general, the one hour peak period following an event has larger volumes of traffic, while the inbound traffic preceding an event is spread out over a longer period of time. Since these traffic conditions are quite similar for a single event, the distinction between worst and average cases is determined by meteorological conditions.

C.2 SPORTS FACILITY DATA, WORKING ASSUMPTIONS, AND CASES ANALYZED

2.1 Sports Complex Activity Data

Data was provided to ERT by the New Jersey Sports Authority, its architects and engineers, and various other consultants. The data described the possible facilities and enumerated the sports events that might take place at the sports complex. These activities include football and horse racing in the sports complex itself and activities in the adjacent hotel and arena area located between Route 3, Paterson Plank Road, the New Jersey Turnpike, and the Sports Complex boundary.

The activities which may contribute to additional pollution levels include both continuous activities, such as heating requirements at the hotel and in the administrative offices in the stadium complex, and specific scheduled spectator activities, such as the football games, horse races, and arena events. The sources of pollution can be divided into two categories: motor vehicle related, and heating related.

For the motor vehicle related sources, the distribution of motor vehicles on the highway network and idling in the parking lot was considered for football, horse racing, and arena events. For calculation of one hour average concentrations, the conservative assumption was made that the parking lot at the facility would fill (or empty) for the number of automobiles assumed for each activity, during the one hour period. Therefore the average emission rates during the one hour period were calculated with the assumption that one half of the designated number of vehicles were idling for the complete hour in the parking lots and one half of the vehicles were distributed in the road network in the vicinity of the Sports Complex.

Heating sources were determined for the hotel and arena complex and for the stadium and race track complex. A large combination of source distributions and activity levels could be identified in terms of day, evening, or night events, weekday versus weekend events, different seasons of the year, and different sport events.

2.2 Cases Selected for Analysis from Sports Complex Operations

From the numerous combinations of possible facility operations, the cases shown in Table C-1 were selected for specific study. The cases not considered are either similar to those shown in Table C-1 or would yield air pollution impact slightly less than those actually considered. In all situations a conservative approach was used. For instance, for Facility Case "D", which represents the peak exit hour for winter racing, the weekend estimates of automobile traffic were used but a background inventory for a weekday was assumed. This yields slightly greater impact than if the weekday traffic and weekday background were used, or alternatively the weekend traffic and background.

2.3 Discussion of Cases

Each of the cases analyzed requires a brief explanation. Facility Cases "A" and "B" respectively represent the peak exit hour and peak entrance hour for the football games. The entrance hour is noon to 1 pm and the exit hour is 4 to 5 pm, both on an autumn Sunday. The peak hour automobile estimates provided by Wilbur Smith and Associates, the traffic consultants for the sports complex, were used directly. These are shown in the second column in Table C-1. The third column shows the peak hour bus estimates. It was assumed that the same number of buses would be found in

TABLE C-1

SUMMARY OF FACILITY OPERATING CONDITIONS EXAMINED

Facility Class	Peak Hour Auto.	Peak Hour Bus	Heating Load	Background Factors		
				[CO]	[Tsp & SO_2]	[HC & NO_2]
A. Football (peak exit hour) 4-5 p.m.	18,330	400	Average	1.5	1.0	1.0
B. Football (peak entrance hour) 12-1 p.m.	14,700	400	Average	1.5	1.0	1.0
C. Winter Racing (peak entrance hour) 12 noon, weekday	6,400	100	cold winter day; 3 x average	1.0	2.0	1.0
D. Winter Racing (peak exit hour) 5 pm, weekday	8,000	100	cold winter day; 3 x average	3.0	2.0	1.0
E. Summer Racing (peak entrance hour) 1 pm, weekend	6,400	100	(none)	1.0	0.5	1.0
F. Summer Racing (peak exit hour) 6 pm, weekend	8,000	100	(none)	1.5	0.5	1.0
G. Arena (peak exit hour) midnight, weekday	5,400	30	average	1.0	1.0	1.0
H. Combined: Summer Racing & Arena (peak exit hour) 6 pm, weekend	13,400	130	(none)	1.5	0.5	1.0
I. All facilities average hourly use*	500	5	average	1.0	1.0	1.0

*Based on 2 hours (peak), 200 days per year; average of 10,000 autos and 100 buses per hour.

the peak entrance hour as had been estimated for the peak exit hour. For the autumn case the space heating load from the hotel arena complex and the stadium race track complex are considered to be average.

These localized sources are added to the region-wide background air quality concentration resulting from all sources in the Greater New York area and the specific sources of the Hackensack Meadowlands Master Plan projections. Since concentrations resulting from these background sources were determined on an annual average basis, adjustments had to be made for each of the facility cases examined to account for seasonal differences and other factors.

Since the Autumn is representative of the annual average in most cases, a factor of 1.0 was used for all pollutants except carbon monoxide for Facility Cases "A" and "B". The adjustment factor of 1.5 for carbon monoxide represents the fact that 1) carbon monoxide levels are mainly a function of automotive sources, and 2) the average automobile usage for the hour modeled is 1.5 times the average of a 24-hour day.

Cases "C", "D", "E", and "F" all represent different assumptions for racing events. "C" and "D" represent winter weekday racing, whereas "E" and "F" represent summer weekend racing. Inferences can be drawn from these for all harness racing and for winter weekend and summer weekday thoroughbred racing. Facility Case "C" uses the peak hour bus and auto entrance traffic estimated by the traffic engineers for the weekend event. As mentioned, this is a conservative analysis since the weekend traffic volume is expected to be greater than that for the weekday. Similarly, a relatively cold winter day is presumed and therefore the heating load for the hotel and arena space heating and the race track heating is assumed to be three times the annual average. Likewise, since background concentrations for particulates and

sulfur dioxide are very much a function of space heating demand, a background factor of 2.0 was assigned for these pollutants. No statistical variation in hydrocarbon and nitrogen dioxide for particular source categories could be identified for the background inventory. Therefore no variations in background factors were made. For carbon monoxide, it was assumed that noon on a weekday would be close to the 24 hour average traffic volume.

Similar assumptions were made for Facility Case "D", winter racing, with one exception: since 5 pm weekday exit hour was postulated, it was assumed that rush hour automobile traffic for the region would coexist. Therefore the background factor for carbon monoxide was set at 3.0.

Local traffic volumes for the summer racing cases, "E" and "F", were set at the same levels as winter racing for the purpose of comparison. Since our assumptions as to heating load postulate the use of distillate oil for heating and a central electric cooling system, no load for heating was assigned to summer racing. Reductions in space heating requirements as they influence particulates and sulfur dioxide background levels are reflected in a background factor of 0.5. Finally, carbon monoxide background factors of 1.0 and 1.5 were used for the entrance and exit hours, respectively.

The arena case "G" was examined for an average day for the peak exit hour occurring at midnight on a weekday. The heating load and all background factors were considered to be average for this case.

Among all the possible sporting event combinations that may exist, several situations can occur where multiple events take place. The one of greatest potential impact is summer racing and arena events on a weekend evening. The peak exit hour for this case was examined for Facility

Case "H". All parameters except the local traffic were assumed to be the same as the summer racing case.

Finally a case was determined that would be representative of the average annual impact of all facilities. The average annual impact takes into account the number of days and hours of operation of all facilities throughout the year. Based on the data provided by the Sports Authority and its various consultants, it was assumed that the facilities would be used on an average of 200 days per year with two hours of peak traffic per day and an average of 10,000 autos and 100 buses per hour. This yields the 500 autos per hour and 5 buses per hour shown under Case "I". Since most of the heating load is due to the hotel and administrative offices and therefore independent of facility usage, the heating load was assumed to be average. Likewise, the background factors are automatically considered to be 1.0 for this case.

C.3. AIR QUALITY MODELING DATA & PROCEDURES

3.1 Model Description

The model used for the dispersion calculations is called MARTIK in the ERT program library. It is a gaussian plume model which follows the physical and mathematical basis described by Martin and Tikvart (1968). The model has been modified to improve computational accuracy for receptors near source areas, to permit tradeoffs between accuracy requirements and computation time, and to permit improved flexibility in the treatment of rectangular area sources of any size and orientation.

The general MARTIK program provides for calculations both in an averaging mode and in an instantaneous mode. In the instantaneous mode fixed values of the three basic meteorological parameters (wind speed and direction, and stability class) are used to determine the concentration pattern at a specific time. The instantaneous mode of calculation has been used in the present study for the calculation of one hour average concentrations in the vicinity of the Sports Complex.

In the averaging mode, MARTIK uses joint frequency of occurrence data for the basic meteorological parameters to calculate long period (e.g. annual) average concentration patterns. In this study the average impact of the Sports Complex facilities was calculated with the MARTIK averaging mode, using annual average meteorological data based on a ten year record (1956 - 1965) of hourly observations at Newark Airport.

A detailed description of the ERT/MARTIK program is contained in the report "Development and Validation of a Modeling Techniques for Predicting Air Quality Levels for the Meadowlands Planning Region", submitted by ERT

to the New Jersey Department of Environmental Protection.

3.2 Current Air Quality & Model Calibration

As a part of our study of air pollution for the Hackensack Meadowlands for 1990, we examined current levels of air quality for the purposes of calibrating the diffusion model. Measurements of five pollutants (particulates, sulfur dioxide, carbon monoxide, hydrocarbons, and nitrogen dioxide) from two to five monitoring sites operated by the N.J. Dept. of Environmental Protection were averaged to produce an annual average value for the Meadowlands as shown in Table C-2. The actual monitoring sites are shown in Figure C-2. Comparing of the measured annual average values shown in Table C-2 with the annual air quality standards in Table 2 (of Chapter 3), we find that standards are currently exceeded for all five pollutants.

The lower portion of Table C-2 presents the calibration coefficients used in the ERT model study of the Hackensack Meadowlands. These same coefficients were used in the present study. Thus, for example, the concentrations of CO calculated by the dispersion model are multiplied by the factor 1.70 to produce the estimates of CO concentration reported in this study.

3.3 Meteorological Conditions Analyzed

Preliminary calculations indicated that the maximum air pollution impact resulting from activities at the Sports Complex would result from motor vehicle operation, and this impact would occur primarily in the first few kilometers surrounding the site. The annual wind rose for Newark (Figure C-3) indicates that,

TABLE C-2

CURRENT AIR QUALITY LEVELS

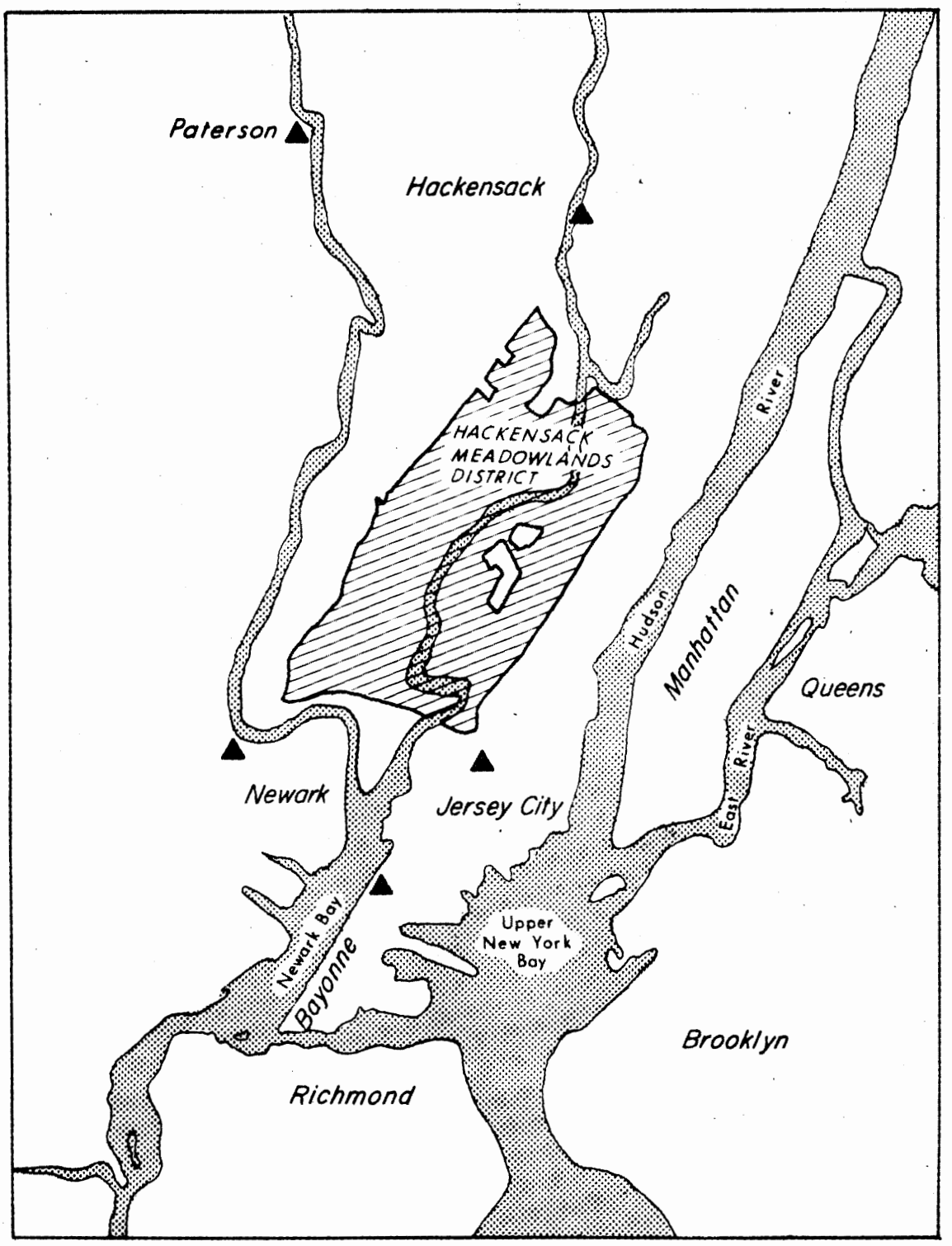
1970 Average Annual Concentrations, based on New Jersey Department of Environmental Protection Measurements at Five Monitoring Sites.

(HC and NO_2 at Newark and Bayonne only)

Particulates	113.3	$\mu g/m^3$
SO_2	0.043	ppm
CO	4.24	ppm
HC	2.09	ppm
NO_2	0.113	ppm

Calibration Constants applied to model calculations; based on annual data and derived for the Hackensack Meadowlands Air Pollution Study.

Particulates	1.19
SO_2	0.66
CO	1.70
HC	2.02
NO_2	0.614



▲ Validation Sites

Figure C-2 Current Air Quality Monitoring Sites

5215

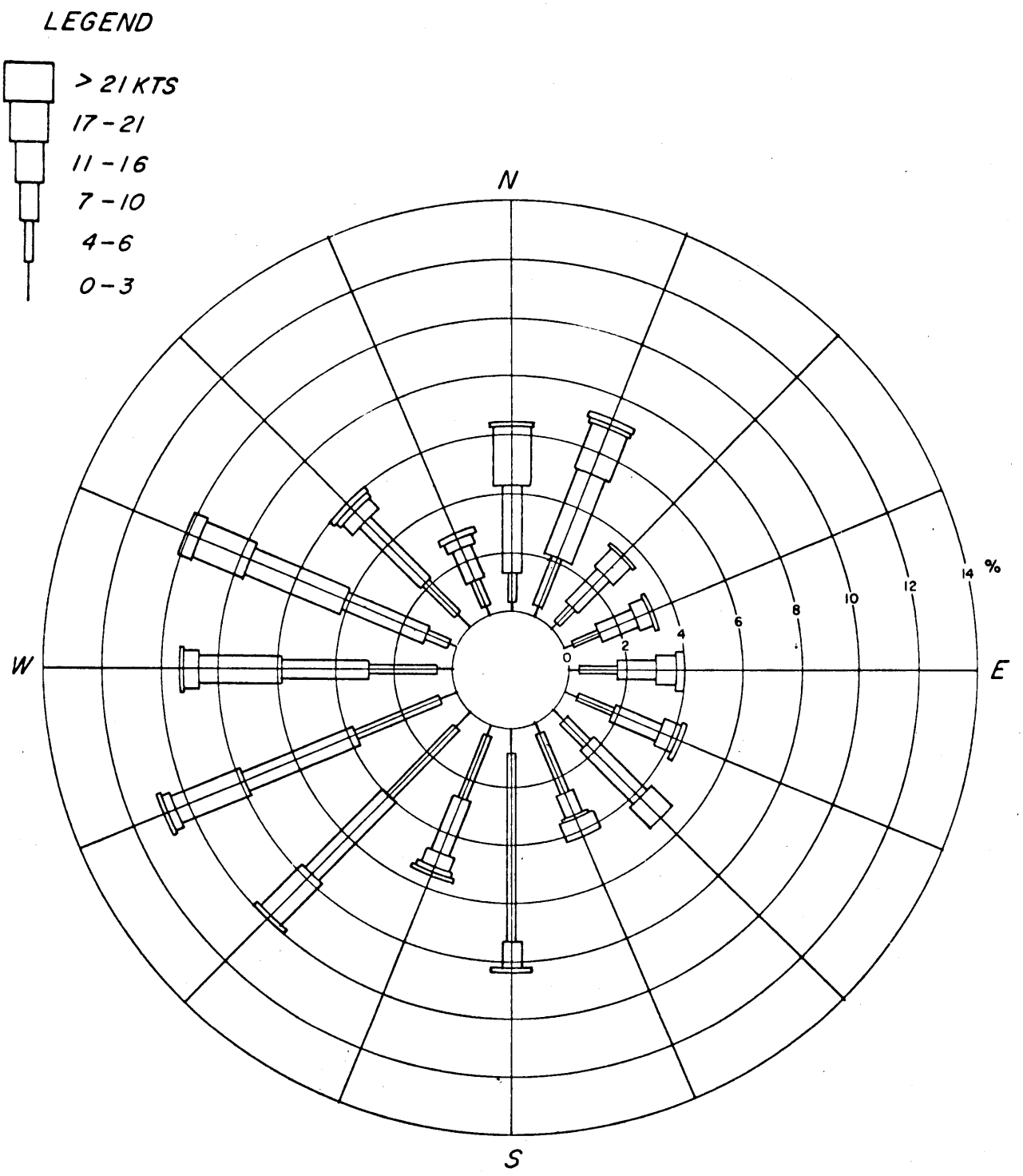


Figure C-3 Annual Newark Wind Rose

5096

while winds with westerly components are more frequent than those from the east, all wind direction and speed combinations occur with non-vanishing frequency. Therefore the wind directions selected for worst case calculations were chosen to maximize the contributions of the major pollutant source regions in New York City and New Jersey. Directions in an arc from SE through S to W were used in the calculations.

Table C-3 summarizes the meteorological conditions examined in the study, and indicates the facility operation cases studied for each meteorological condition. Daytime facility activities were modeled by neutral stability conditions and by 200 and 100 meter mixing depths. Evening and night operations were modeled by the stable category and by 100 meter mixing depth in all cases.

Table C-4 indicates the probability of occurrence of light wind speeds and neutral and stable atmospheric conditions in the vicinity of the Sports Complex. Based upon these data it is expected that stable conditions with approximately 2 meter/sec winds (the cases which result in the highest calculated concentrations) will occur approximately 5% of the time. Also, the light-to-moderate winds, with both stable and neutral conditions, can be expected to occur approximately 30% of the time.

3.4 Emissions Data & Assumptions

The impact of the various sports facilities on ambient air quality levels is a function of the source emissions and the meteorological conditions. Likewise, the source emissions are a function of the usage of the facilities in terms of automobile traffic and space heating as well as the emission factors used to translate this usage into emission levels. Table C-5 summarizes all of the emission factors used in our analysis.

TABLE C-3

SUMMARY OF METEOROLOGICAL CONDITIONS

Meteorological Condition (Met. Code)	Wind Direction	Speed	Stability Class*	Mixing Depth	A	B	C	D	E	F	G	H	I
1	S	2	Neutral	200		X							
2	S	2	Neutral	100		X							
3	WSW	2	Neutral	200			X		X				
4	WSW	2	Neutral	100	X								
5	E	4	Neutral	200	X		X		X				
6	SE	4	Neutral	200		X	X		X				
7	S	2	Stable	100	X								
8	SW	2	Stable	100	X			X		X	X	X	
9	W	2	Stable	100	X						X		
10	SE	2	Stable	100	X			X		X	X	X	
11	- - Annual Wind Rose --		Various		X	X	X	X	X	X	X	X	X

*Corresponds to Turner-Pasquill categories 4 (neutral) and 5 (stable).

TABLE C-4
Frequency of Occurrence of Light Wind Speed Cases
and Neutral and Stable Conditions Observed at Newark Airport

Wind Speed Category / Stability	0 - 3 knots	4 - 6 knots	7 - 10 knots
Neutral	1.8%	8.1%	18.8%
Stable	4.5%	14.0%	9.0%

TABLE C-5

1990 EMISSION FACTORS USED IN ANALYSIS

1. Motor Vehicle

	Tsp	SO_2	CO	HC	NO_2	Units
Automobile	0.19	0.11	3.01	0.27	0.41	mg/m
Diesel Bus	0.69	2.47	2.19	0.22	0.47	mg/m
Idling Auto.	0.45	0.50	45.9	5.7	1.83	mg/sec.

Assumptions:

- Automobile and diesel bus factors derived from EPA data for use with ERT Hackensack Meadowlands Air Pollution Study.

- Idling auto factors derived on basis of the following:

  a. Current EPA data show emissions per hour for CO and HC nearly constant for urban speeds; e.g., the total emissions per vehicle in an hour are nearly the same, regardless of average speed.

  b. 1970 idling emission factors were derived using 10 mph speed emission factors for CO and HC, and average urban factors for the other pollutants; the exhaust characteristics at idle are very similar to those at an average speed of 10 mph, which includes a lot of idling, stop and go.

  c. 1990 idling factors were assumed to have the same proportional reduction (1970 to 1990) as the emission factors for moving automobiles; this assumption had been suggested previously by EPA.

2. Space Heating

For average conditions, heating of approximately:

1,000,000 sq. ft., hotel and arena area
200,000 sq. ft., stadium and race track area

Average space heating demand of 20 BTU/sq. ft/hr. or 24,000,000 BTU/hr.

For distillate oil, approximately 150,000 BTU/gal. or 1600 gal/hr.

1990 emission factors, derived for Hackensack Meadowlands Air Pollution Study in consultation with EPA:

Particulates	6.81 g/gal.
SO_2	5.00
CO	0.09
HC	1.36
NO_2	10.90

These are sub-divided into motor vehicle emission factors and space heating assumptions.

EPA has been analyzing and updating automotive emission factors as the result of ongoing test procedures. However all assumptions as to emission factors for 1990 remain speculative and quite controversial. ERT has made a practice of using the latest available emission factors provided by EPA for all of its highway related studies. The emission factors shown for automobile and diesel buses for 1990 in milligrams per meter in Table C-5 represent such an approach. These factors were derived as part of ERT's ongoing Hackensack Meadowlands air pollution study and represent the best assumptions available as to vehicle behavior for this region.

No data has been published or is specifically available however to represent emissions from idling automobiles. In the past, ERT has used rough estimates made in conjunction with EPA to represent small sources of idling automobiles. However, because this category is of such utmost importance to this particular study, we endeavored to do a more detailed analysis of the appropriate emission factors. The assumptions used are listed in Table C-5. Idling automobile factors were derived on the following basis: Current EPA data shows emissions per hour for carbon monoxide and hydrocarbon to be nearly constant for urban speeds (total emissions per vehicle in an hour are nearly the same); accordingly, we developed an idling factor representative of current emissions and then projected this forward to 1990 based on a proportional reduction in the idling emission factors relative to the emission factors characteristic of moving automobiles. In the first case, the numbers generated for 1970 are consistent with measurements actually made for similar situations. In the second case, no information is available to make a better assumption than a proportional reduction

in the idling factors.

The procedures used to derive emissions and emission factors for space heating are more straight forward although numerous steps are involved. The specifications for the Sports Complex are adequate to determine heating demand only for the stadium. In the case of the hotel, the arena, the race track and other facilities, insufficient data is available to determine the appropriate amount of square footage to be heated. However, based upon the incomplete data, a value of a million square feet was assigned to the hotel and arena area and 200,000 sq. ft. to the stadium and race track area. Based upon the ERT Hackensack Meadowlands air pollution study, an average space heating demand of 20 BTU's per square foot per hour was assigned yielding a total demand of 24 million BTU's per average hour. If the facilities are to contain their own heating system, as opposed to the use of electric heat as proposed in the design specifications, the fuel most likely to be used is distillate oil. This has a heating value of approximately 150,000 BTU's per gallon of oil. Therefore, 1600 gallons per hour would be required. Finally, Table C-5 shows the 1990 emission factors (as derived in the Hackensack Meadowlands air pollution study) which were applied to this average number of gallons per hour demand to generate average space heating emissions for the two portions of the complex.

3.5 Emission Source Configuration

The traffic consultants determined the proportional allocation of automobiles to a highway network for any given entering and exiting traffic volume. It should be pointed out that those estimates assumed that the proportional assignment would be the same regardless of the event.

Figure C-4 shows the assignments made. The numbers circled represent the actual percentages of the total automobile volume whereas the numbers in boxes represent the proportion of the bus volumes. All of the bus traffic is assumed to go on New Jersey Route 3 to the east or on the New Jersey Turnpike North or South. In terms of automobile traffic by far the greatest amount comes from the East and Southeast of the Sports Complex, reflecting the large concentration of population in the New York City area.

The diffusion model used for our studies accepts information on highway sources approximated as straight line segments between two end points. Figure C-5 shows the characterization of the highway network shown in Figure C-4 as line sources for modeling purposes. Line sources A through P represent each of the highway links for which automobile emissions were determined. Figure C-6 shows the same network but with sources Q through U representing the line sources for which bus emissions were estimated.

The sports complex contains many parking lots which are the major source of emissions during the peak exit hour and to a lesser extent during the peak entrance hour. The idling emissions from these parking lots were represented in the modeling by a uniformly distributed area source of one square kilometer as shown by Source V in Figure C-7. The size and location of this source is designed to 1) abstractly represent all of the parking lots and 2) to give the best accuracy in model calculations as a function of the relationship between source and receptor locations. Finally, Sources W and X, as shown in Figure C-7, represent respectively the space heating demand for the stadium and race track area, and for the hotel and arena areas.

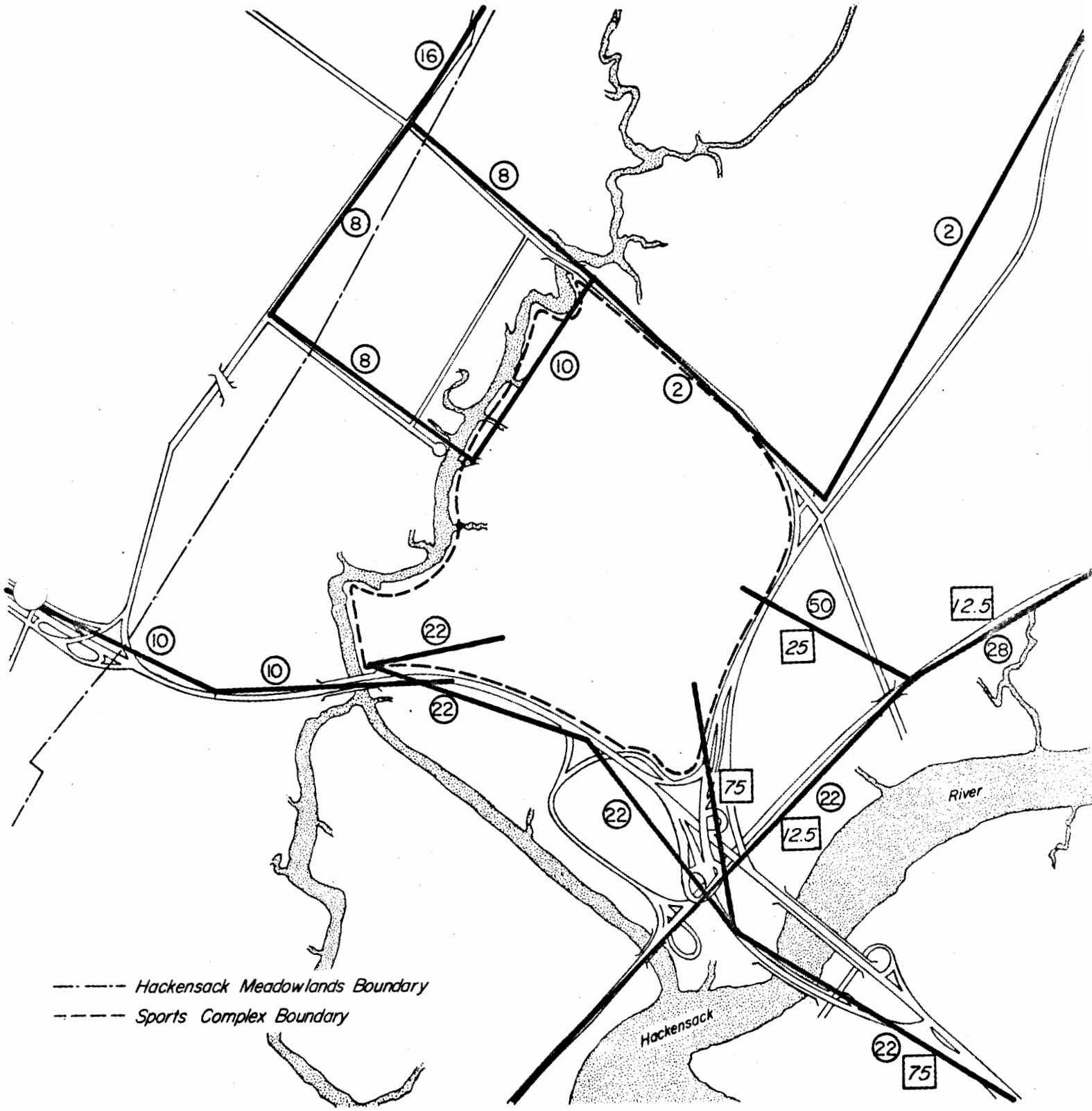


Figure C-4 Allocation of Traffic to Highway Network

○ = car % by direction

□ = bus % by direction

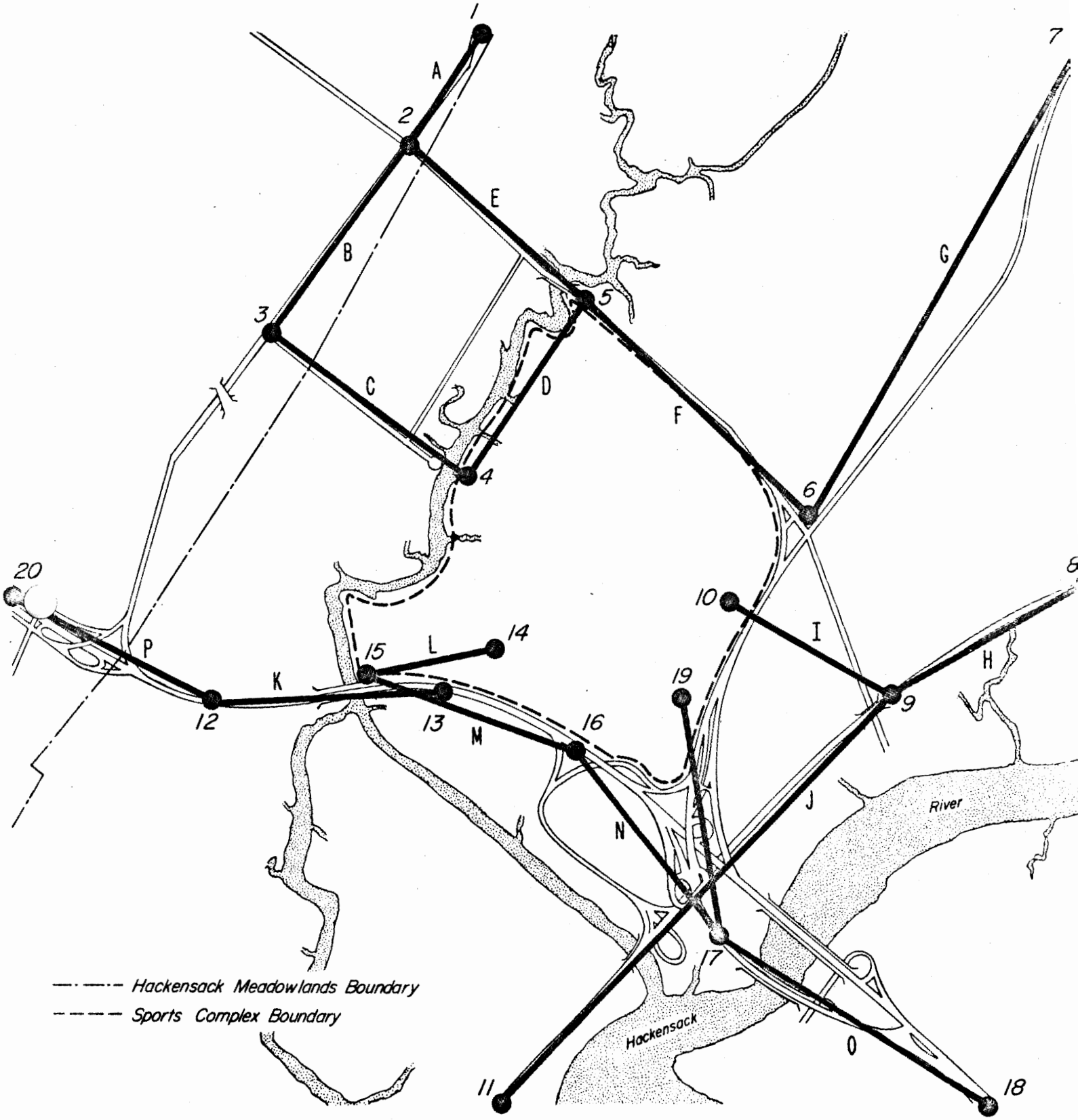


Figure C-5 Automobile Line Sources

5212

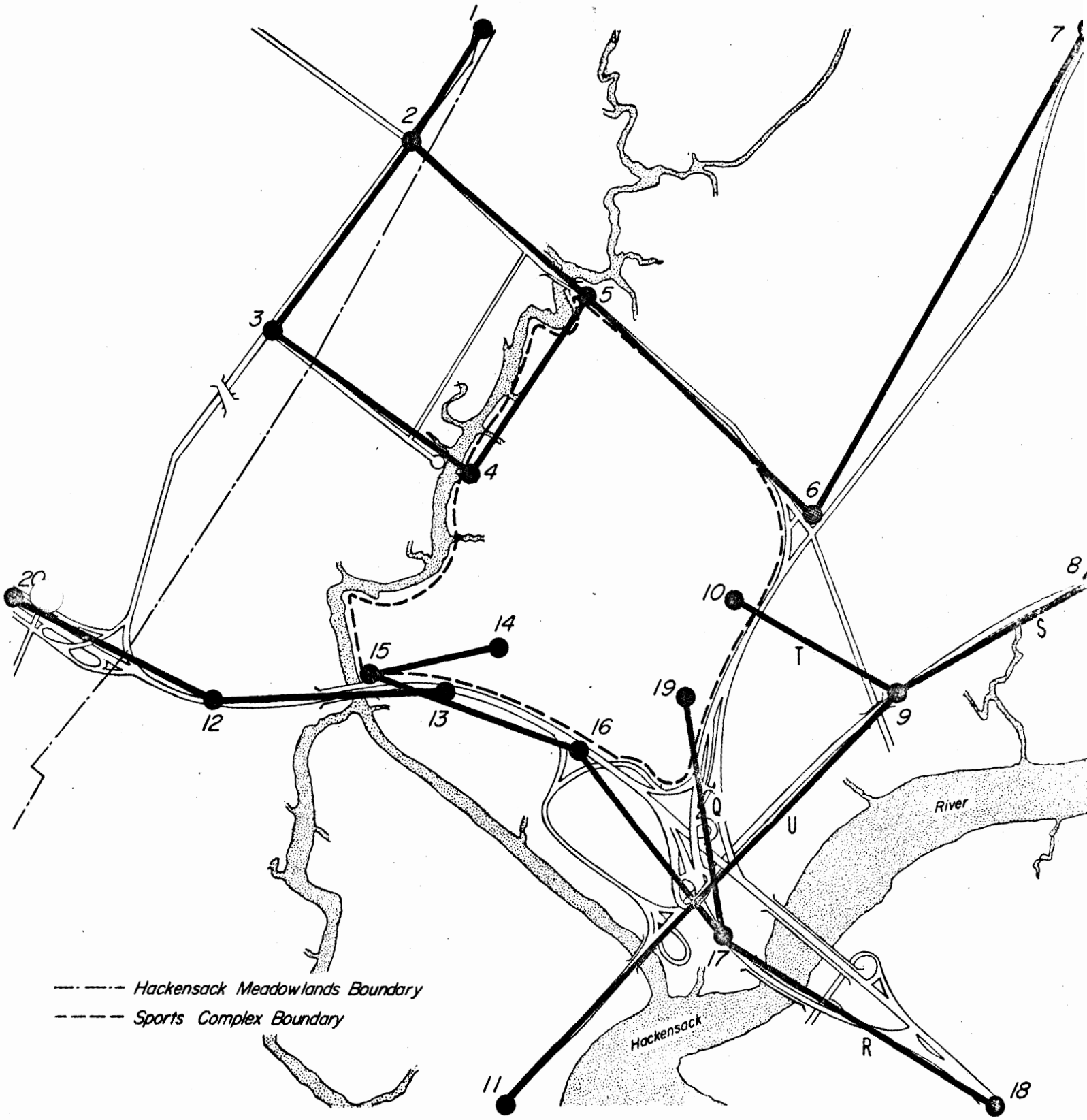


Figure C-6 Bus Line Sources

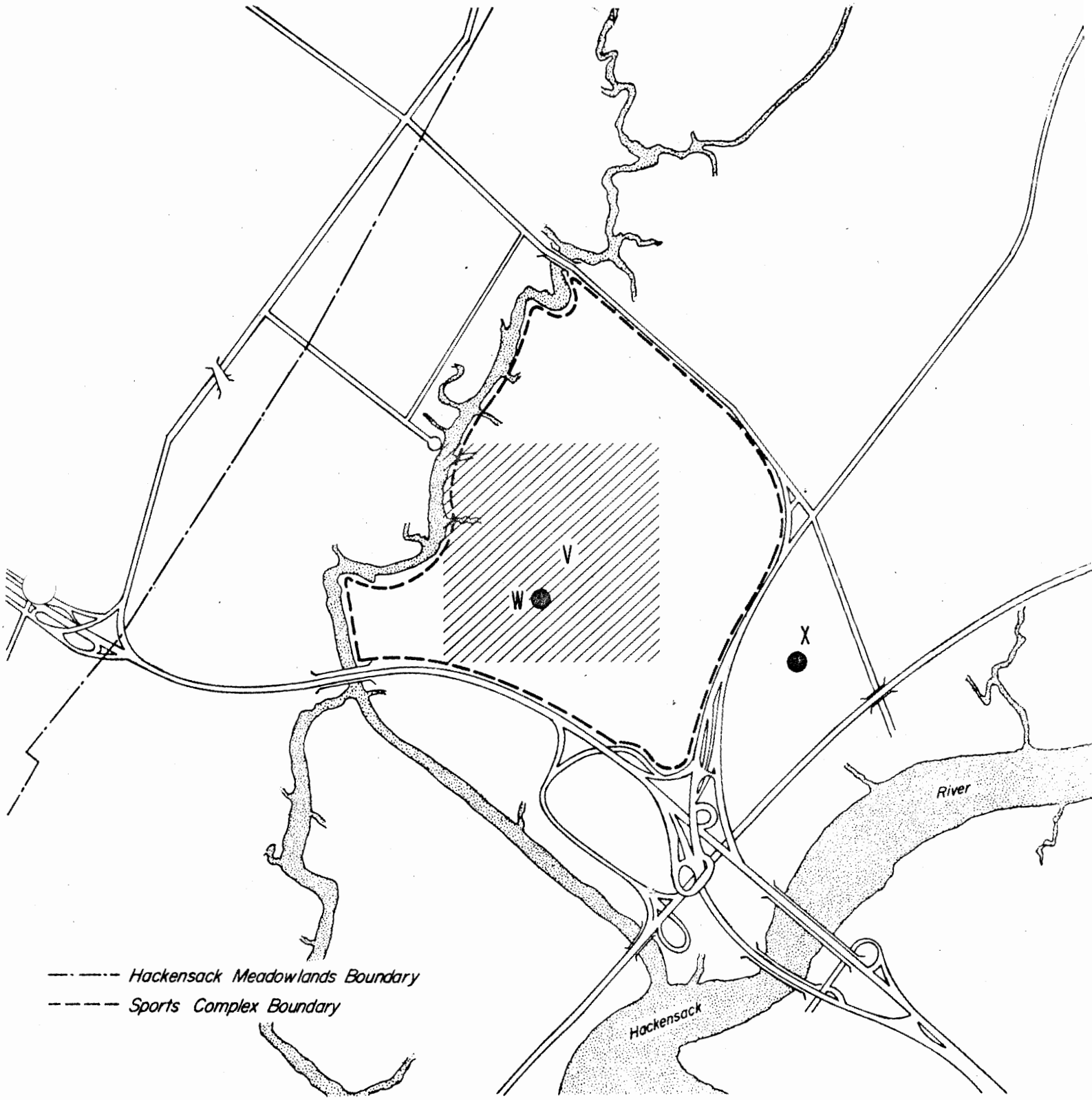


Figure C-7 Parking Lot Idling and Space Heating Sources

3.6 Model Output Receptor Configuration

Figure C-8 shows the receptor grid used for most of the single or worst case calculations. It is a modified equal-interval grid totaling 25 receptors. The receptor locations were chosen so as to best characterize the concentrations in the center of the region where the impact of emissions would be the greatest. Figure C-9 shows an expanded receptor grid of 41 points. This includes all of the 36 points on the 5 by 5 kilometer grid as well as the 5 extra points in the center also shown in Figure C-8. As a result of running test cases it was determined that the added accuracy by using 41 receptors rather than the 25 shown in Figure C-8 did not justify the added computer costs involved. Finally, for all calculations involving the average case, the 36 receptors shown in Figure C-9 were used (i.e., the 5 center receptors were not added--these were used only for the more detailed worst case analysis.)

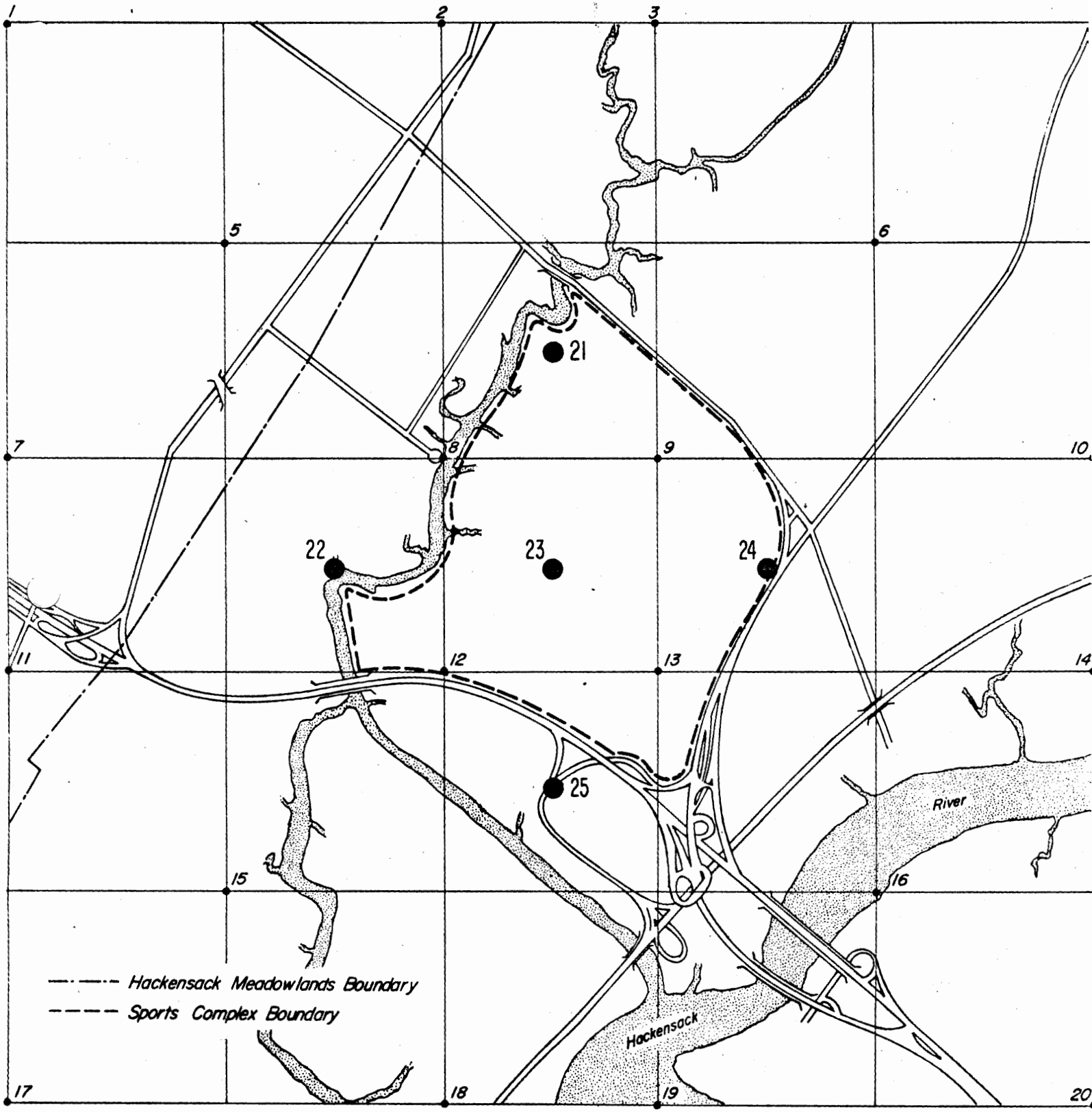


Figure C-8 Receptor Grid

5214

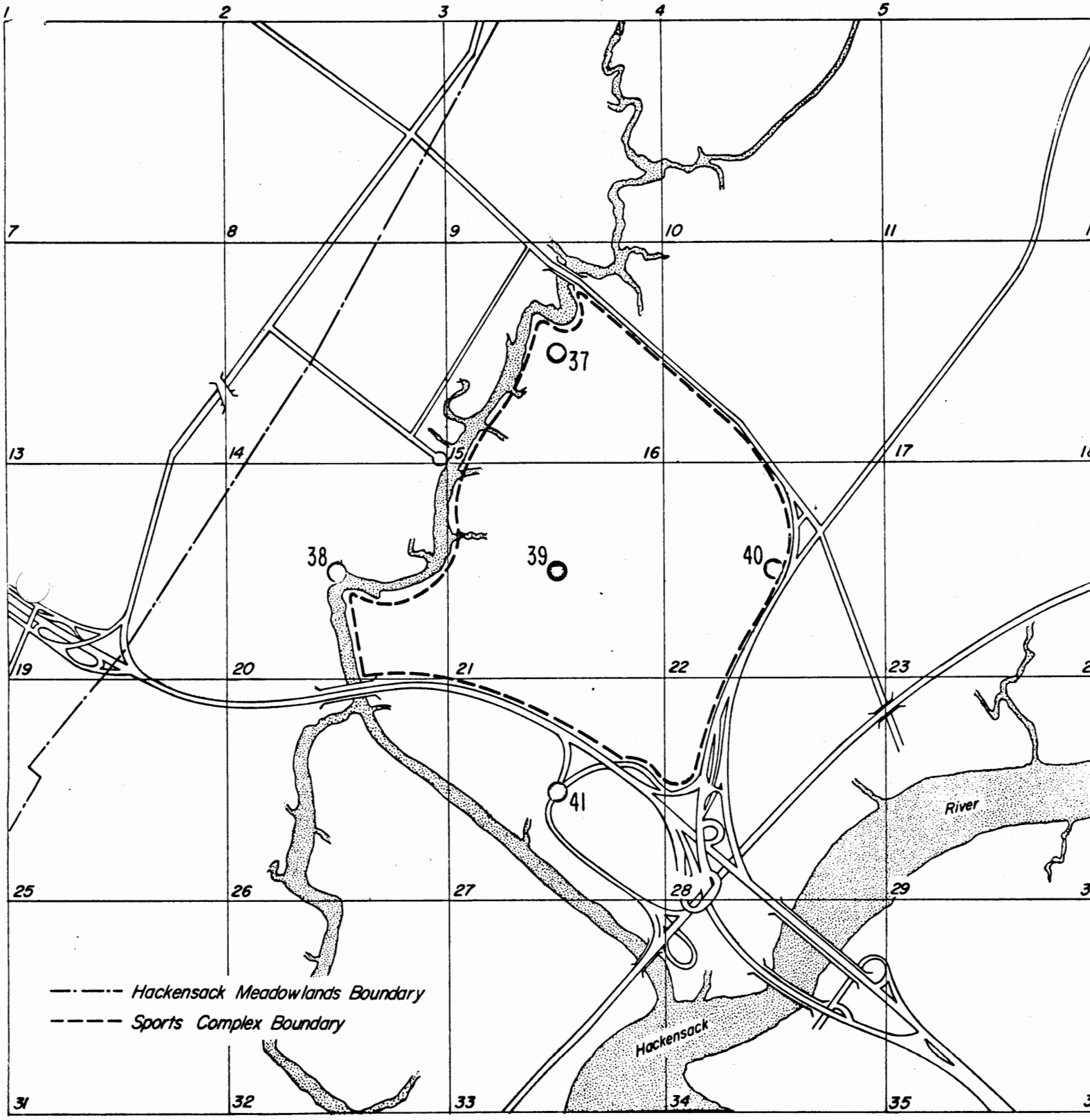


Figure C-9 Expanded Receptor Grid

5213

XIII. Documents Examined

Anon. 1972. Preliminary draft of vegetation study of the Hackensack Meadowlands. Hackensack Meadowlands Development Commission, Lyndhurst, New Jersey, [27] pp.

Bergen County Mosquito Extermination Commission. 1972. Fifty-seventh annual report [to the] Bergen County Board of Chosen Freeholders. Annual Report 1971. Author, Paramus, New Jersey, 55 pp.

Black, Irving H. 1970. Past and present status of the birds of the lower Hackensack River marshes. New Jersey Nature News 25:57-70.

Bull, J. 1964. Birds of the New York area. Harper and Row, New York, xiv + 540 pp.

Ewing Cole Erdman & Eubank/Clauss & Nolan. 1972. Letter from Robert M. Parsky to Dr. Jack McCormick, Jack McCormick & Associates, including a report titled, "New Jersey Sports Complex, Site Selection Review--General Information." 5 June 1972, 1 + 4 pp.

Ewing Cole Erdman & Eubank/Clauss & Nolan. 1972. Preliminary specifications for footfall stadium at New Jersey Sports Complex, East Rutherford, New Jersey, for New Jersey Sports & Exhibition Authority. Project No. 542, five sections, 30 pp.

Ewing Cole Erdman & Eubank/Clauss & Nolan. 1972. Preliminary specifications for racing facility for New Jersey Sports Complex, East Rutherford, New Jersey, for New Jersey Sports & Exhibition Authority. Project No. 3971, 22 February 1972, variously paged, 16 divisions.

PROPERTY OF
NEW JERSEY STATE LIBRARY
186 W. STATE ST. PO BOX 520
TRENTON, NJ 08625-0520

Hackensack Meadowlands Development Commission. 1970. Hackensack Meadowlands comprehensive land use plan. Author, Lyndhurst, New Jersey, 60 pp.

Hackensack Meadowlands Development Commission. 1971. Master plan, Hackensack Meadowlands District zoning regulations. [Lyndhurst, New Jersey], 28 December 1971, sections I, IV, V, VI, VII, VIII, 171 pp. and map.

Harmon, Kathryn P., and J. C. F. Tedrow. 1969. A phytopedologic study of the Hackensack meadowlands. Mss. report prepared by Rutgers University, New Brunswick, New Jersey, for the New Jersey Department of Conservation and Economic Development and the Hackensack Meadowlands Development Commission, 104 pp. (in copy seen).

Frederic R. Harris, Inc. 1971. Preliminary investigations of subsurface conditions effecting site development for the New Jersey Sports Complex. Prepared for Ewing Cole Erdman & Eubank/Clauss & Nolan, executive architects engineers & project managers, 23 pp., figures, and tables.

Harshberger, John W., and Vincent G. Burns. 1919. The vegetation of the Hackensack Marsh: A typical American fen. Trans. Wagner Free Inst. Science of Philadelphia 9 (Part 1):1-35.

Heusser, Calvin J. 1949a. A note on buried cedar logs at Secaucus, N. J. Torrey Bot. Club Bull. 76:305-306.

Heusser, Calvin J. 1949b. History of an estuarine bog at Secaucus, New Jersey. Torrey Bot. Club Bull. 76:385-406.

Heusser, Calvin J. 1963. Pollen diagrams from three former cedar bogs in the Hackensack tidal marsh, northeastern New Jersey. Torrey Bot. Club Bull. 90:16-28.

John J. Kassner & Co., Inc. 1971. Feasibility report, water pollution control systems in connection with the development of the Hackensack Meadowlands, Bergen and Hudson Counties. Prepared for State of New Jersey, Hackensack Meadowlands Development Commission, 148 pp., appendixes, and addendum.

Kivett and Meyers and Ewing Cole Erdman & Eubank. 1971. Outline specifications, football stadium for the New York Football Giants, Inc., New Jersey Sports Complex. Kansas City, Missouri, and Princeton, New Jersey, 17 pp.

Lee, L. L., J. E. Tine, and R. L. Gillett. 1936. Soil survey of the Bergen Area, New Jersey. U. S. Dept. Agric., Bur. Chemistry and Soils, Series 1925, no. 32, 28 pp.

Lewis, J. Volney, and Henry B. Kummel. 1910-1912. Geologic map of New Jersey. Revised by H. B. Kummel, 1931, and by Meredith E. Johnson, 1950. New Jersey Department of Conservation and Economic Development, Atlas Sheet 40 (Scale 1:250,000), 1 sheet.

New Jersey Sports and Exposition Authority and The New York Football Giants, Inc. 1971. Lease agreement [and annex]. Dated as of August 26, 1971. Conformed copy, n.p., 46 pp.

[Newark College of Engineering. 1971. Water quality monitoring in the Hackensack Meadowlands. Study performed by a Newark College of Engineering water quality team under the supervision of Chester P. Mattson, Hackensack Meadowlands Development Commission. Map indicating locations of 11 stations, tabular summaries of data from stations, 12 pp.]

Pierce, J. 1820. Account of the geology, mineralogy, scenery, etc. of the secondary region of New York and New Jersey and the adjacent regions. Amer. Jour. Science 2:181-199.

Potera, George T. 1970. A preliminary ecologic study and evaluation of a section of the Hackensack Meadowlands. [Report submitted to the Hackensack Meadowlands Development Commission, Lyndhurst, New Jersey], 34 pp.

Public Health Service. 1966. Environmental engineering study, Hackensack River Basin. Phase II, Preliminary stage 2 draft, Characterization of existing conditions. U. S. Dept. Health, Educ., and Welfare, Public Health Service, Region II, New York (Working draft preliminary, subject to revision), variously paged (about 100 pp.)

Real Estate Research Corporation. 1969. Analysis of Hackensack Meadowlands District development. Prepared for the Hackensack Meadowlands Development Commission, 33 pp. + maps.

Reeds, C. A. 1926. The varved clays at Little Ferry, New Jersey. Amer. Museum Novitates 209:1-16.

Reeds, C. A. 1927. Glacial lakes and clays near New York City. Natural History 27:54-64.

Reeds, C. A. 1933. The varved clays and other glacial features in the vicinity of New York City. Intern. Geol. Congress Guide 9: 52-63.

[Renlund, Robert. 1970.] Hackensack Meadows, scale 1:1200. [Submitted to the Hackensack Meadowlands Development Commission, 1 sheet.]

Schultz, T. J., and Nancy M. McMahon. 1971. Noise assessment guidelines. U. S. Dept. of Housing & Urban Development. 20 pp.

Shuberth, Christopher J. 1968. The geology of New York City and environs. Published for the American Museum of Natural History, the Natural History Press, Garden City, New York, 304 pp.

Sipple, William Stanton. 1971. The past and present flora and vegetation of the Hackensack Meadows, New Jersey, and suggestions for management. University of Pennsylvania, Dept. of Landscape Architecture and Regional Planning, unpublished thesis for Master of Regional Planning, 165 pp.

[Site Plan] Clauss & Nolan, Frederic R. Harris, Inc., Ewing Cole Erdman & Eubank, and Wilbur Smith & Associates. 1972. Site development. New Jersey Sports Complex. New Jersey Sports & Exhibition Authority. Ewing Cole Erdman & Eubank/Clauss & Nolan, Coordinating architect/ engineers/planners. Scale 1" = 200' or as shown, 22 February 1972.

Drawing No. S/SK-100. Site master plan.

Drawing No. S/SK-101. East site plan.

Drawing No. S/SK-102. Site development plan I.

Drawing No. S/SK-103. Site development plan II.

Drawing No. S/SK-104. Site development sections.

Drawing No. S/SK-105. Grading and drainage plan I.

Drawing No. S/SK-106. Grading and drainage plan II.

Drawing No. S/SK-107. Grading and drainage plan III.

[Site Plan] Clauss & Nolan, etc., continued.

Drawing No. S/SK-108. Grading and drainage plan IV.

Drawing No. S/SK-109. Drainage details.

Drawing No. S/SK-110. Parking field & roadway sections & details.

Drawing No. S/SK-111. Pump station no. 1 plan.

Drawing No. S/SK-115. Cofferdam, football stadium & racing grandstand.

Drawing No. S/SK-116. Cofferdam sections.

Drawing No. S/SK-128. Water supply & sanitary site plan.

Drawing No. S/SK-132. Landscape master plan.

Drawing No. S/SK-133. Landscape details.

Drawing No. S/SK-134. Bus traffic and parking pattern (football)

Drawing No. S/SK-135. Electrical distribution site plan.

United States Geological Survey. 1967. Weehawken quadrangle, New Jersey-New York, 7.5 minute series (topographic). Scale 1:24,000. United States Department of the Interior, Washington, D. C., 1 sheet.

Vermeule, C. C. 1897. Drainage of the Hackensack and Newark tide marshes. New Jersey State Geologist Ann. Rept. 1896:287-317.

Waksman, Selman A., H. Schulhoff, C. A. Hickman, T. C. Cordon, and S. C. Stevens. 1943. The peats of New Jersey and their utilization. New Jersey Dept. Conservation and Development Bull. 55 (Geologic Series, Part B):1-278.

Widmer, Kemble. 1964. The geology and geography of New Jersey. D. Van Nostrand Company, Inc., Princeton, New Jersey, New Jersey Historical Series 19:1-193.

Wilbur Smith & Associates. 1970. Letter from Arnold D. Hirvela, P. E., Associate-in-Charge, to Mr. Robert Parsky, Ewing Cole Erdman & Eubank. 22 July 1970, 4 pp.

Wilbur Smith and Associates. 1971. Traffic access, New Jersey Sports Complex, East Rutherford, New Jersey. Author, New Haven, Connecticut, prepared for the New Jersey Sports and Exposition Authority, revised 14 July 1971, 28 pp.

Wilbur Smith and Associates. 1972. Supplemental traffic analysis, New Jersey Sports Complex. Author, New Haven, Connecticut, prepared for Ewing, Cole, Erdman & Eubank/Clauss & Nolan, Philadelphia, Pennsylvania, revised February 1972, 7 pp., 2 tables, 8 figures.

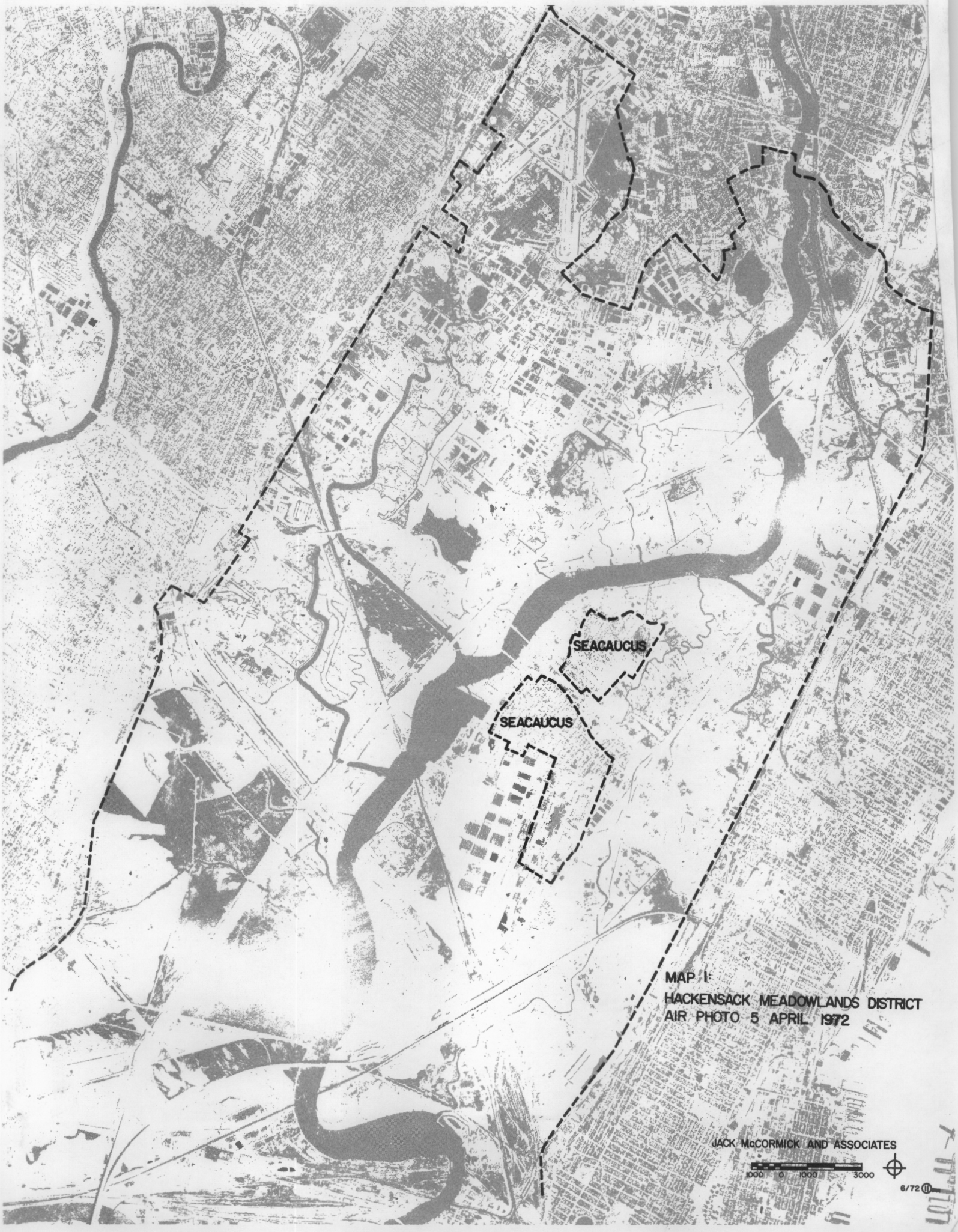
Works Progress Administration. 1941. Map of Carlstadt Meadow. Federal Works Agency, prepared by Project 6994-2 for the Bergen County Mosquito Extermination Comm., 5 orig., scale 1 inch equals 400 feet, 1 sheet.

Zurn Environmental Engineers. 1970. Analysis of alternative solid wastes management systems for the Hackensack Meadowlands District. Prepared for the Hackensack Meadowlands Development Commission, eight sections, 130 pp.

Addenda

Ewing Cole Erdman & Eubank. No date. Index of outline specifications. Eight divisions, 37 pp.

Aero Service Corporation. [1971. Topographic map of the Sports Complex Site, East Rutherford, Bergen County, New Jersey. Nineteen sheets, contour interval 1 foot, scale: 1 inch = 50 feet.]

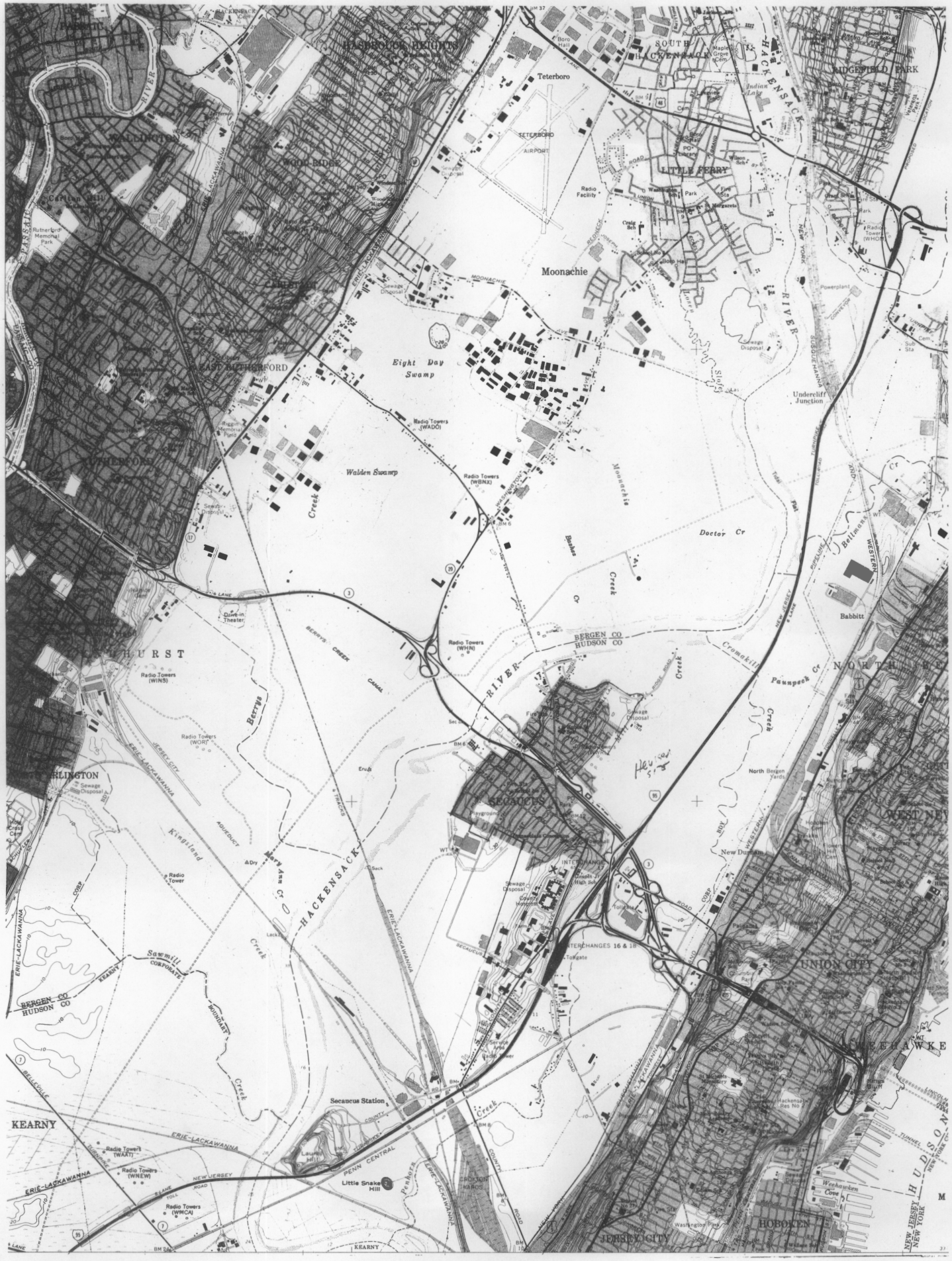


MAP I:
HACKENSACK MEADOWLANDS DISTRICT
AIR PHOTO 5 APRIL 1972

JACK McCORMICK AND ASSOCIATES

1000 0 1000 3000

6/72



MAP 2:
WEEHAWKEN QUADRANGLE

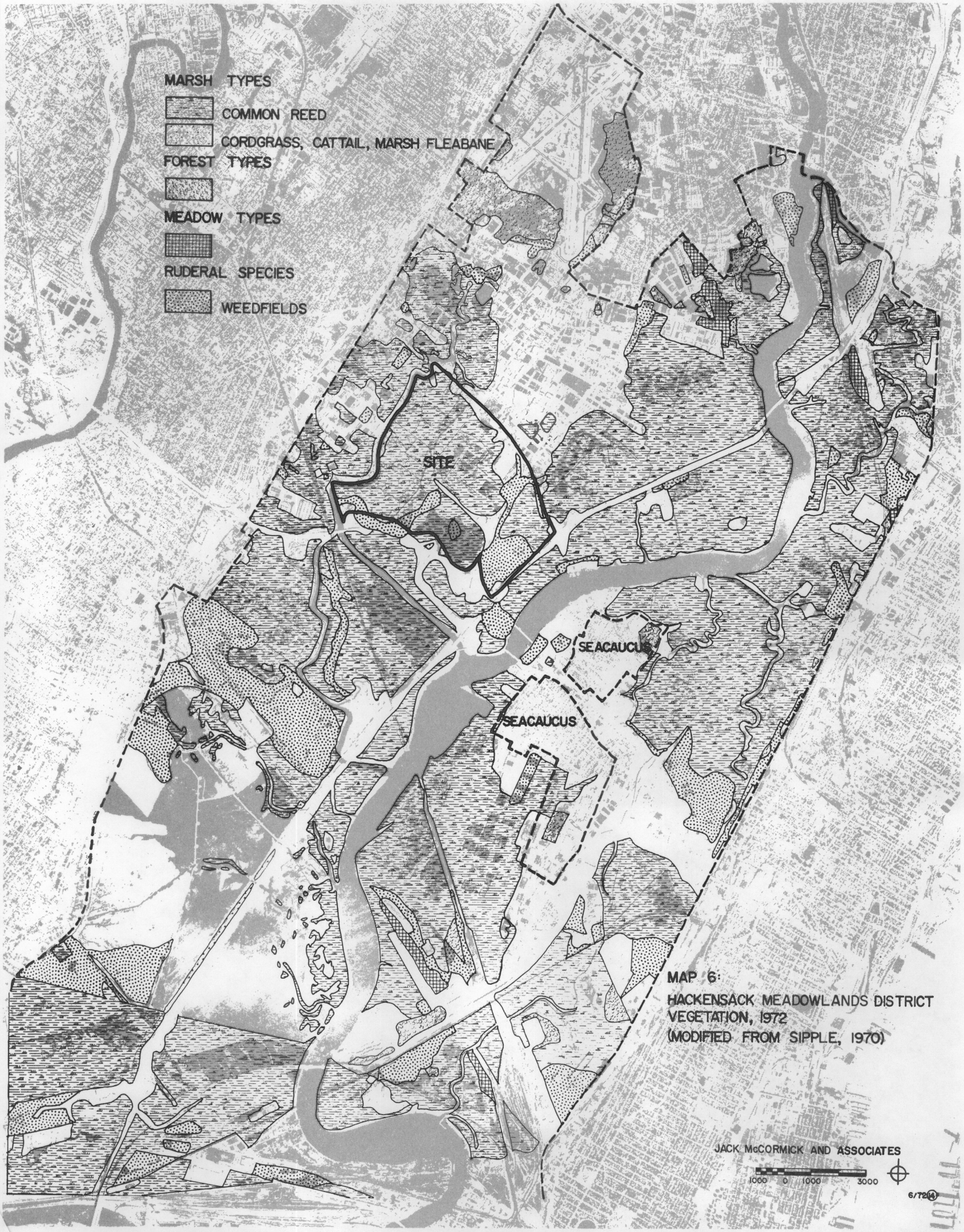

SITE
SEACACUS
SEACAUCUS
MAP 3
HACKENSACK MEADOWLANDS DISTRICT
TIDAL MARSHS, 1925
(AFTER LEE, TINE, AND GILLETT, 1936)
JACK McCORMICK AND ASSOCIATES
1000 0 1000 3000
6/72



MAP 4:
HACKENSACK MEADOWS
FROM VERMEULE, 1897



MAP 5:
HACKENSACK MEADOWLANDS DISTRICT
WETLANDS, 1972

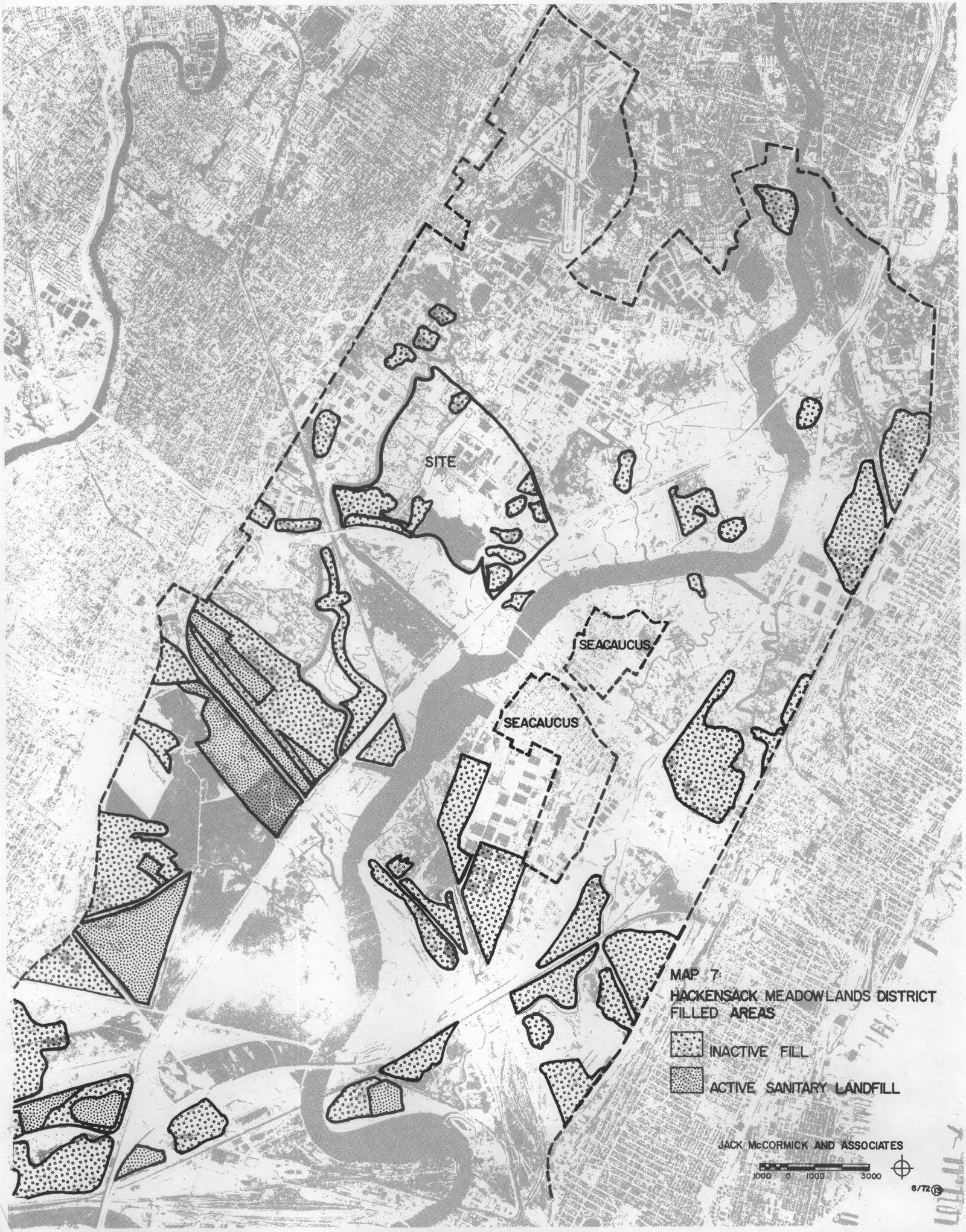


MAP 6:
HACKENSACK MEADOWLANDS DISTRICT
VEGETATION, 1972
(MODIFIED FROM SIPPLE, 1970)

JACK McCORMICK AND ASSOCIATES

1000 0 1000 3000

6/72(A)



MAP 7:
HACKENSACK MEADOWLANDS DISTRICT
FILLED AREAS

INACTIVE FILL

ACTIVE SANITARY LANDFILL

JACK McCORMICK AND ASSOCIATES

1000 0 1000 3000

6/72



MAP 8:
HACKENSACK MEADOWLANDS DISTRICT
SPORTS COMPLEX SITE ALTERNATIVES


MAP 9: PROPOSED SITE
NEW JERSEY SPORTS COMPLEX
WETLANDS JUNE 1972
AND HISTORIC BOUNDARIES
WETLANDS
POSITION OF CONTROL STRUCTURES, 1941:
(Work Projects Administration, 1941)
DIKE
TIDAL GATE
POSITION OF NATURAL LIMITS, 1896:
(Vermeule, 1897)
UPLAND LIMIT
SWAMP FOREST LIMIT
CEDAR SWAMP BOTTOM LIMIT
JACK McCORMICK AND ASSOCIATES
BERRYS CREEK
PATERSON PLANK ROAD
SERVICE ROAD
NEW JERSEY ROUTE 3
NEW JERSEY ROUTE 20
WHN RADIO TOWERS
NEW JERSEY TURNPIKE
N


MAP 10: PROPOSED SITE
NEW JERSEY SPORTS COMPLEX
VEGETATION JUNE 1972
COMMON REED GRASSLAND
VEGETATED FILL
OAK WOODLAND
BIRCH-ASPEN SHRUBLAND
FLOODED SHRUBLAND
OPEN WATER
BARREN FILL
HIGHWAYS
JACK McCORMICK AND ASSOCIATES
BERRYS CREEK
PATERSON PLANK ROAD
NEW JERSEY ROUTE 3
N.J. ROUTE 20
WHN RADIO TOWERS
NEW JERSEY TURNPIKE
N