Report to the

MASSACHUSETTS BAYS PROGRAM

GEOGRAPHIC ANALYSIS OF BACTERIAL CONTAMINATION IPSWICH, BEVERLY, AND PROVINCETOWN

Prepared by

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Geographic Analysis of Bacterial Contamination
Ipswich, Beverly, and Provincetown Watershed Studies

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Final Report
Submitted to

Massachusetts Bays Program
Office of Coastal Zone Management
Massachusetts Executive Office of Environmental Affairs
100 Cambridge Street, Room 2000
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October 1996

FOREWORD

The roots of the Massachusetts Bays Program extend back to 1982, when the City of Quincy filed suit against the Metropolitan District Commission and the Boston Water and Sewer Commission over the chronic pollution of Boston Harbor, Quincy Bay, and adjacent waters. Outdated and poorly maintained sewage treatment plants on Deer Island and Nut Island were being overwhelmed daily by sewage from the forty-three communities in the Metropolitan Boston area. Untreated and partially treated sewage were spilling into Boston Harbor.

Litigation over the pollution of Boston Harbor culminated in 1985 when the United States Attorney filed suit on behalf of the Environmental Protection Agency against the Commonwealth of Massachusetts for violations of the Federal Clean Water Act. The settlement of this suit resulted, in 1988, in the creation of the Massachusetts Water Resources Authority, the agency currently overseeing a multi-billion dollar project to repair and upgrade Metropolitan Boston's sewage treatment system. In addition, the settlement resulted in the establishment of the Massachusetts Environmental Trust - an environmental philanthropy dedicated to improving the Commonwealth's coastal and marine resources. $2 millon in settlement proceeds were administered by the Trust to support projects dedicated to the restoration and protection of Boston Harbor and Massachusetts Bay.

The Trust provided $1.6 million to establish the Massachusetts Bays Program, a collaborative effort of public officials, civic organizations, business leaders, and environmental groups to work towards improved coastal water quality. The funding was used to support both a program of public education and a scientific research program focusing on the sources, fate, transport and effects of contaminants in the Massachusetts and Cape Cod Bays ecosystem. To maximize the efficiency of limited research funding, the sponsored research program was developed in coordination with research funded by the MWRA, the United States Geological Survey, and the Massachusetts Institute of Technology Sea Grant Program.

In April, 1990, following a formal process of nomination, the Massachusetts Bays Program became part of the National Estuary Program. The additional funding provided as part of this joint program of the Environmental Protection Agency and the Commonwealth of Massachusetts is being used to continue a coordinated program of research in the Massachusetts Bays ecosystem, as well as supporting the development of a comprehensive conservation and management plan for the coastal and marine resources of Massachusetts and Cape Cod Bays. This report presents results of a model, FecaLOAD, which is used to estimate fecal coliform loading to selected embayments from stormwater runoff. While the model cannot substitute for fecal coliform sampling, it is a useful tool that can be used to estimate the magnitude of fecal coliform loading to an embayment area. The model was developed as a management tool, especially in areas of shellfish beds and swimming beaches. The Companion Guidelines for FecaLoad provides detailed information about the model and the data needed to run the model. This information is helping to meet the Massachusetts Bays Program goal of producing an area-wide management plan for water quality enhancement and protection.

The information in this document has been subject to Massachusetts Bays Program peer and administrative review and has been accepted for publication as a Massachusetts Bays Program document. The contents of this document do not necessarily reflect the views and policies of the Management Conference.

ACKNOWLEDGMENTS

Horsley & Witten, Inc. acknowledges the subcontracting services of Applied Geographics, Inc. Applied Geographics, Inc. conducted Geographic Information Systems analysis for each watershed, provided statistical data that were used as inputs to the FecaLOAD model, and produced maps of each community's land use, soils, and zoning.

Horsley & Witten, Inc. also acknowledges the assistance of Wayne Castonguay of the MDMF and the ICPCC, Sam Cleaves of Salem Sound 2000, Russel DiConti of the Provincetown Center for Coastal Studies, and Joe Borgessi of the Provincetown Department of Public Works. We also wish to thank Marie Studer and Dillon Scott of the Massachusetts Bays Program for their valuable assistance at every juncture of this project.

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I. EXECUTIVE SUMMARY

Horsley & Witten, Inc. (H&W) was retained by the Massachusetts Bays Program (MBP) to identify and estimate fecal coliform loadings and runoff from land uses in subwatersheds for coastal embayment drainage areas in Ipswich (Lower Ipswich River), Beverly (Bass River), and Provincetown (Provincetown Harbor), Massachusetts. The land areas directly adjacent and upgradient of these three resources drain into the embayments; therefore, land uses located within the drainage areas represent the most immediate potential threat of pathogenic contamination. Subwatersheds were selected as the basis for evaluation because, in most cases, each has a single outlet point through which runoff flows before discharging into the resource.

Current land use and potential fully developed (buildout) conditions were evaluated for two hypothetical rainfall events, the 0.5 inch and 3.0 inch storms. In all, twenty-one subwatersheds were evaluated for both hypothetical rainfall events for existing and buildout land use conditions. Fecal coliform loading and runoff estimates were combined to estimate average concentrations of fecal coliform in the runoff for each land use within the subwatershed, as well as for the subwatershed as a whole.

Geographic Information Systems (Arc/Info) was used as the primary platform to generate the data required for this analysis. Subwatershed boundaries were delineated on topographic maps and then digitized into Arc/Info. Local soil characteristics were also digitized directly from the Soil Conservation Service County Soil Survey maps into Arc/Info. These digitized data were combined with digital data for sewered areas, MacConnell Land Uses, and zoning to determine aerial extent of different land uses and soil types as well as the proximity of those land uses to downgradient surface waters.

Once the land use and soils data were generated they were entered into FecaLOAD, a spreadsheet model designed by H&W to estimate fecal coliform loadings from different land uses within watersheds associated with runoff from a rainfall event. In addition to estimating fecal coliform loadings, FecaLOAD calculates the amount of watershed runoff as well as concentration of fecal coliform within that runoff. Fecal coliform concentrations are calculated for the discharge point of the subwatershed.

In addition to the hypothetical modeling, historical comparisons were conducted for three subwatersheds in Beverly and four subwatersheds in Ipswich as a means of verifying the validity of the model results. This historical comparison involved running FecaLOAD using recorded climatic data and assuming existing land use conditions, and then comparing the fecal coliform concentrations predicted by the model to water quality samples collected at discharge points of those subwatersheds.

The results of the modeling reflect the differences between the three embayment drainage areas in land use intensity and suitability of local soil conditions to attenuate fecal coliform. Pasture land and on-site waste disposal systems located in areas underlain by soils considered "moderate" or "severe" for treating septic effluent were shown to contribute significant amounts of fecal coliform. For subwatersheds containing agricultural land, estimated concentrations of fecal coliform displayed sensitivity to land-application of manure within 5 days of the modeled rainfall event.

Results of the historical modeling demonstrated that, in most cases, FecaLOAD is capable of estimating fecal coliform inputs from land uses within one order of magnitude, its calibration target. In its present form, FecaLOAD is not designed to estimate concentrations of fecal coliform beyond the limit of the modeled subwatershed, such as concentrations for the embayment.

The approach used for this study is a useful technique for evaluating the combined effects of local hydrogeology and land use conditions on coastal water quality. Using GIS as the data management platform facilitates rapid data generation and analysis, as well as graphic display of local subwatershed characteristics such as land uses, soil suitabilities, subwatershed boundaries, and zoning. This approach is also an effective technique for estimating potentially harmful effects of changes in land uses or land use intensity.

II. INTRODUCTION

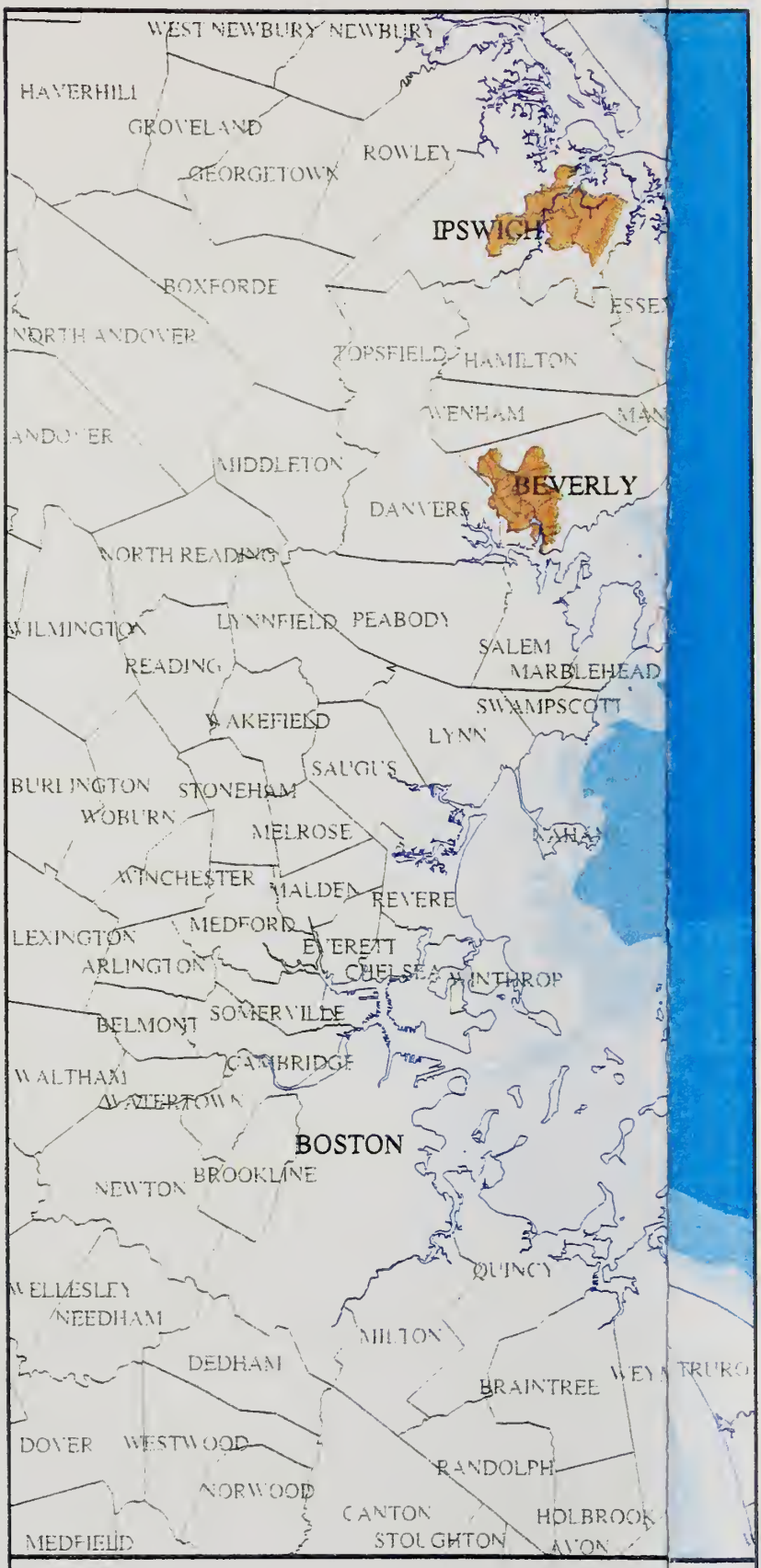
Ipswich, Beverly, and Provincetown, three coastal communities in Massachusetts (Figure 1), were selected by the Massachusetts Bays Program (MBP) for evaluation of bacteria loadings associated with non-point source pollution from land uses. Horsley & Witten, Inc. (H&W) was retained by MBP to conduct this evaluation. The primary means for this evaluation was to estimate total fecal coliform bacteria loadings at watershed discharge points from nearby land uses using a spreadsheet model developed by H&W called FecaLOAD. This report provides a description of the methods and results of this watershed modeling.

III. PURPOSE AND SCOPE

The purpose of this project was to develop transferable methods for evaluating water quality impacts of land uses on coastal water quality. To accomplish these goals, MBP contracted for consultant services with H&W, and its subcontractor, Applied Geographics, Inc. (AGI) to model fecal coliform loadings for selected coastal watersheds to assist land use/environmental managers in setting priorities for the protection of coastal resources. As much of the coastal-area jurisdiction in Massachusetts falls under the auspices of local government, modeling efforts were based on information which is ordinarily available to local officials. Modeling included evaluation of water quality impacts associated with land uses for each watershed as well as evaluation of water quality impacts related to future land use changes. Land use may range from specific proposed land use changes (such as creating a housing subdivision from agricultural land) to conditions under a full "buildout" (if all the development within each subwatershed allowable by zoning bylaws/ordinances were to be realized).

The intended use of FecaLOAD is to calculate fecal coliform loading from the various land uses within a watershed under stormwater runoff conditions (of various magnitudes). Environmental managers, land use planners and local officials can use FecaLOAD to evaluate water quality impacts from existing conditions as well as to provide predictions of impacts under differing future development scenarios.

Model results are intended to be used as a frame of reference for making decisions regarding how best to modify sources or pathways in order to reduce pathogen loading to local shellfish beds or swimming beaches. The watershed models are designed such that they can be transferred to, and used by, other coastal communities in Massachusetts.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NEWBURY
HAVERHILL
GROVELAND
ROWLEY
GEORGETOWN
IPSWICH
BOXFORDE
ESSEX
NORTH ANDOVER
TOPSFIELD
HAMILTON
WENHAM
MANCHESTER
ANDOVER
MIDDLETON
BEVERLY
DANVERS
NORTH READING
WILMINGTON
LYNNFIELD
PEABODY
SALEM
READING
MARBLEHEAD
SWAMPSCOTT
WAKEFIELD
LYNN
SAUGUS
BURLINGTON
STONEHAM
WOBURN
MELROSE
NAHANT
WINCHESTER
MALDEN
REVERE
LEXINGTON
MEDFORD
EVERETT
ARLINGTON
CHELSEA
WINTHROP
BELMONT
SOMERVILLE
CAMBRIDGE
WALTHAM
WATERTOWN
BOSTON
NEWTON
BROOKLINE
QUINCY
WELLESLEY
NEEDHAM
MILTON
DEDHAM
BRAINTREE
WEYMOUTH
TRURO
DOVER
WESTWOOD
RANDOLPH
NORWOOD
CANTON
HOLBROOK
MEDFIELD
STOUGHTON
AVON
0

FIGURE 1

Base Data: EOEA, MassGIS
PLOT PRODUCED: 17-AUG-1996

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Massachusetts Bays Program
Geographic Analysis of Bacterial Contamination

IV. BACKGROUND

Bacterial pollution from land-based sources has been identified as a major factor contributing to the degradation of coastal water quality in Massachusetts. Coastal communities that were once thought to have pristine waters, such as Plum Island Sound and Essex Bay, routinely experience "rainfall closures" of their shellfish beds. In Plum Island Sound, for example, a rainfall event between 0.5 and 1.0 inches triggers a one-day shellfish bed closure, and a one-inch rainfall can cause the clam flats to close for eight days (Mass Audubon Society, 1992).

Poor coastal water quality in Beverly and Ipswich has resulted in closures of all shellfish beds in those areas (Table 1). In Provincetown, much acreage remains open for shellfishing; however, localized areas have been closed (Table 1).

Table 1. Status of Shellfish Acreage for each Community (Source: MBP, 1994)

Town	Area Name	Acreage	Status
Beverly	Beverly Coastal	9,120	Closed
Ipswich	Ipswich River	187*	Closed
	Upper Ipswich River	33	Closed
Provincetown	Hatches Harbor-	142	Closed
	Herring Cove, Long Point	19,750	Open
	Inner Harbor	223	Closed
	Inner Harbor	2,595	Open
	North Coastal	2,595	Open
	Outer Coastal	29,673	Open
	The Breakwater	1,308	Closed
	The Breakwater	4	Open

* Source: personal communication, MBP, 1996

Shellfish beds are closed when fecal coliform concentrations in the water at the growing areas exceeds the standard of 14 fecal coliforms per 100 milliliters of water established by the U.S. Department of Agriculture and the Massachusetts Division of Marine Fisheries (MDMF), the agencies charged with monitoring coastal waters and classifying shellfish beds. Several species of shellfish can concentrate harmful bacteria and viruses in their stomachs if they live in contaminated waters. Shellfish growing in Massachusetts coastal waters include quahogs, soft-shelled clams, scallops, mussels, and oysters.

Shellfish bed closures have greatly increased since 1970, due in part to better monitoring practices by MDMF, but also to the increased development of coastal watersheds and related water quality degradation (Mass Audubon Society, 1992). This trend has generated an overall awareness for better resource and land use management practices. As a result several efforts have been recently undertaken to address this issue. The Ipswich Coastal Pollution Control Committee (ICPCC), in its 1995 report on the Ipswich River, identified locations where discharges of

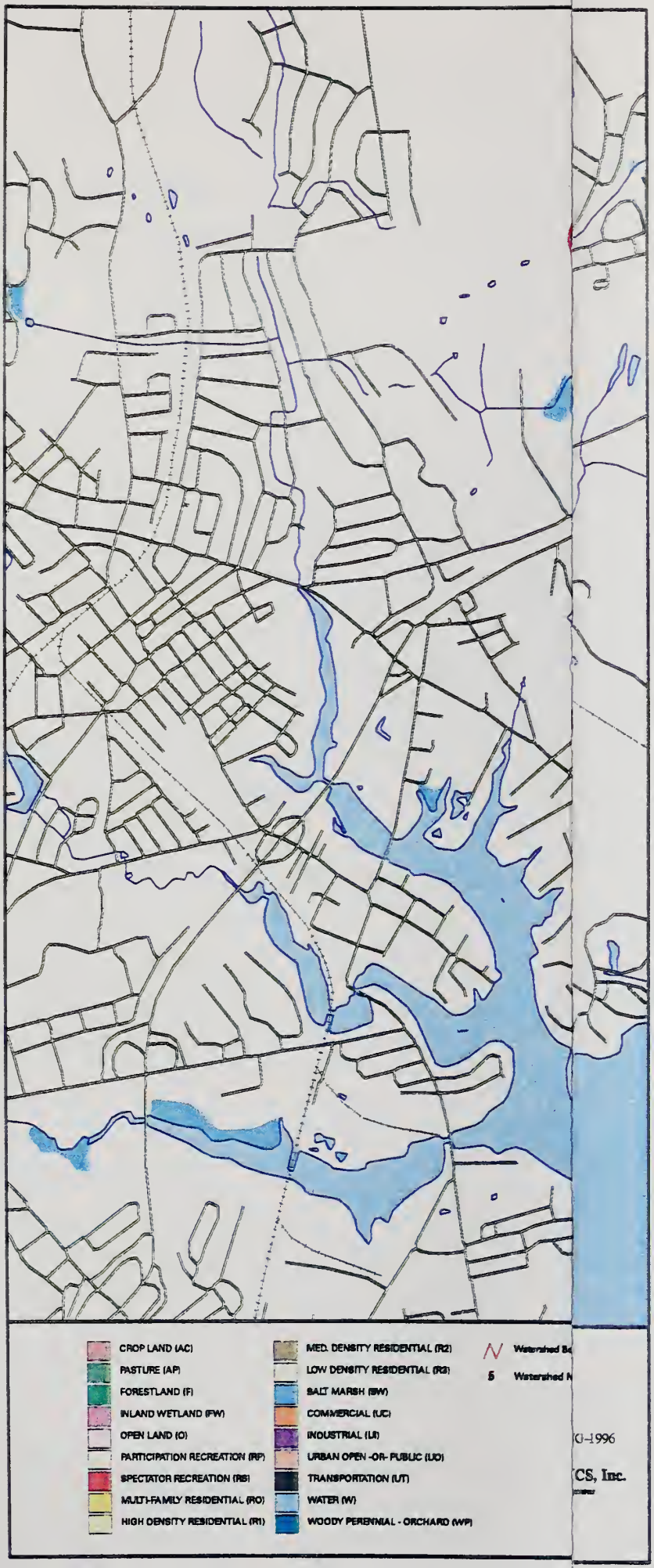
stormwater runoff containing elevated levels of fecal coliform occur. In Beverly, data from a stormwater sampling program conducted between 1993 and 1994 by the Salem Sound 2000 project identify discrete locations where contaminated discharges have been a continual problem. A similar monitoring program is underway in Provincetown Harbor where water quality samples are being collected to assess the impact of stormwater on receiving water quality.

Fecal coliform bacteria (e.g. *Escherichia coli* and similar types) are considered indicators of the presence of pathogens through contamination by animal waste. The presence of such indicators are used by local and state health officials to decide whether coastal waters are safe for shellfishing and swimming. Sources of these bacteria, their pathways through the watershed, loading coefficients, and attenuation mechanisms, identified through a literature review, have been incorporated into the FecaLOAD model and are explained and documented in this report. Further guidance on how and where this information may be obtained is available in the accompanying document *Companion Guidelines for FecaLOAD* (H&W, 1996a), a document which includes names and phone numbers of government agencies to contact for assistance in obtaining data and/or materials required for FecaLOAD, as well as step-by-step instructions for its operation.

V. DESCRIPTIONS OF THE STUDY AREAS

Beverly and Ipswich are located north of Boston and Provincetown is located on the outer extreme of Cape Cod (Figure 1). These three geographic areas were selected by MBP because 1) they represent a variety of hydrogeologic, climatic, and land use conditions including low, medium and high density development, impervious surfaces, storm sewers and drainage swales, septic systems and sewered areas, and wetlands (fresh and salt water), and 2) fecal coliform sampling data were available for subwatersheds for the Ipswich and Bass River embayment drainage areas, as well as for the Provincetown Harbor embayment. Surficial geology in Beverly and Ipswich is predominantly till-covered bedrock with soils derived from these materials having a generally low permeability; Provincetown is situated on high-permeability sand which has been strengthened with added fill to support development. All three communities have residential areas ranging from low-density to high-density.

The Bass River embayment drainage area includes the drainage areas along the final two miles of the Bass River as shown on Figure 2 (Beverly Land Use Map). The area closest to the mouth of the Bass River was selected for modeling because water quality data from samples collected from storm drains in 1993 and 1994 for the Salem Sound 2000 project indicates that fecal coliform concentrations are elevated in stormwater runoff (Salem Sound 2000 unpublished data, 1994). Twenty-three subwatersheds for the Bass River embayment drainage area were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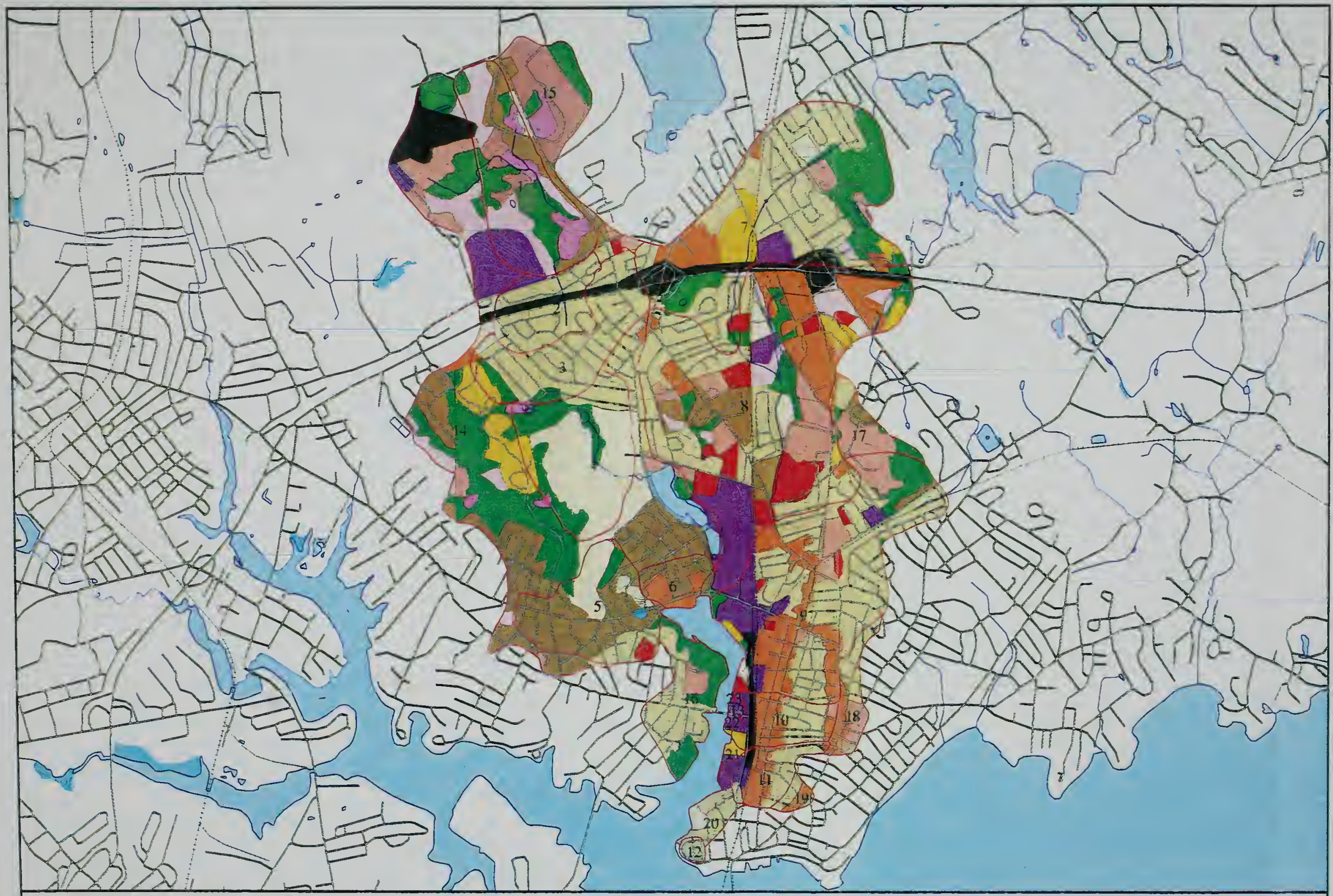

FIGURE 2

1985 Land Use
Beverly: Watersheds

Base Data: EOEA, MassGIS
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evaluated in this study (Table 2). The corresponding storm drain numbers for each subwatershed as listed in the Salem Sound 2000 project data are also provided for reference in Table 2.

Table 2. Bass River Embayment drainage area subwatersheds

Subwatershed Name	Storm Drain Number
B1	#345
B2	#341
B3	#342
B4	#343
B5	#338
B6	#339
B7	#340
B8-23	N/A

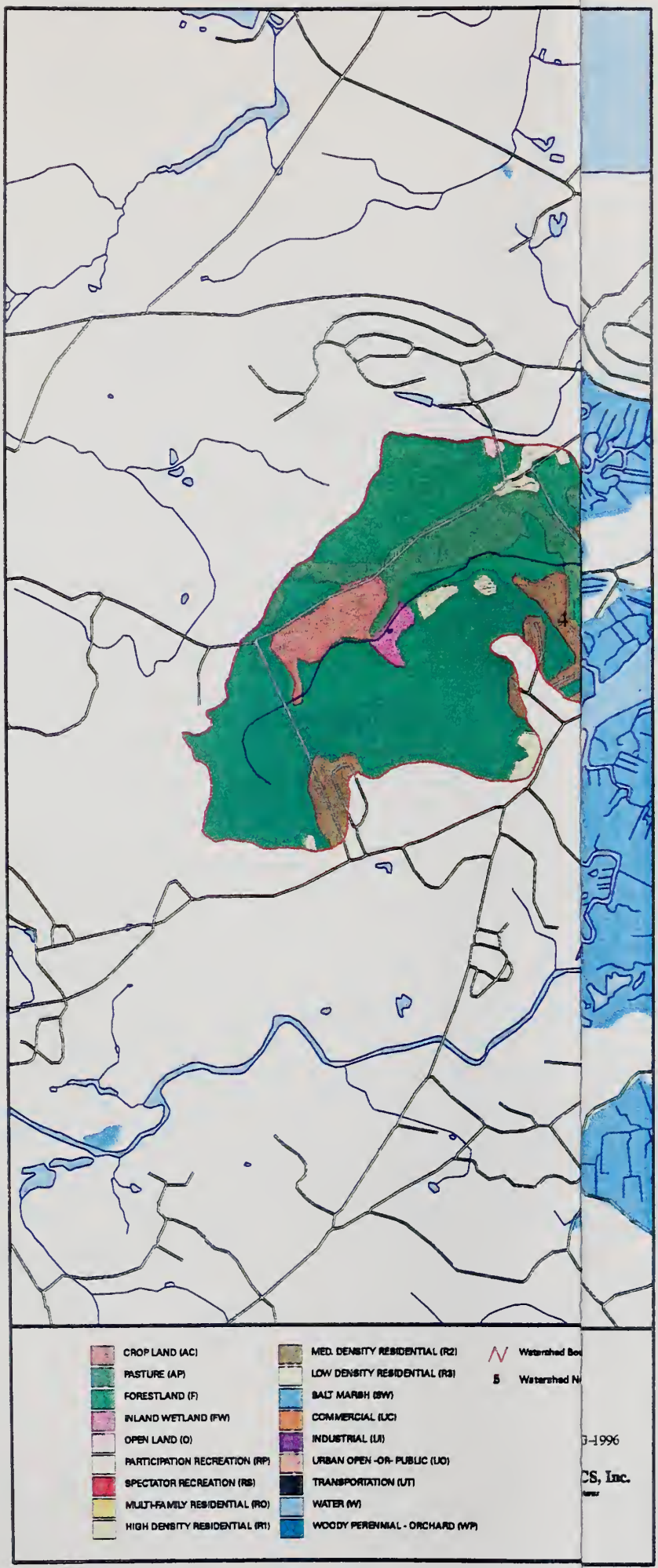
Note that subwatersheds 8 through 23 are referred to as one unit. This watershed represents an aggregation of 16 discrete areas. There are no identifiable discharge points that drain directly from these areas into surface waters; however, MBP requested these areas be included as one composite watershed for this evaluation.

The Ipswich River embayment drainage areas includes the immediate drainage areas on the north and south sides of the Ipswich River approximately two miles inland from Plum Island Sound as shown on Figure 3 (Ipswich Land Use Map). It was selected according to where problematic discharges have historically been identified according to the ICPCC study which reports results of fecal coliform concentration sampling at subwatershed discharge points. Nine subwatersheds in the Ipswich River embayment drainage area were evaluated in this study, some of which have also been identified in the ICPCC (1995) report by the names of the tributaries with which they are associated (Table 3).

Table 3. Ipswich River Embayment drainage area subwatersheds

Subwatershed Name	Tributary Name
IP 1	Greenwood Creek
IP 2	Farley Brook
IP 3	Labor in Vain Creek
IP 4	Kimball Brook
IP 5	Saltonstall Brook
IP 6	N/A
IP 7	N/A
IP 8	N/A
IP 9	N/A

There were no identifiable confined discharge points such as a storm drain or tributary from subwatersheds 6, 7, 8, and 9 into the Ipswich River, however, MBP requested that each of these areas be included as discrete watersheds for this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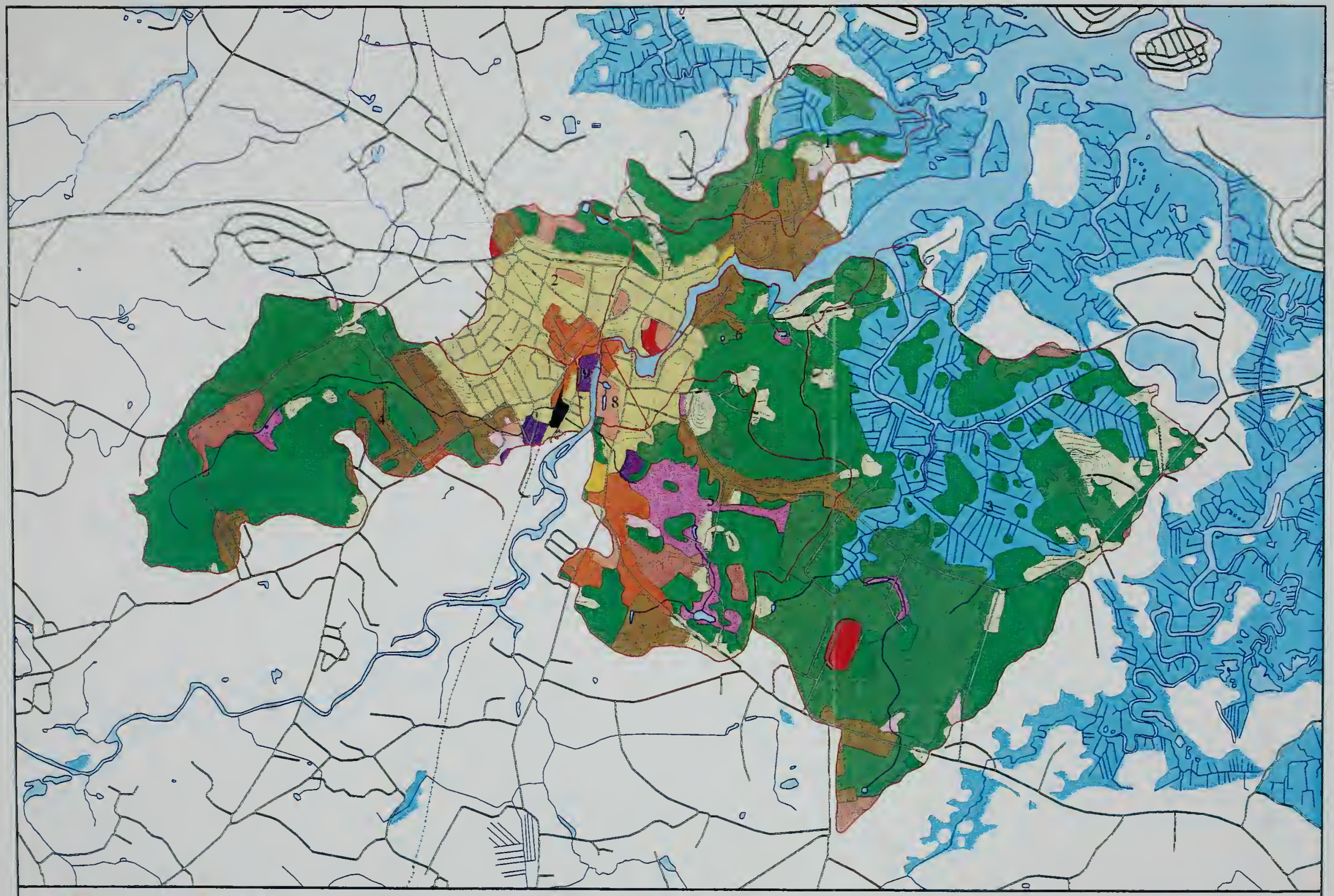

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LOW DENSITY RESIDENTIAL (R3)
SALT MARSH (SW)
COMMERCIAL (UC)
INDUSTRIAL (UI)
URBAN OPEN -OR- PUBLIC (UO)
TRANSPORTATION (UT)
WATER (W)
WOODY PERENNIAL - ORCHARD (WP)

Watershed Boundary
5 Watershed Number

KILOMETERS 0 0.5 1 2

MILES 0 0.5 1 2

N W E S

FIGURE 3

Base Data: EOEA, MassGIS
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1985 Land Use
Ipswich: Watersheds

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evaluation because they are located adjacent to the Ipswich River, and because overland runoff from these adjacent areas is a potentially significant source of pathogens.

The Provincetown Harbor embayment area includes land which drains into the Provincetown Harbor section of Cape Cod Bay as shown on Figure 4 (Provincetown Land Use Map). It was delineated according to a local town storm drain map (Weston & Sampson, 1974) because, in some instances, areas located outside of the topographic boundary are drained by the stormwater drainage system which discharges into Provincetown Harbor. Three subwatersheds of Provincetown Harbor were evaluated in this study.

Table 4. Provincetown Harbor Embayment drainage area subwatersheds

Subwatershed Name	Storm Drain Name
P1	N/A
P2	Gosnold Street
P3	N/A

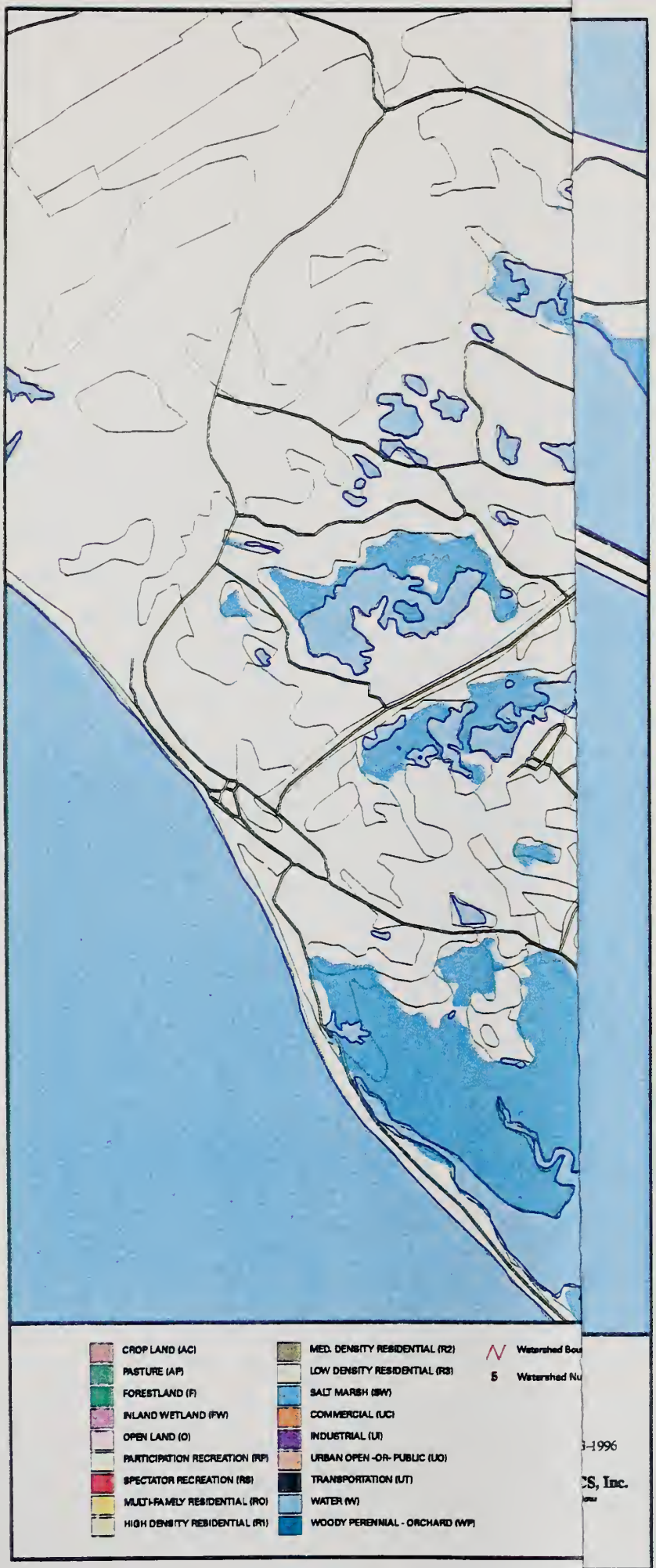
Watershed boundaries were delineated onto USGS 1:25000 scale quadrangle maps, then digitized along with soil characteristics from the (Natural Resource Conservation Service (NRCS) Soil Surveys for Essex (North and South) and Barnstable Counties. Where necessary, watershed boundaries were enhanced with the 1:25000 scale coastline and 1:25000 scale hydrography, coverages distributed by MASSGIS. To ensure precise analysis, datalayers describing soil type and land cover/land use were similarly enhanced.

Within each watershed smaller subwatersheds were delineated, each with its own drainage area. FecaLOAD modeling was conducted at the subwatershed level.

A. Soils

Information on soil characteristics was obtained from the U.S. Department of Agriculture - NRCS (formerly the Soil Conservation Service or SCS) County Soil Survey. An example Soil Survey map is provided in Figure 5. In addition to the maps of the various soil types, the County Soil Survey includes a table of Sanitary Facilities that classifies each soil type as "Slight", "Moderate", or "Severe," according to its difficulty in assimilating septic effluent. These classifications are referred to in this report as soil suitability which is a collective expression of the combined effects of depth to seasonal high water table, depth to bedrock, and permeability.

Soil characteristics were digitized in accordance with the "Slight", "Moderate", and "Severe" ratings as described above for subwatersheds of the three embayment drainage areas from soil maps in the Essex County Soil North Survey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1985 Land Use
Provincetown: Watersheds

FIGURE 4

Base Data: EOEA, MassGIS
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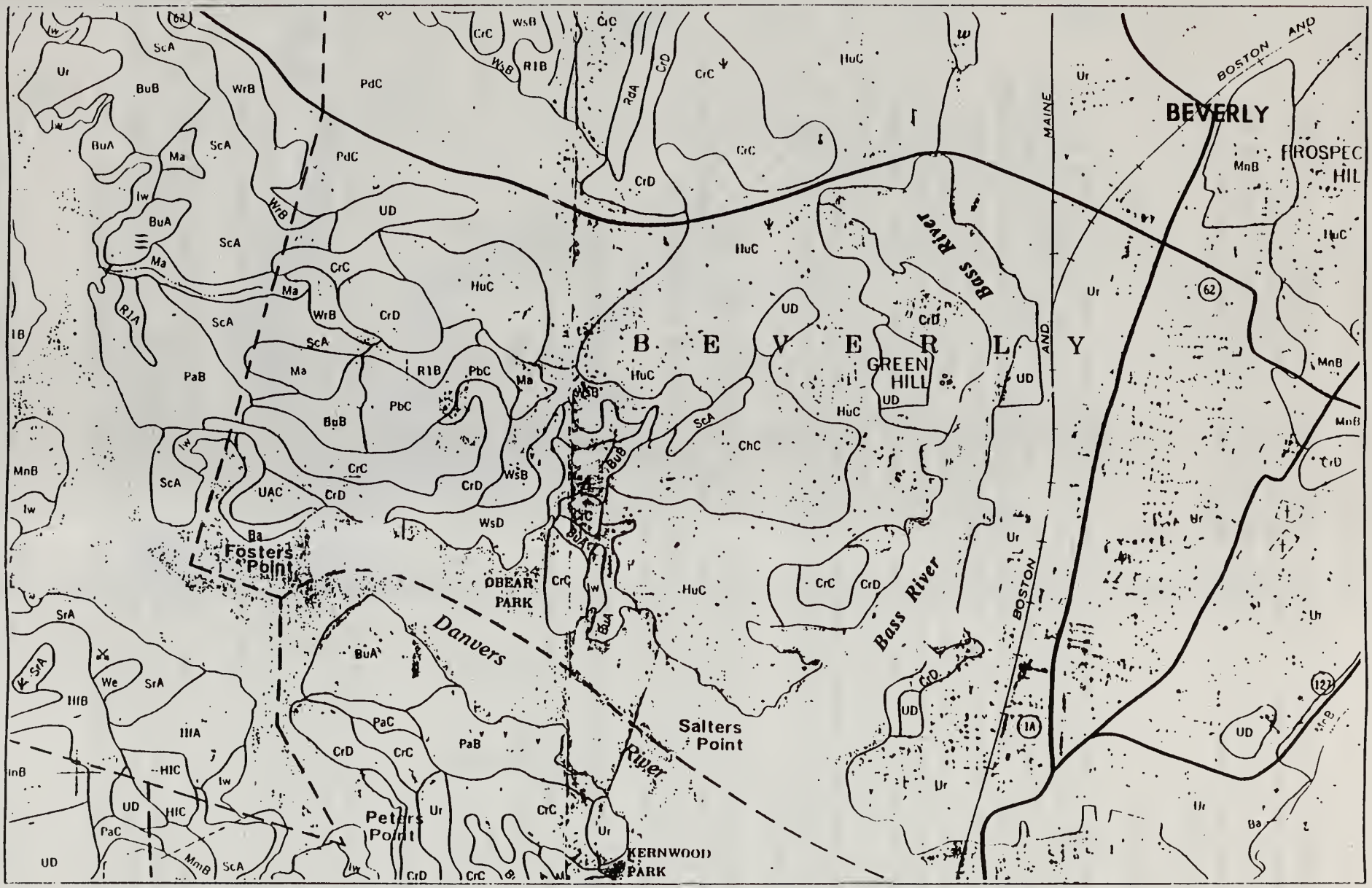


FIGURE 5.
Soil Survey Map Example (Bass River Area, Beverly, MA)

(Ipswich), the Essex County South Survey (Beverly), the Barnstable County Soil Survey (Provincetown). Because the FecaLOAD model is based in part on watershed soil characteristics, the data presented in the Soil Survey were used for assessing local soil characteristics. Soil characteristics for the three watersheds are summarized below.

1. Beverly Soils

Surficial geology in the vicinity of the terminus of the Bass River in Beverly is characterized by two predominant soil types. The first soil type, located mainly on the east side of the Bass River, is called "Urban Land" according to the SCS Essex County Soil Survey. Urban Land soils are natural soils that have been altered with the addition of fill for the purpose of strengthening the soil to support developed areas. The Essex County Soil Survey table of Sanitary Facilities does not classify the suitability of Urban Land, presumably because Urban Land is not conducive to siting on-site wastewater treatment systems. Thus, for this study, H&W classified the suitability of Urban Land as "moderate". The second soil type is an aggregation of soil types including relatively permeable soils (sand and gravel), urban land, and exposed bedrock. This material comprises most of the land area on the west side of the Bass River.

With the exception of subwatershed B8-23, soil coverage in Beverly is predominantly "severe", with four subwatersheds (B1, B2, B3, and B4) underlain entirely by "severe" soils (Table 5 and Figure 6). A summary of the percent coverage for each soil classification is provided below:

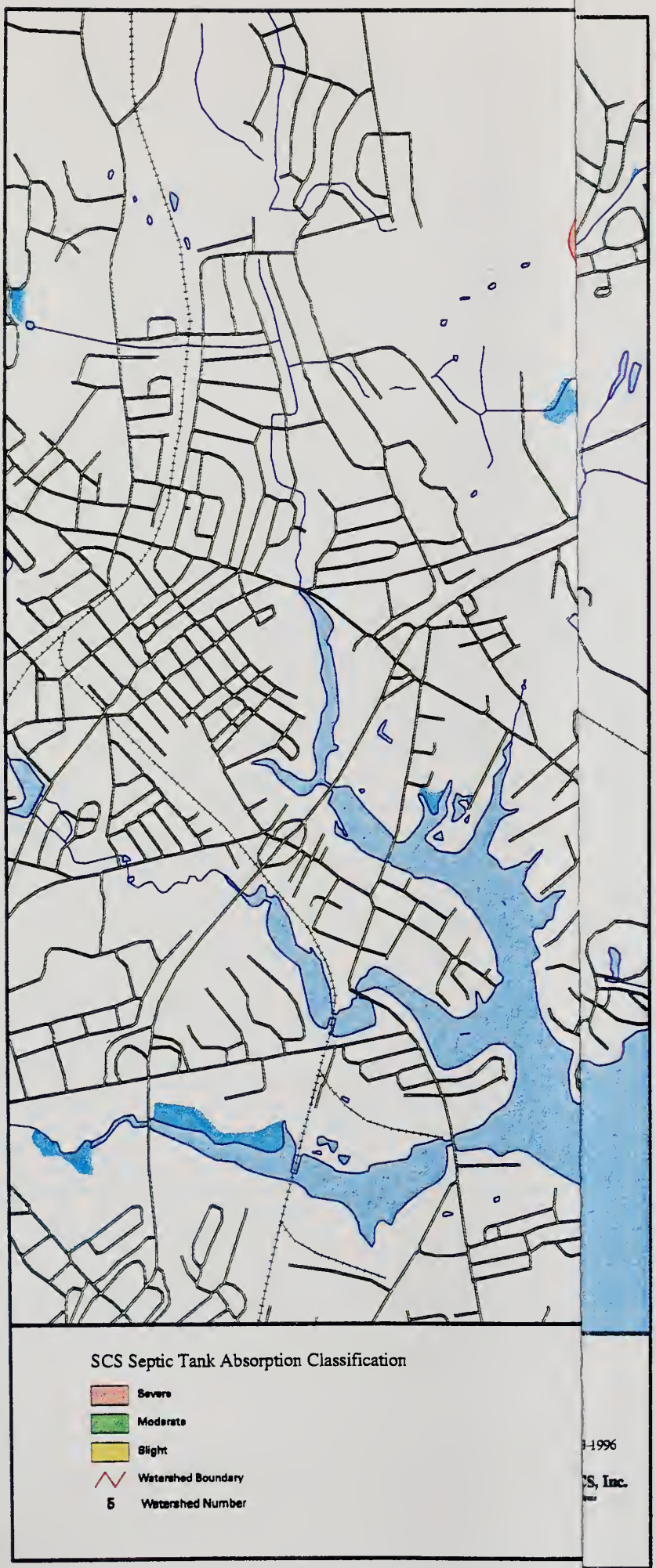
Table 5. Soil Suitability of the Bass River embayment drainage area subwatersheds

Soils	B 1	B 2	B 3	B 4	B 5	B 6	B 7	B 8-23
Severe	100%	100%	100%	100%	97%	99%	96%	59%
Moderate	0%	0%	0%	0%	3%	1%	4%	41%
Slight	0%	0%	0%	0%	0%	0%	0%	0%

2. Ipswich Soils

The soils of the coastal watersheds that occur near the terminus of the Ipswich River consist primarily of glacially-derived deposits. The SCS Essex County Soil Survey and the USGS Surficial Geology map of the Ipswich Quadrangle, Massachusetts (Sammel, 1963) show two distinct physiographic sections occurring in the adjacent lands along approximately the final two miles of the Ipswich River.

Near the mouth of the river, the soils consist mostly of salt-water marsh deposits, with small isolated pockets of marine and estuarine deposits. The salt-marsh deposits are comprised of fibrous organic material mixed with sand and silt. The average thickness of this soil is 5 feet (Sammel, 1963). The organic material,


SCS Septic Tank Absorption Classification
Severe
Moderate
Slight
Watershed Boundary
5 Watershed Number
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SCS Septic Tank Absorption Classification

- Severe
- Moderate
- Slight
- Watershed Boundary
- 5 Watershed Number

KILOMETERS 0 0.5 1 2

MILES 0 0.5 1 2

N W E S

Soil Septic Suitability
Beverly: Watersheds

FIGURE 6

Base Data: EOEA, MassGIS
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together with the variably sized inorganic sand and silt grains, combine to produce a low permeability soil. The marine and estuarine deposits are comprised largely of low permeability silty clay material.

Approximately one mile inland, there is a distinct change in the distribution of soil type, as well as in soil composition. In this area, the soils consist of large isolated deposits of low-permeability ground moraine material, mostly dense clayey till, surrounded by continuous sections of salt-water marsh deposits. The denser material that occurs inland buttresses much of the development in this area. Long, thin kame deposits of well sorted sand and gravel occur sporadically between the ground moraine material and the salt-marsh deposits.

Most of the soils in Ipswich are classified as "severe" in the County Soil Survey, with lesser amounts of "moderate" and "slight" soils (Table 6 and Figure 7). In general, there is greater diversity of soil suitability in Ipswich than in Beverly or Provincetown.

Table 6. Soil Suitability of the Ipswich River embayment drainage area subwatersheds

Soils	IP 1	IP 2	IP 3	IP 4	IP 5	IP 6	IP 7	IP 8	IP 9
Severe	87%	60%	84%	58%	69%	68%	93%	94%	100%
Moderate	6%	33%	11%	25%	24%	24%	6&	6%	0%
Slight	7%	8%	5%	17%	7%	4%	1%	0%	0%

3. Provincetown Soils

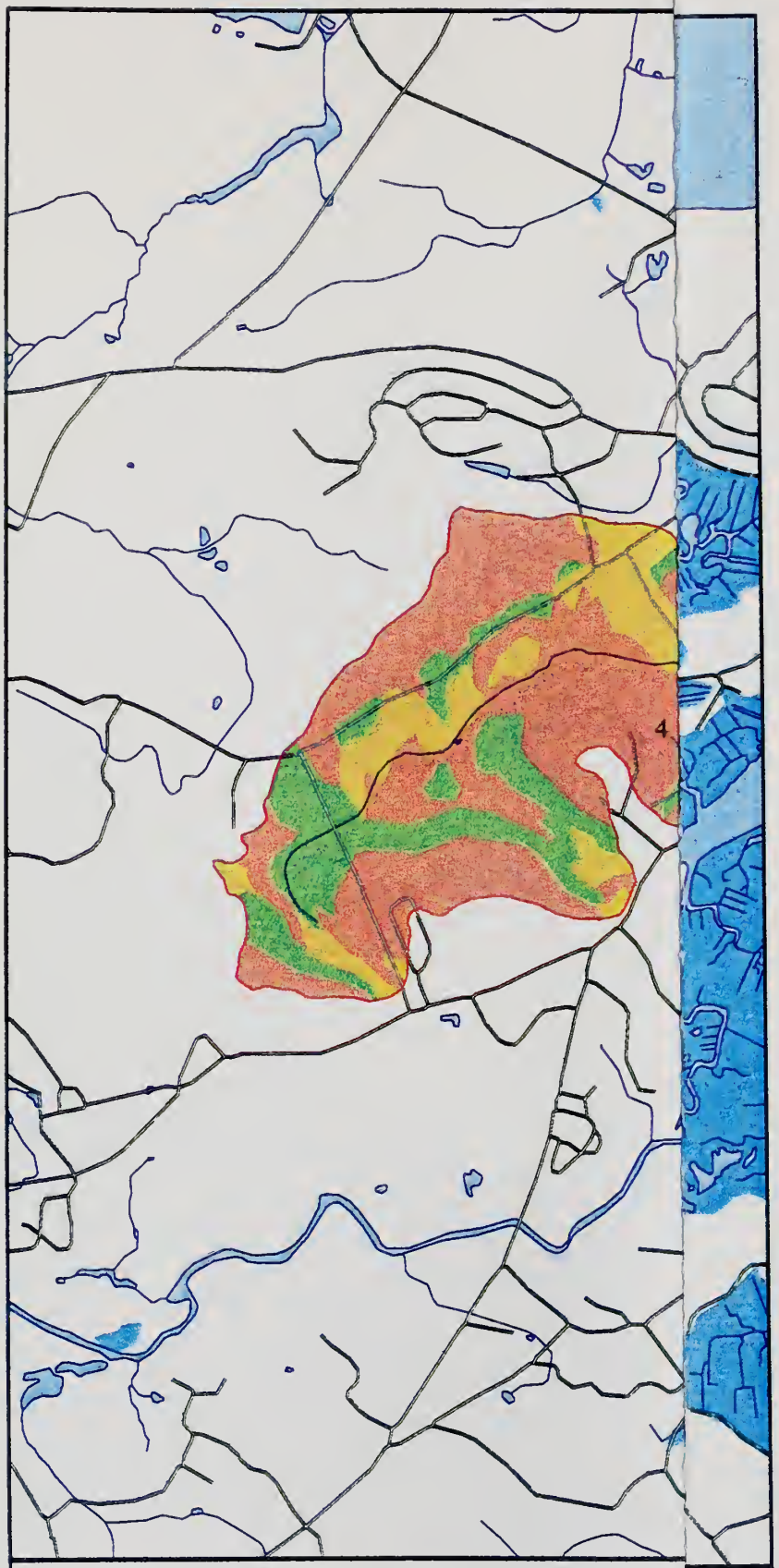
Unlike the glacially deposited soils that occur in most of Cape Cod, Provincetown soils are primarily post-glacial wave and wind "beach deposits" of eroded material from glacial drift. However, most of the coastal watershed to Provincetown Harbor delineated for this study consists of "Urban Land." This accounts for the predominance of "moderate" soils (Table 7 and Figure 8).

Table 7. Soil Suitability of the Provincetown Harbor embayment drainage area subwatersheds

Soils	P 1	P 2	P 3
Severe	36%	16%	25%
Moderate	64%	84%	75%
Slight	0%	0%	0%

B. Climate

Modeling water quality on a per-rainstorm basis requires rainfall data that are considered representative of average conditions for coastal areas of Massachusetts. Rainfall events of 0.5 inches and 3.0 inches were selected for modeling. The 0.5



SCS Septic Tank Absorption Classification

- Severe
- Moderate
- Slight
- Watershed Boundary
- 5 Watershed Number

3-1996

CS, Inc.

SCS Septic Tank Absorption Classification

- Severe
- Moderate
- Slight
- Watershed Boundary
- 5 Watershed Number

KILOMETERS 0 0.5 1 2

MILES 0 0.5 1 2

N W E S

FIGURE 7

Base Data: EOEA, MassGIS
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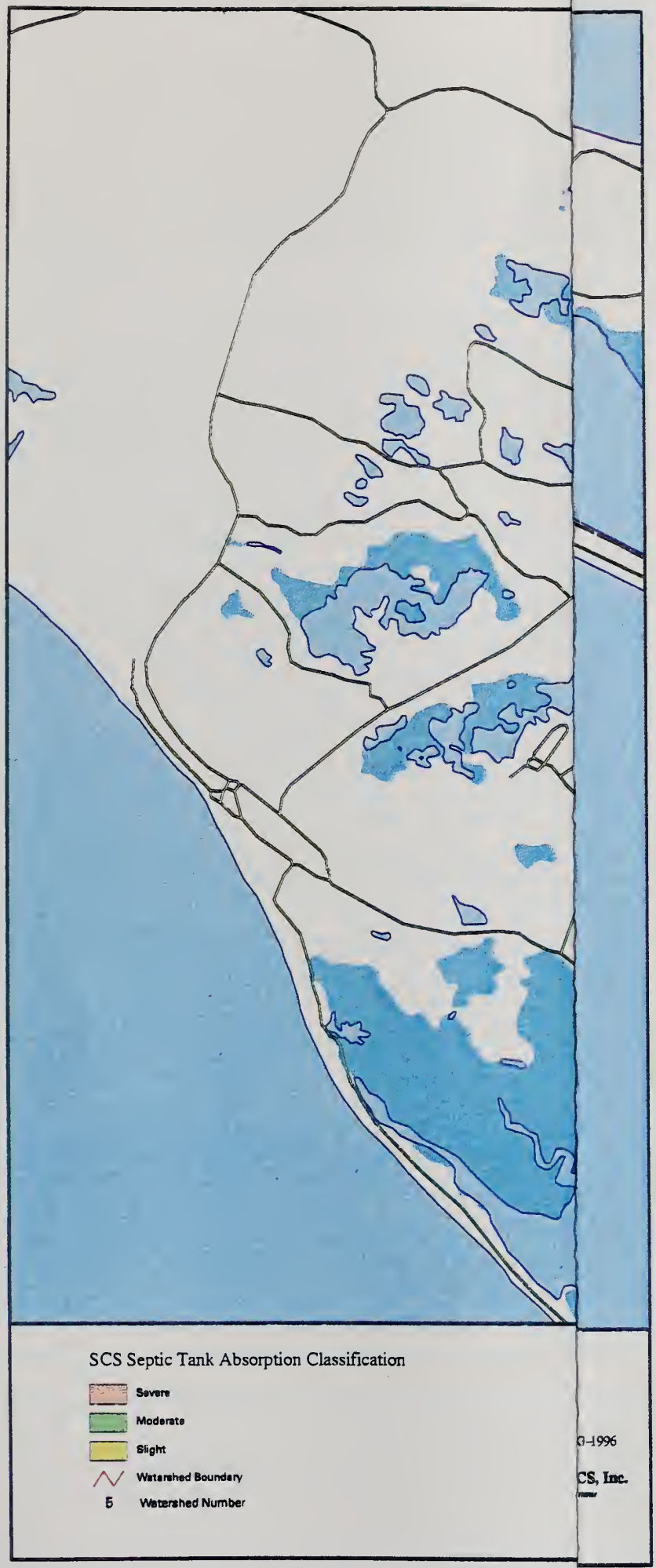
Soil Septic Suitability
Ipswich: Watersheds


SCS Septic Tank Absorption Classification
Severe
Moderate
Slight
Watershed Boundary
5 Watershed Number
0-1996
CS, Inc.

SCS Septic Tank Absorption Classification

- Severe
- Moderate
- Slight
- Watershed Boundary
- 5 Watershed Number

KILOMETERS 0 0.5 1 2

MILES 0 0.5 1 2

N W E S

Soil Septic Suitability
Provincetown: Watersheds

FIGURE 8

Base Data: EOEA, MassGIS
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inch rainfall event is considered to be representative of average storm conditions. According to Driscoll (1989), greater than 75 percent of the storm events that occurs in coastal areas of Massachusetts are approximately 0.5 inches. Extreme conditions, or storm events that occur less frequently, were also modeled. The 3.0 inch storm was selected to represent severe rainfall conditions because it represents the 10 year storm event (6 hour duration) for this region (Hershfield, 1961). The FecaLOAD model was run for each rainfall volume for existing and buildout land use conditions.

Factors which affect the rate at which precipitation becomes runoff include drainage density, the sum of all stream channel lengths divided by the watershed area; antecedent moisture conditions of the soil; vegetation type and density; percent basin coverage of surface water bodies; and urbanization with its associated impervious surfaces.

VI. SOURCES, FATE AND TRANSPORT OF FECAL COLIFORMS

Non-point source pollution is primarily responsible for bacterial contamination to coastal waters (Heufelder, 1988). It is caused when rainwater or snow melt flows over land characterized by a particular land use, such as commercial, industrial, residential, agriculture, grazing land, road surface, and open land (parks, beaches), and washes pollutants that have accumulated on those land surface into storm drains, streams, and rivers, and eventually into coastal waters. Contaminants may also reach coastal waters via subsurface transport in ground water.

Fecal coliform bacteria in non-point source pollution originates in humans, livestock, domestic pets and wildlife. Estimates of the number of fecal coliform organisms derived from these sources are shown in Table 8.

Table 8. Sources of Fecal Coliform Organisms

Source	Fecal Coliforms/Source	Reference
Humans	2 billion/day	(ICPCC, 1995)
Cats	320 million/day	(Koppelman, et. al., 1978)
Dogs	5 billion/day	(Koppelman, et. al., 1978)
Horses	2 billion/day	(ICPCC, 1995)
Cows	5 billion/day	(Koppelman, et. al., 1978)
Duck	11 billion/day	(ICPCC, 1995)
Goose	1 billion/day	(ICPCC, 1995)
Swan	1 billion/day	(ICPCC, 1995)

The quantity of fecal coliform bacteria (number of organisms) contained in the runoff from a given rainfall event is classified as its bacterial load. The mathematical expression for this is:

$$Q \times C = L$$

where:
Q is the volume of watershed runoff
C is the concentration of fecal coliforms in the runoff
L is the bacterial load

Several past studies have quantified the number of fecal coliform organisms typically generated by most of the common land uses. The range of these values and the corresponding references are shown in Appendix A. The loading coefficients used for each land use in the FecaLOAD model are also included in Appendix A.

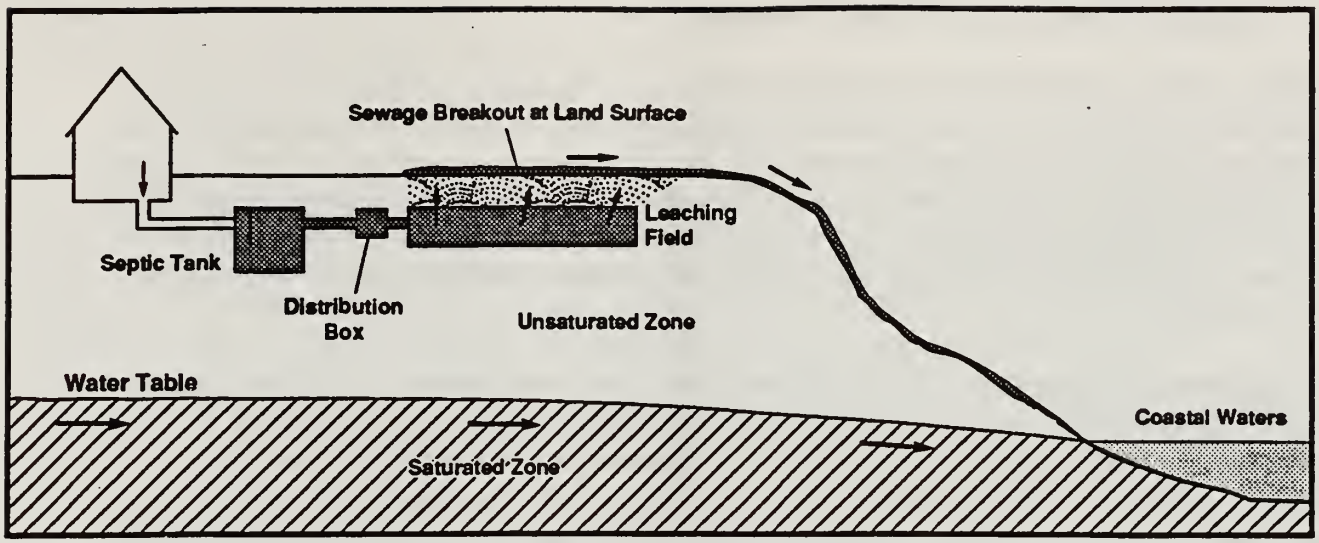
Fecal coliform derived from human waste is typically discharged into the subsurface environment via septic system effluent or into a wastewater collection system. Water quality impacts associated with septic effluent are minimized through the use of properly functioning septic systems. However, in some instances leaky septic systems can be important sources of pathogenic contamination because they discharge untreated or poorly treated waste to onto the ground surface or into the subsurface. Where septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soils to attenuate bacteria) adverse impacts to downgradient surface waters may occur (Figure 9). In some instances septic systems are located within the water table. In these cases, contamination from fecal material is more likely to occur. Loadings from sewered residences is assumed not to occur due to standard disinfection practices associated with wastewater treatment plants. This is a simplifying assumption extrapolated to these areas for the purposes of modeling and should not be interpreted as being representative of sewered areas in general.

Fecal coliform bacteria from livestock, domestic pets, and wildlife are deposited on the land surface in the watershed and are, therefore, directly available for transport via stormwater. In rural areas, cow manure is typically applied to the ground surface as a crop fertilizer, a practice that greatly increases the amount of fecal coliforms available for entrainment in runoff. In residential and open land areas, dogs and cats commonly deposit fecal matter onto road surfaces and adjacent areas. Fecal coliforms that accumulate on road surfaces in residential, commercial, industrial, open land, and on major roads or highways are sources of fecal coliform loadings for those land uses.

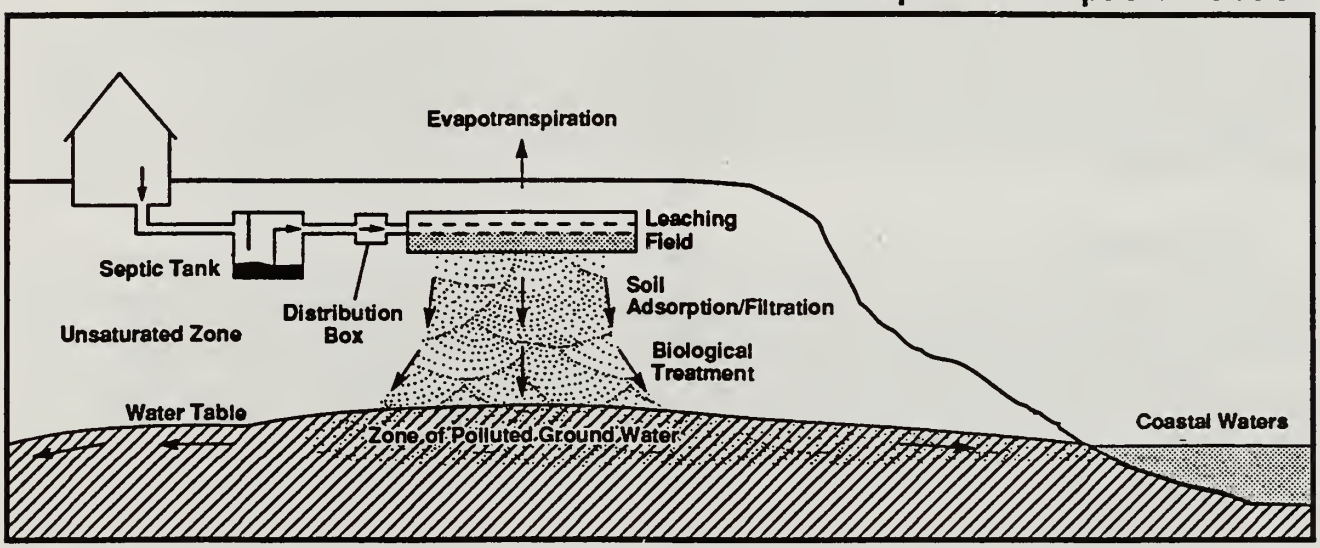
Waterfowl can also be significant sources of fecal coliform to surface waters (Heufelder, 1988). However, no survey data estimating the number of waterfowl living in the embayment drainage area subwatersheds were available for this study. Potential loadings from waterfowl were therefore not included in the modeling calculations for this study.

Figure 9.

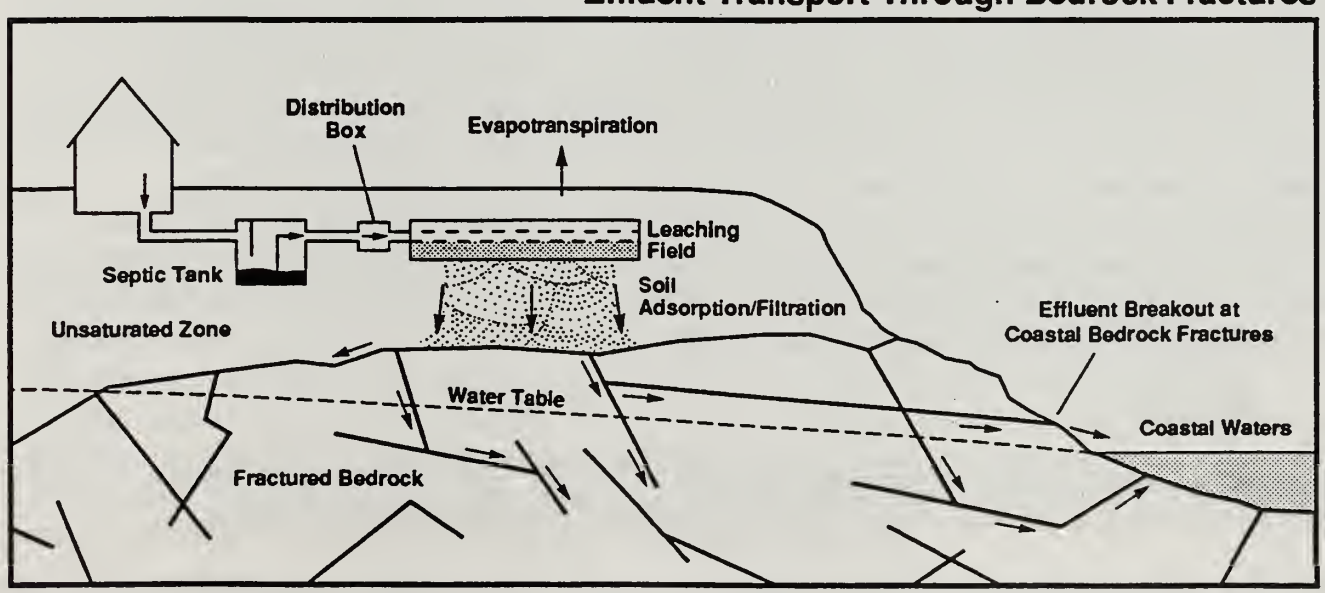
Hydraulic Failure



Inadequate Adsorption/Filtration



Effluent Transport Through Bedrock Fractures



Not to Scale

A. Surface Transport of Fecal Coliforms

Surface water flows within a watershed occur as overland runoff and as stream flow. Overland flow, or stormwater runoff, is generated when the capacity of the soils and vegetation to absorb water from precipitation is exceeded and water runs across the surface of the land. In clay-rich soils this adsorption capacity is low and is reached quickly. In sandy soils, a larger portion of the precipitation infiltrates the land surface and recharges the underlying ground water system, resulting in less runoff.

Stormwater runoff is one of the primary transport mechanisms for fecal coliform to receiving waters. Another potentially important transport mechanism is subsurface, or ground water, transport (see Subsurface Transport of Fecal Coliforms below). The quantity of fecal coliform bacteria available for entrainment in stormwater runoff is primarily a function of the amount of waste available, temperature, solar radiation, soil pH, and soil moisture. Because soil moisture is controlled by climatic conditions prior to the precipitation event, the timing of the rainfall or snow melt is also a significant factor because it often determines how much water will be available for the "first flush" of the watershed. More details on the factors controlling fecal coliform variability are provided below.

1. Temperature:

Studies on the effect of temperature on survival of coliform bacteria shows that they tend to die off as temperature increases (Yates and Yates, 1988). Die-off rates are reported to approximately double with a 10 °C rise in temperature, at least for temperatures in the 5-30 °C range (Reddy, et al., 1981).

2. Solar Radiation:

Bacteria die-off rates rise as exposure to sunlight is increased. Solar radiation intensity varies seasonally, with the greatest exposure to sunlight occurring during the longer days in the summer months and the least exposure occurring during the shorter days in the winter. Moore et al. (1982) developed die-off coefficients of .51 log units/day for the summer months and .36 log units/day for the winter months. Generally, however, fecal coliforms derived from sources far from receiving waters experience more exposure to solar radiation during transport, and thus die off more readily than fecal coliforms derived from sources near receiving waters. Consequently, inputs originating farther from the receiving waters may be less important than those located closer to the water body.

3. Soil pH:

In general, bacteria survival decreases in low pH soils. For soils with pH levels between 3 and 4, bacterial die-off usually occurs within a few days; however, in

slightly acidic to slightly alkaline soils (pH between 5.8 to 7.8), bacteria may survive up to several weeks (Yates and Yates, 1988).

4. Soil Moisture:

Survival time of bacteria increases with the moisture content of the soil (Teutsch et al, 1991). Increased soil moisture can result from greater available moisture or a greater moisture-holding capacity of the soils. Soils rich in clay are capable of retaining larger volumes of water than other soils because of the ability of clay material to absorb water. Consequently, clay content increases soil moisture retention, and therefore bacteria survival (Reddy et al., 1981). Because the amount of water that runs off a land surface rather than percolating through soils depends on the degree of soil saturation, wet soils generally increase runoff and bacterial loading to surface waters.

5. First Flush

The first flush of the watershed is the amount of rainfall required to remove the majority of contaminants from a watershed. According to a 1974 study by the USEPA, 90% of the total suspended solids are contained within the first 0.5 inches of rainfall. Because of this, the 0.5 inch rainfall event is generally considered to produce the first flush of the watershed.

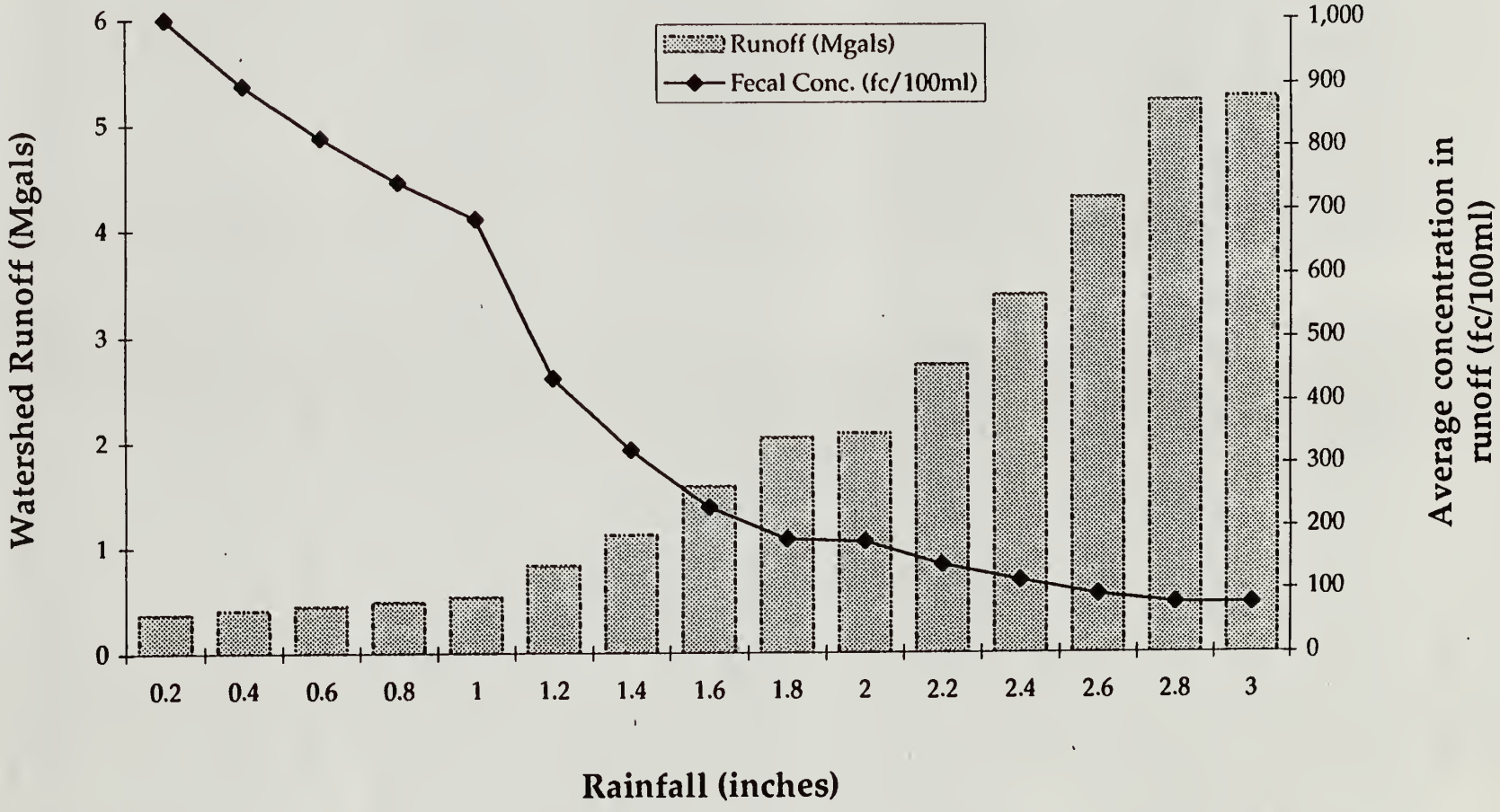
Because stormwater runoff is the primary transport mechanism for bacteria, larger and more intense rain events carry more bacteria from the watershed into adjacent waters. The first inch of rainfall typically removes most of the bacteria available for entrainment in runoff (Moore, et al., 1982). Average concentrations of fecal coliform in runoff from a one-inch or less rainfall, expressed as the number of fecal coliforms in a 100 milliliter water sample, are typically higher than average concentrations for rainfalls in excess of one-inch. Thus, as rainfall exceeds one inch, fecal coliform concentrations will decrease significantly, even though total loading will continue to slightly increase. This trend is exhibited in Figure 10, a graph which was constructed using existing land use data from the IP 5 (Saltonstall Brook) watershed and running the model for successive rainfall events, each increasing by 0.2 inches. Average concentrations are shown on Figure 10 to be generally greater for smaller storms than for larger storms.

B. Subsurface Transport of Fecal Coliforms

Septic effluent is the principal source of fecal coliforms found underground. Once below the surface, bacteria are removed from the effluent primarily through filtration and adsorption (US EPA, 1987). Filtration occurs during septic effluent percolation where the bacteria are too large to pass through pore spaces in the soil matrix. Adsorption is a process by which microorganisms adhere to clay and other particles in the soil. While these two processes are the primary means of attenuating bacteria that has been discharged directly into the subsurface, they also affect bacteria that infiltrates soil from the ground surface.

Figure 10

Modeled watershed runoff and fecal coliform concentrations in runoff for various rainfall events



1. Filtration:

As bacteria are transported through the soil, their rate of removal depends on the particle size of the soil (US EPA, 1987). Many bacteria are large enough to be filtered out as water percolates through soil pores, but fractured bedrock and coarse-grained soils such as gravel, which have larger spaces between particles, permit rapid movement. Thus, soils with smaller pores (silts and fine sands) are more efficient at removing bacteria than soils with larger pores such as coarse-textured soils. Most bacteria are filtered out within a distance of 4-100 feet in permeable sand (Reddy, et al., 1981). Fractures in bedrock provide virtually no bacteria filtration, and bacteria can migrate significantly longer distances. Therefore, septic systems placed in soils with a shallow depth to bedrock (less than four feet) represent a more significant risk to downgradient waters.

2. Adsorption:

In addition to filtration, subsurface attenuation occurs when bacteria adhere to soil particles (Lower, et al., 1979). Bacteria are adsorbed more effectively by fine soils than coarser soils, generally because fine soils contain a higher content of clay material than coarse soils, and thus typically have a high sorptive capacity.

VII. FECAL COLIFORM MODELING APPROACH; FecaLOAD

FecaLOAD is a computer model designed to estimate fecal coliform loadings from land uses in watersheds associated with runoff from a specified rainfall event. It was developed by H&W in Microsoft® Excel (version 4.0), a spreadsheet program that is compatible with Macintosh® and IBM® operating systems.

In addition to the Massachusetts Bay Region, FecaLOAD has been successfully applied in Casco Bay, Maine (H&W, 1996b). Using data on precipitation, runoff and water quality collected over a one year period, the model was applied to three coastal subwatersheds of Maquoit Bay, Maine. This application provided an opportunity to calibrate the results predicted by FecaLOAD with data collected in the field. Due to the wide variability of fecal coliform concentrations found in the environment, the calibration target for FecaLOAD output is one order of magnitude of measured value where possible, and two orders of magnitude in limited instances as an upper limit of acceptability. The calibration from the Casco Bay, Maine study showed close correlation between model output and field data.

In addition to fecal coliform loading coefficients, transport pathways, and attenuation mechanisms incorporated in its design, FecaLOAD also incorporates a qualitative ranking system that determines the bacterial pollution potential of three land uses: non-sewered residential land, agriculture and pasture land.

A. FecaLOAD Qualitative Ranking System

H&W developed a ranking system to predict potential fecal coliform pollution from non-sewered residential, agricultural, and pasture land uses. FecaLOAD automatically calculates rankings for these land uses. The ranking system is a function of hydrogeological conditions and proximity to receiving surface waters. The hydrogeological factors include 1) depth to seasonal high water table, 2) soil permeability, and 3) depth to bedrock. These factors are evaluated together in the SCS County Soil Survey: Table for Sanitary Facilities in which the suitability of each soil type is classified as "slight, "moderate", or "severe" according to its difficulty in assimilating septic effluent (see Table 9, Septic tank absorption fields).

The SCS defines the soil suitability of each soil type in qualitative terms. "Slight" soils are defined generally favorable for siting septic systems; "moderate" soils are defined as unfavorable for siting septic systems, but limitations can be overcome by special planning and design; "severe" soils are defined as so unfavorable for siting septic systems that major soil reclamation, special designs, or intensive maintenance is required. If any of these factors causes the soil to be classified as "moderate" or "severe", or if the land use is in close proximity to receiving waters, adverse impacts to downgradient surface waters may occur. This ranking system is explained below for non-sewered residential, agricultural, and pasture land.

Table 9. Example of SCS County Soil Survey: Table of Sanitary Facilities

Soil name and map symbol	Septic tank absorption fields (Soil Suitability)	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill
CrB*:				
Charlton-----	Moderate: large stones.	Severe: seepage.	Severe: seepage.	Severe: seepage.
Rock Outcrop.				
Hollis-------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage.
CrC*:				
Charlton-----	Moderate: Slope, large stones.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.
Rock outcrop.				
Hollis-------	Severe: depth to rock.	Severe: slope, depth to rock, seepage.	Severe: depth to rock, seepage.	Severe: seepage.
CrD*:				
Charlton-----	Severe: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage, slope.

Source: Soil Survey of Essex County, Massachusetts, Northern Part, USDA, Soil Conservation Service, 1981.

1. Non-Sewered Residential Land

For residential land with septic systems, the Soil Suitability Rating and proximity to surface water combine in the manner shown in Table 10 to arrive at a qualitative Category Ranking, where Category I indicates no pollution potential, Category II indicates moderate pollution potential, and Category III indicates the greatest pollution potential.

Table 10. Qualitative Rankings for Residential Land Uses on Septic Systems

Proximity to Surface Water	NRCS Soil Suitability		
	Slight	Moderate	Severe
<100	Cat II	Cat III	Cat III
100-500	Cat II	Cat II	Cat III
>500	Cat I	Cat I	Cat II

The rationale for use of these factors is as follows: A septic system failure leading to surface break-out or groundwater contamination is typically caused by the inability of the underlying soil to assimilate the effluent due to one or a combination of hydrogeological factors. Effluent running over the land surface is apt to be transported to receiving waters without sufficient pathogen attenuation, making the septic system a more likely candidate for potential bacterial pollution of a water resource--but only if the septic system is in relatively close proximity to that resource. A poorly functioning septic system located high in the watershed (more than 500 feet from a stream) poses less of a threat as a marginally functioning system located immediately adjacent to a stream. The exception to this assumption is the condition in which septic effluent discharges into fractured bedrock. Because effluent can travel longer distances through subsurface fractures, especially bedrock fractures, fecal coliform bacteria are more likely to reach downgradient surface waters with minimal attenuation. To account for the elevated pollution potential associated with these conditions, residential land on septic systems in "severe" soils located beyond 500 feet from surface water is considered Category II.

H&W assigned coefficients of pollution potential to each category in the FecaLOAD model during its calibration for the Casco Bay, Maine study. The coefficient of pollution potential is 0.0 for Category I, 0.6 for Category II, and 0.8 for Category III. These coefficients are multiplied by the residential land loading value and the number of residential units to determine total loadings.

This ranking system is a useful method of assessing potential impacts on receiving surface waters from septic systems because it combines distance to the surface water of interest with the most important hydrogeological factors affecting fecal

coliform fate and transport. However, broad application of this ranking system to an entire subwatershed area is associated with the possibility of overestimating or underestimating the water quality impact of localized conditions exists. For example, septic systems that may be located in "moderate" or "severe" soils may nevertheless function properly with respect to bacterial attenuation, even if located relatively close to receiving waters. In these cases, the model would overpredict the impact of these septic systems. In other instances, poorly functioning septic systems located in "slight" soils may represent a greater potential of contamination than suggested by a Category II ranking. If local information on the condition of septic systems in the watershed is available (for example, from a septic survey), this information may be incorporated into the data entry section of the FecaLOAD model (see *Companion Guidelines for FecaLOAD; Data Entry*) (H&W, 1996a).

2. Agricultural and Pasture Land

The pollution potential of an agricultural area with land-applied manure spreading and/or livestock grazing is dependent on proximity of the area to surface water and the assimilation capacity of the soils. For example, agricultural lands on thin soils (shallow depth to bedrock) with low permeability will become saturated by rainfall and display runoff rates greater than fields with deeper, more permeable soils. Applied manure that is spread on lands with thin soils and/or poorly permeable soils and close to a surface water body represents a greater likelihood of causing bacterial pollution via stormwater runoff to surface waters than manure which is spread on thicker and/or more permeable soils located farther from the resource of interest or farther from a conduit to that resource (i.e. storm drain or tributary).

For Agriculture and Pasture Land, the soil suitability data and proximity to surface water combine in the manner shown in Table 11 to determine the qualitative Category Rankings of those two land uses, where Category I indicates no pollution potential, Category II indicates moderate pollution potential, and Category III indicates the greatest potential for bacterial pollution.

Table 11. Qualitative Category Rankings for Agriculture and Pasture Land

Proximity to Surface Water	NRCS Soil Suitability		
	Slight	Moderate	Severe
<100	Cat III	Cat III	Cat III
100-500	Cat II	Cat II	Cat III
>500	Cat I	Cat I	Cat I

Coefficients of pollution potential were also assigned to agriculture and pasture lands in the FecaLOAD model during its calibration for the Casco Bay, Maine

study. The coefficient of pollution potential is 0.4 for Category I, 0.6 for Category II, and 0.8 for Category III. These coefficients are multiplied by the respective loading coefficients and acreages to determine the total amount of fecal coliform produced by each land use. Therefore, the total loadings of fecal coliform to the resource of interest are the amount of fecal coliforms left over after accounting for surface die-off (see Model Variables below and Appendix A).

As mentioned above for residential areas with septic systems, broad application of this ranking system to all agricultural or pasture lands in an entire subwatershed area may overestimate or underestimate the water quality impact of localized conditions. For instance, if some of the agricultural or pasture land in a particular watershed employs best management practices (BMPs), loadings from those areas may be lower than what would otherwise be estimated by the model. This information, if available, may be incorporated into the data entry section of the FecaLOAD model (see *Companion Guidelines for FecaLOAD; Data Entry*) (H&W, 1996a).

B. Summary of Bacteria Modeling Approach

Perhaps the most challenging aspect of modeling fecal coliform loading is the choice of which attenuation factors to incorporate into the model, given the wide range identified in the scientific literature. Attenuation coefficients are difficult to measure; in part because bacteria populations both grow and die off at varying rates based on one or more of the factors previously described. The parameters affecting bacterial sources, fate and transport discussed above were selected for incorporation into FecaLOAD because they represent the most important environmental conditions and are accessible to, and/or easily determined by, environmental managers and other potential model-users. Because of the frequency with which bacteria grow and die-off, modeling the amount of living bacteria at any one time must allow for these fluctuating conditions.

VIII. FecaLOAD INPUTS

A. Land Use Data

For each watershed, the FecaLOAD model requires inputs of land use and road length through each land use. This information was obtained from MassGIS as digitized MacConnell Land Use data, updated in 1985 for most of Massachusetts and 1990 for Cape Cod Massachusetts. Although a significant time period has lapsed since these data were digitized, the MacConnell Land Use data are still a valuable resource because of their accessibility for analysis and speed with which data can be extracted on a GIS. The land use maps shown on Figures 2, 3, and 4 were generated using MacConnell land use data.

The MacConnell Land Use maps identify twenty-one different land use classifications for most of Massachusetts. An additional 16 land uses are classified for Cape Cod. For this study, twenty-one MacConnell Land Use classifications were used. These classifications, and their corresponding FecaLOAD classifications are listed in Table 12 below.

Table 12. MacConnell Land Use Classifications and Corresponding FecaLOAD Land Uses.

MacConnell Land Use	Definition	Corresponding FecaLOAD Land Use
Cropland	Intensive Agriculture	Agriculture
Pasture	Extensive Agriculture	Pasture
Forest	Forest	Forest
Wetland	Nonforested Freshwater Wetland	Not Modeled
Mining	Sand, Gravel & Rock	Industrial
Open Land	Abandoned Agriculture, power lines, areas of no vegetation	Open Land
Participation Recreation	Golf, Tennis, Playgrounds, Skiing	Open Land
Spectator Recreation	Stadiums, Racetracks, Fairgrounds, Drive-ins	Open Land
Water Based Recreation	Beaches, Marinas	Open Land
Residential Multi-Family	Multi-family	Multifamily Residential
Residential High Density	Smaller than 1/4 acre lots	High density Residential
Residential Medium Density	1/4 - 1/2 acre lots	Medium density Residential
Residential Low Density	Larger than 1/2 acre lots	Low density Residential
Salt Wetland	Salt Marsh	Not Modeled
Commercial	General Urban, Shopping Center	Commercial
Industrial	Light & Heavy Industry	Industrial
Urban Open	Parks, Cemeteries, Public & Institutional Greenspace, also Vacant Undeveloped land	Open Land
Transportation	Airports, Docks, Divided Hwy., Freight Storage, Railroads	Commercial
Waste Disposal	Landfills, sewage lagoons	Not Modeled
Water	Fresh water, coastal embayment	Not Modeled
Woody Perennial	Orchard, Nursery, Cranberry bog	Agriculture

1. Residential Dwellings:

FecaLOAD is designed to automatically calculate the number of residential dwellings by multiplying the acreage of each residential land use by the corresponding MacConnell Land Use Housing Density factor (Costa et al., 1994). Housing densities are as follows:

Multi-family: .....5.0 dwellings/acre
High density (less than 1/4 acre lots): .....3.7 dwellings/acre
Medium density (1/4 - 1/2 acre lots): .....2.0 dwellings/acre
Low density (greater than 1/2 acre lots): .....1.0 dwellings/acre

FecaLOAD calculates fecal coliform loadings to receiving surface waters from roads that pass through residential areas, and from on-site wastewater disposal (septic) systems. Some residential areas are serviced by a municipal sewer system, thus only loading from roads occur from these areas. For modeling, it is therefore important to differentiate between sewered and non-sewered areas. To determine where sewered areas were located, a coverage defining the areas that are sewered and those non-sewered was obtained from the Metropolitan Area Planning Council (MAPC).

Geographic Information Systems (GIS) technology contributes to watershed modeling of storm events by permitting the overlay of a number of spatially defined variables. These variables include soil type, land use/land cover, population densities with septic systems and on sewers, and proximity to surface water. Not only does GIS permit rapid aerial and linear statistics for import to the watershed model, but it is also capable of producing statistics for many land use scenarios. For the modeled communities, aerial and linear statistics have been entered into the model for two distinct scenarios: Current land use and future (or buildout) land use. Land use data tables are provided in Appendix B. Tables 13 through 15 below are summaries of the existing land uses for each subwatershed in the three modeled communities. The corresponding land use maps for each community are shown on Figures 2 (Beverly), 3 (Ipswich), and 4 (Provincetown).

Table 13. Existing Land Use Acreage of Bass River embayment drainage area subwatersheds.

Land Use	B1	B2	B3	B4	B5	B6	B7	B8-23
Commercial	1	7	7	0	0	12	44	242
Industrial	10	2	0	0	73	17	9	212
Open Land	0	0	4	87	18	0	17	274
Agriculture	0	0	0	0	0	0	0	51
Pasture	41	2	0	0	0	0	0	18
Forest	26	0	5	34	0	0	86	231
Residential	46	58	98	18	14	0	172	534
Residential Units on Septic	60	16	0	0	0	0	0	40

Table 14. Existing Land Use Acreage of Ipswich River embayment drainage area subwatersheds.

Land Use	IP1	IP2	IP3	IP4	IP5	IP6	IP7	IP8	IP9
Commercial	0	21	0	12	49	2	0	3	2
Industrial	0	0	0	7	5	0	0	0	6
Open Land	49	14	20	10	11	0	14	9	0
Agriculture	2	0	8	26	24	0	0	0	0
Pasture	46	0	389	85	51	14	0	0	0
Forest	57	139	387	353	175	113	30	1	0
Residential	18	28	133	184	132	82	118	11	3
Residential Units on Septic	61	0	166	122	31	61	8	0	0

Table 15. Existing Land Use Acreage of the Provincetown Harbor embayment subwatersheds.			
Land Use	P1	P2	P3
Commercial	49	12	34
Industrial	0	0	0
Open Land	21	6	0
Agriculture	0	0	0
Pasture	0	0	0
Forest	7	0	5
Residential	105	11	40
Residential Units on Septic	364	37	143

To determine aerial statistics by proximity to water, a datalayer describing the watershed unit in terms of its proximity to open water was first required. Open water was defined as lakes, ponds, streams and rivers, and coastal waters (wetlands are included as their own land use category).

Once land uses were grouped for the defined subwatersheds, a spreadsheet for each subwatershed was created which sub-divided each land area by: 1) land use category, 2) proximity to surface water, 3) whether the land area is sewered or on septic, 4) acreage, and 5) zoning. An example of this is shown below in Table 16. Acreages from this spreadsheet were entered directly into FecaLOAD.

Residential, agriculture, and pasture land use acreages are used by FecaLOAD to determine (rank) the pollution potential according to the Soil Suitability Rating of the soil on which those land uses are located, as well as their proximity to receiving surface waters (see FecaLOAD Qualitative Ranking System).

Table 16. Example Table of Hypothetical Input Data for FecaLOAD					
Land Use	Soil Suitability Rating	Proximity to Surface Waters	Sewered	Acres	Zoning Code
Agriculture	Moderate	<100	N	2.60	RRA
Agriculture	Moderate	>500	N	4.10	RRA
Commercial	Severe	<100	Y	8.64	C
Commercial	Severe	100-500	Y	0.08	I
Forest	Moderate	<100	N	25.34	RRA
Industrial	Severe	<100	Y	5.03	I
Pasture	Severe	100-500	N	27.96	RRA
Resid 1/4 - 1/2 Acre	Severe	<100	N	0.86	RRA
Resid < 1/4 Acre	Moderate	100-500	N	6.70	RRA
Resid < 1/4 Acre	Slight	<100	N	1.68	RRA
Resid < 1/4 Acre	Severe	>500	Y	4.95	RRA
Resid > 1/2 Acre	Severe	100-500	N	6.00	RRA
Open Land	Severe	100-500	N	2.96	RRA
Open Land	Moderate	100-500	Y	1.16	RRA
			Total Watershed Acreage =	98.06	

2. Roads

Road length data were obtained in digital format from MASSGIS. Roads located within areas classified as Recreation fall under the Open Land category. Roads that are located within areas classified as wetlands and open water (bridges) are not modeled. Fecal coliform loadings from domestic animals such as dogs and cats are included in the runoff from road surfaces for residential and open land uses. In some instances, birds congregating on bridges provide direct input of fecal matter into surface water bodies; however, the level of precision of the model does not account for these isolated situations. Values for road length and curbside accumulation of fecal coliform are included in Appendix A.

B. Model Variables

Once the land use and road length data have been entered into FecaLOAD, there are five variables that can be changed to evaluate modeled runoff and water quality under different scenarios. These are:

1) Rainfall (inches)
2) Time since last rain (days)
3) Amount of precipitation in previous five days (inches)
4) Season (summer, fall, winter, or spring)
5) Days since manure was applied (to croplands, or agricultural land).

Making small adjustments to any of these variables can have a profound impact on model output. For hypothetical model scenarios, any combination of these variables may be used as input. Historical modeling, however, requires specific knowledge of each variable, and, in the case of comparing model output to historical water column fecal coliform data, the method used to sample for fecal coliform content (i.e. composite or grab samples), as well as the time of sampling relative to the beginning of the rainfall event are required.

Variables 2 and 3 are used by FecaLOAD to determine soil antecedent moisture conditions (AMCs) as dry, normal, or wet. Antecedent moisture conditions is an index of the degree to which watershed soils are saturated, and are determined by the total rainfall in the 5-day period preceding the storm event. Wet AMCs will produce greater volumes of runoff than dry AMCs because soils are sufficiently saturated prior to a rainfall event, thus more of the rainfall will become runoff rather than infiltrate the surface soil. In the FecaLOAD model, dry AMCs reflect less than or equal to 0.5 inches of rain in the five days preceding a rain event, normal AMCs reflect between 0.5 and 2.0 inches of preceding rainfall, and wet AMCs occur when greater than or equal to 2.0 inches of rainfall occurs in this five-day period. Each model scenario was run using values of one day since last rain and one inch of rain in the previous five days, or normal AMCs.

Springtime was selected as the input for variable number 4 for hypothetical modeling because it is assumed to represent the median seasonal die-off rate. The

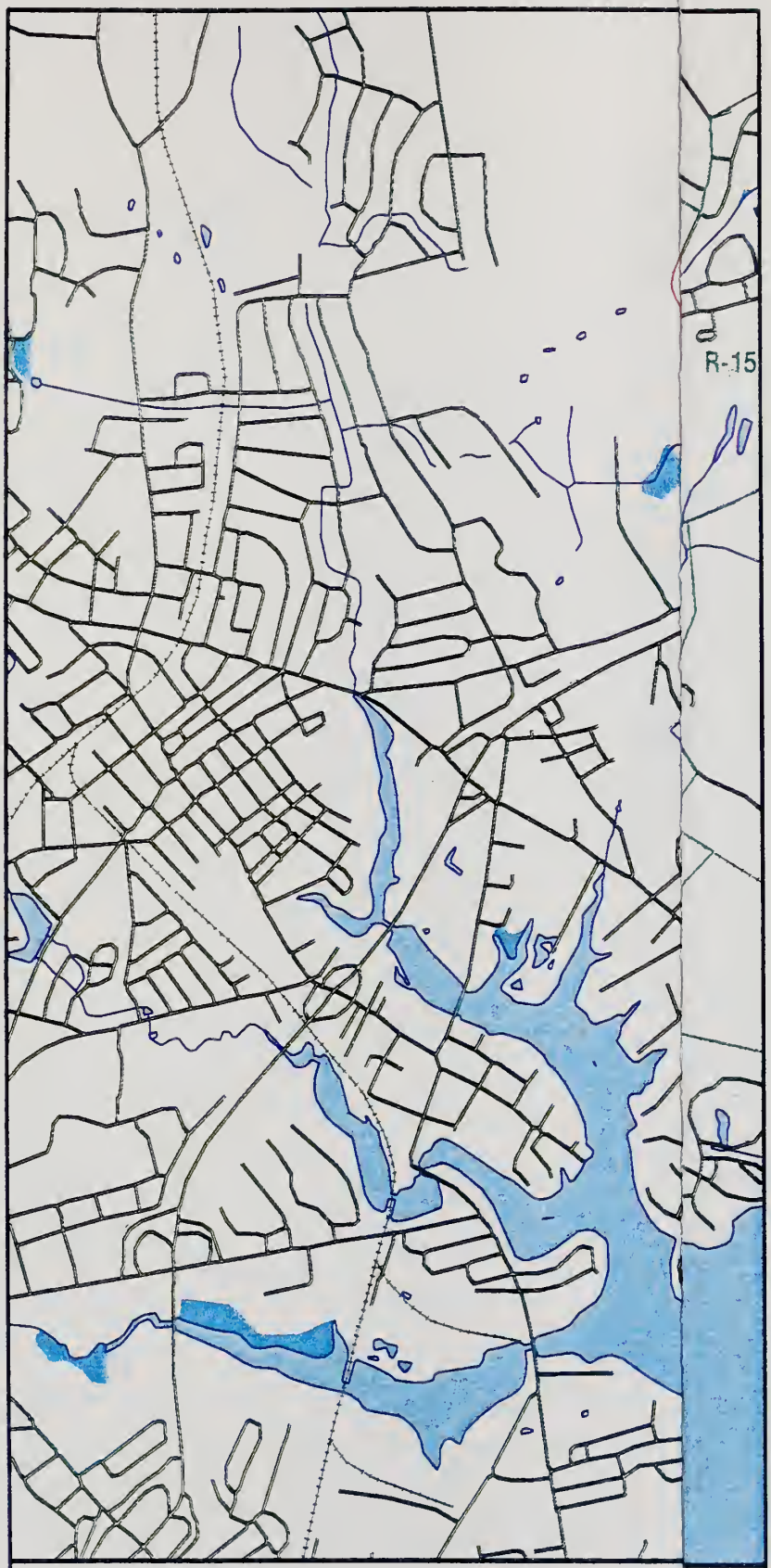
significance of this variable is that fecal coliform die-off most rapidly in the summer and least rapidly during the winter. Die-off coefficients, developed by Moore et al. (1982), are .51 log units/day during the summer months and .36 log units/day for the winter months. H&W assumed a median value (.435) for these coefficients to represent the spring and fall seasons. Historical modeling was based on the seasons in which the samples were collected.

The most difficult of these five variables to quantify for a model scenario is number 5, Days since manure was applied. Generally, this information is not readily accessible, or if it is, it is most likely by word-of-mouth. FecaLOAD uses a loading value of 10 tons of applied manure per acre. If the number of days since manure was applied is not known, FecaLOAD runs with a default value of 365 days, or one year, since manure was last land-applied and assigns a background concentration of 10 fecal coliforms per 100 milliliters of agricultural runoff, which was the observed concentration found in runoff from agricultural land in the rural watersheds of Maquoit Bay, Maine over a one-year study period during which manure was not applied. This 365 day default value does not significantly affect loadings since most fecal coliform derived from applied manure will typically die-off within approximately three weeks. To evaluate the impacts caused by relatively recent manure spreading, the model was run with an assumed time lapse of 7 days since manure was land-applied for subwatersheds 1, 3, 4, and 5 of the Ipswich River embayment drainage area where agricultural coverage is significant. The aggregate watershed in Beverly (Beverly 8-23) was not modeled with applied manure since Beverly has very little agricultural land.

C. Watershed Buildout

State land use enabling legislation within Massachusetts dictates that once a community programs itself through zoning and subdivision control, it is tied into a development "blueprint" which is difficult to alter. The blueprint frequently results in land development which exacerbates bacterial loading. To evaluate the water quality impacts of both existing and maximum development within each subwatershed, a complete buildout analysis was conducted. Building-out a land area results in a conversion of land use from its existing state to a more developed state. Converting land from one land use to another, or intensifying an existing use of land, results in a corresponding change in runoff and fecal coliform loading when it rains. Buildout conditions represent full development of the watershed according to local zoning.

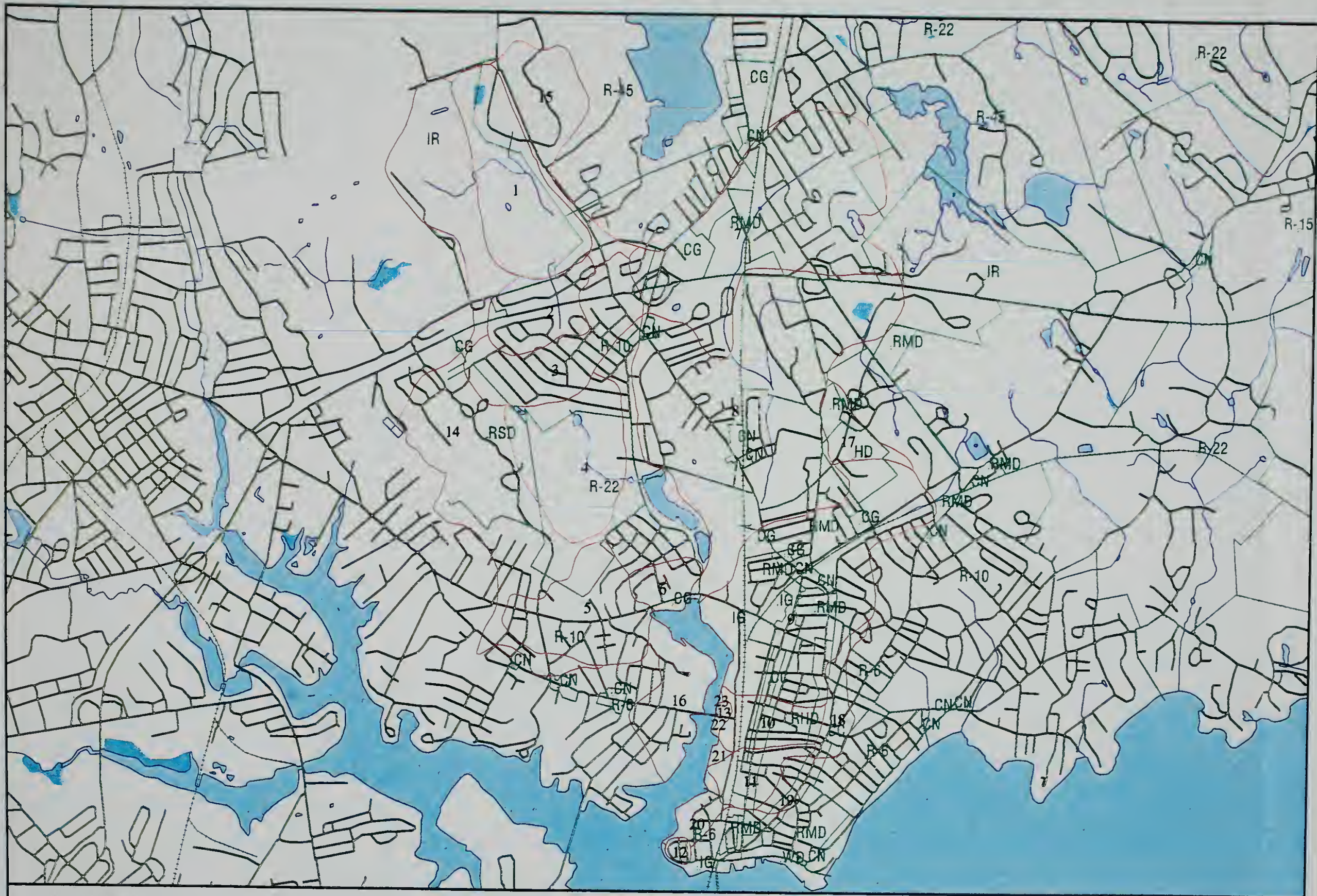
Digital zoning datalayers for each town were obtained from MassGIS and overlaid with the land use datalayer. Zoning datalayers reflect each town's zoning structure at the time they were generated. Datalayer vintages are 1987 for Beverly and 1980 for Ipswich. No date is indicated for the Provincetown datalayer. Each town's zoning is shown on Figures 11 (Beverly), 12 (Ipswich), and 13 (Provincetown).



5 Watershed Number

Beverly Zoning

CC COMMERCIAL CC	R-10 RESIDENTIAL R - 10	RHD RESIDENTIAL RHD
CG COMMERCIAL CG	R-15 RESIDENTIAL R - 15	RMD RESIDENTIAL RMD
CN COMMERCIAL CN	R-22 RESIDENTIAL R - 22	RSD RESIDENTIAL RSD
HD HOSPITAL DISTRICT	R-45 RESIDENTIAL R - 45	UNDEVELOPED
IG INDUSTRIAL IG	R-6 RESIDENTIAL R - 6	WD WATERFRONT DISTRICT
IR INDUSTRIAL IR	R-90 RESIDENTIAL R - 90	



5 Watershed Number

Beverly Zoning

- CC COMMERCIAL CC
- CG COMMERCIAL CG
- CN COMMERCIAL CN
- HD HOSPITAL DISTRICT
- IG INDUSTRIAL IG
- IR INDUSTRIAL IR
- R-10 RESIDENTIAL R - 10
- R-15 RESIDENTIAL R - 15
- R-22 RESIDENTIAL R - 22
- R-45 RESIDENTIAL R - 45
- R-6 RESIDENTIAL R - 6
- R-80 RESIDENTIAL R - 80
- RHD RESIDENTIAL RHD
- RMD RESIDENTIAL RMD
- RSD RESIDENTIAL RSD
- UNDEVELOPED
- WD WATERFRONT DISTRICT

KILOMETERS 0 0.5 1 2

MILES 0 0.5 1 2

Town Zoning Map
Beverly: WATERSHEDS

FIGURE 11

Base Data: EOEA, MassGIS
PLOT PRODUCED: 15-AUG-1996

APPLIED GEOGRAPHICS, Inc.
Environmental & Geographic Information Systems
100 Franklin Street
Boston, MA 02110
Phone: (617) 292-7125

5 Watershed Number

Ipswich
Zoning

B..... BUSINESS

I..... INDUSTRIAL

IR.... INTOWN RESIDENCE

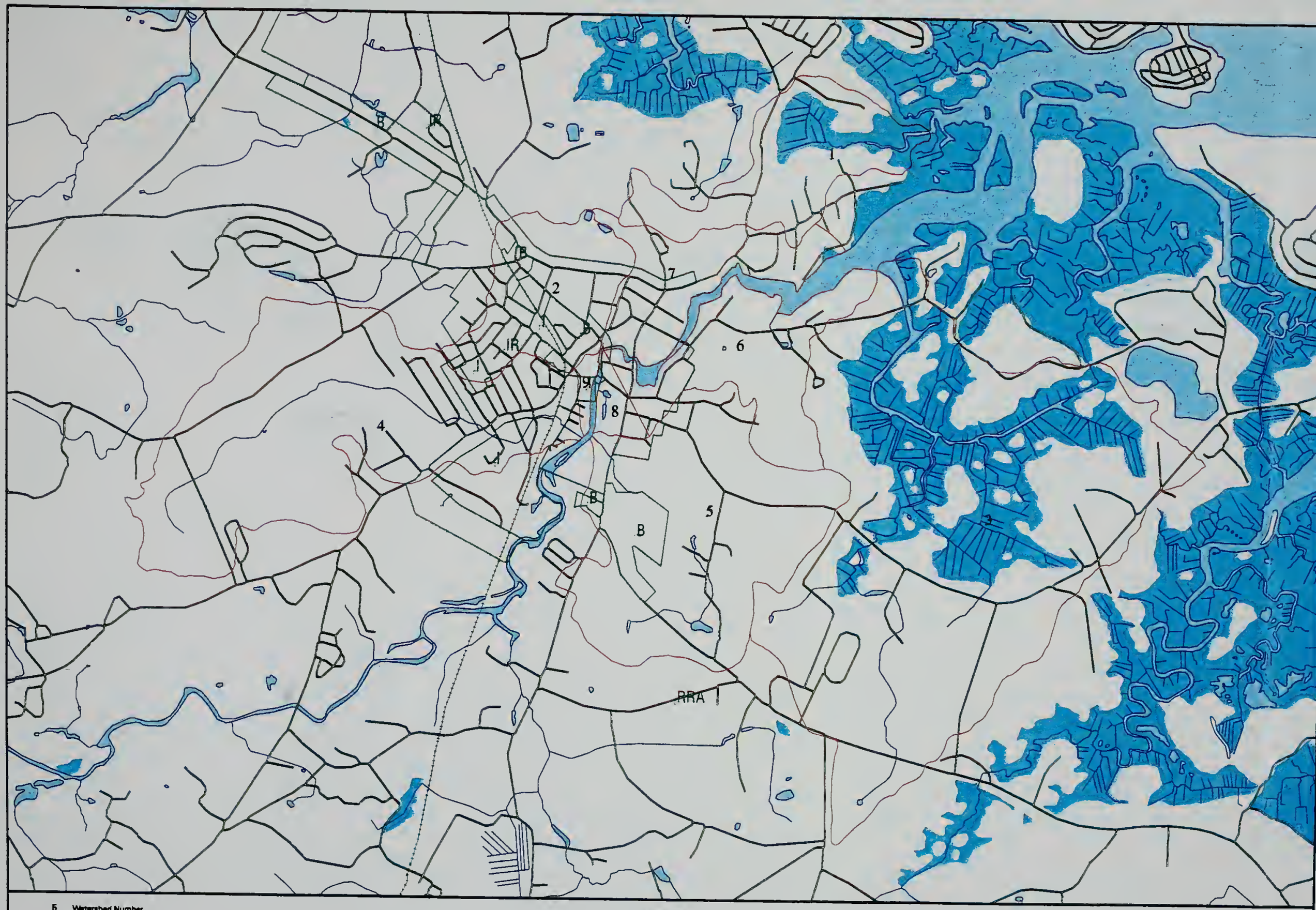
RRA.... RURAL RESIDENCE A

RRB.... RURAL RESIDENCE B

S

UG-1996

ICS, Inc.



5 Watershed Number

Ipswich Zoning

B.... BUSINESS

I.... INDUSTRIAL

IR... INTOWN RESIDENCE

RRA.... RURAL RESIDENCE A

RRB... RURAL RESIDENCE B

KILOMETERS 0 0.5 1 2

MILES 0 0.5 1 2

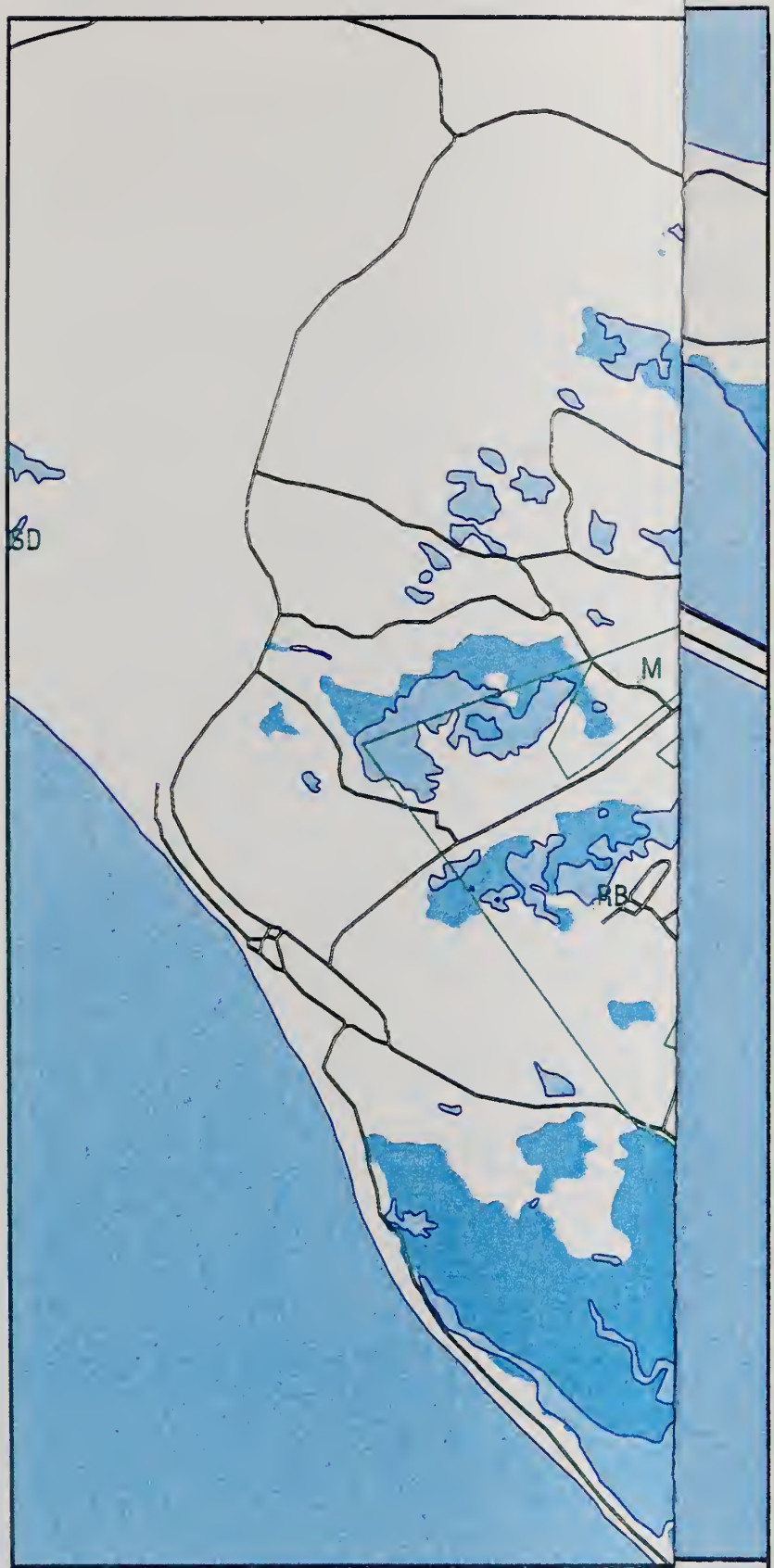
N W E S

Town Zoning Map
Ipswich: WATERSHEDS

FIGURE 12

Base Data: EOEA, MassGIS
PLOT PRODUCED: 15-AUG-1996

APPLIED GEOGRAPHICS, Inc.
Environmental & Geographic Information Systems
100 Franklin Street
Boston, MA 02110
Phone: (617) 292-7125



5 Watershed Number

Provincetown Zoning

CP	RW
CR	RWB
M	SD
RB	
RG	

UG-1996

ICS, Inc.

5 Watershed Number

Provincetown Zoning

CP
CR
M
RB
RG
RW
RWB
SD

KILOMETERS 0 0.5 1 2

MILES 0 0.5 1 2

N W E S

FIGURE 13

Base Data: EOEA, MassGIS
PLOT PRODUCED: 15-AUG-1996

APPLIED GEOGRAPHICS, Inc.
Environmental & Geographic Information Systems
100 Franklin Street
Boston, MA 02110
Phone: (617) 39[illegible]-7135

Town Zoning Map
Provincetown: WATERSHEDS

Using the zoning datalayers as a blueprint for future development, acreages of existing land uses were converted into acreages of potential future land uses according to the intended (zoned) use of each area. Town assessors records were not available in digital format, therefore, several simplifying assumptions (listed below) were incorporated in the buildout.

- Preservation of upland restricted open space was not included because the available digitized open space datalayers were found to be incomplete within each community, and also inconsistent between communities.

- Wetlands were considered unbuildable.

- Under the direction of the MBP, all agricultural and pasture land that could be developed to residential land according to current zoning was completely converted.

- The number of residential units are were calculated by multiplying the acreage of the residential category (low, medium, or high density or multi-family) by the MacConnell Land Use Housing Density values for Massachusetts (shown above) (Costa et al., 1994). This is the same method used for calculating the number of existing residential units.

- Roads that passed through land that was converted from one land use under existing conditions to a different land use under buildout conditions were also converted in order to reflect the buildout land uses through which they would pass.

1. Buildout Land Use Characteristics of Modeled Areas

A summary table showing existing and buildout land uses for each community (sum total for all subwatersheds) is provided below to convey the land use changes that would occur under complete buildout conditions (Table 17). Buildout land uses are also shown for individual subwatersheds for each community (Tables 18 through 20). Small numerical differences may exist between the composite acreages shown in Table 17 and the sum total of the individual subwatershed acreages in Tables 13-15 (existing land uses) and 18-20 (buildout land uses) as a result of whole number rounding. Minor differences such as this do not impact significantly on model results. Interpretations of the land use changes associated with buildout conditions on receiving water quality is addressed below (see Model Results).

Table 17. Comparison of Existing and Buildout Land Use Acreage for each Community			
Community	Land Use	Total Existing Acreage	Total Buildout Acreage
Beverly	Commercial	313	344
	Industrial	313	395
	Open Land	400	3
	Agriculture	51	0
	Pasture	20	0
	Forest	356	1
	Residential	894	1,724
	Number of Residential Units on Septic	56	179
Ipswich	Commercial	89	85
	Industrial	18	58
	Open Land	128	4
	Agriculture	61	0
	Pasture	585	0
	Forest	1,255	0
	Residential	710	2,715
	Number of Residential Units on Septic	449	1,655
Provincetown	Commercial	94	48
	Industrial	0	0
	Open Land	27	0
	Agriculture	0	0
	Pasture	0	0
	Forest	11	0
	Residential	156	242
	Number of Residential Units on Septic	544	1,086

Table 18. Buildout Land Use Acreage of Bass River embayment drainage area subwatersheds.								
Land Use	B1	B2	B3	B4	B5	B6	B7	B8-23
Commercial	0	0	0	0	0	4	30	311
Industrial	90	6	0	0	0	0	11	289
Open Land	0	0	0	0	0	0	0	3
Agriculture	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0
Forest	0	0	0	0	0	0	0	1
Residential	8.2	63	115	139	120	26	289	964
Residential Units on Septic	41	27	0	0	0	0	0	111

Table 19. Buildout Land Use Acreage of Ipswich River embayment drainage area subwatersheds.

Land Use	IP1	IP2	IP3	IP4	IP5	IP6	IP7	IP8	IP9
Commercial	0	29	0	0	49	0	1	1	4
Industrial	0	18	0	36	0	0	0	0	3
Open Land	0	0	0	0	0	0	4	0	0
Agriculture	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0
Forest	0	0	0	0	0	0	0	0	0
Residential	172	155	937	645	409	212	159	23	4
Residential Units on Septic	67	0	933	368	120	159	8	0	0

Table 20. Buildout Land Use Acreage of the Provincetown Harbor embayment subwatersheds.

Land Use	P1	P2	P3
Commercial	22	11	16
Industrial	0	0	0
Open Land	0	0	0
Agriculture	0	0	0
Pasture	0	0	0
Forest	0	0	0
Residential	160	18	64
Residential Units on Septic	725	90	271

IX. MODEL RESULTS

A. Hypothetical Rainfall Conditions

Modeled concentrations of fecal coliform for a 0.5 inch rainfall event are uniformly higher than concentrations from a 3.0 inch event for both existing as well as buildout scenarios (Tables 21, 22, and 23). This trend holds true for every community, and it illustrates the diluting effect of large rain events. It does not mean that fecal coliform loadings also decrease as rainfall increases, only that larger rainfall events will produce larger amounts of stormwater runoff, thereby resulting in more dilute concentrations of fecal coliform (see Figure 10). For further reference, total loadings for each modeled rainfall event were also divided by the subwatershed area to determine an estimated number of fecal coliforms per acre of each subwatershed (Tables 21, 22, and 23).

Table 21. Model Results for Bass River embayment drainage area subwatersheds: Hypothetical Rainfall

			Existing Conditions				Buildout Conditions			
Watershed #	Watershed Name	Area of Watershed (acres)	0.5" Rainfall (fc/100ml)	Estimated fc/acre for 0.5" Rainfall	3.0" Rainfall (fc/100ml)	Estimated fc/acre for 3.0" Rainfall	0.5" Rainfall (fc/100ml)	Estimated fc/acre for 0.5" Rainfall	3.0" Rainfall (fc/100ml)	Estimated fc/acre for 3.0" Rainfall
1	B1 (# 345)	144	17,000	118	1,600	11	3,200	22	480	3
2	B2 (# 341)	68	6,200	91	900	13	8,600	126	1,400	20
3	B3 (# 342)	117	2,000	17	320	3	1,400	12	290	2
4	B4 (# 343)	141	930	7	39	0	500	4	260	2
5	B5 (# 338)	120	530	4	82	1	1,800	15	340	3
6	B6 (# 339)	30	610	21	91	3	1,400	47	220	7
7	B7 (# 340)	330	1,200	4	150	0	1,100	3	180	1
8 - 23	Beverly 8-23	1572	1,100	1	150	0	1,100	1	200	0

Table 22. Model Results for Ipswich River embayment drainage area subwatersheds: Hypothetical Rainfall

			Existing Conditions						Buildout Conditions			
Watershed #	Watershed Name	Area of Watershed (acres)	0.5" Rainfall w/o Manure (fc/100ml)	Estimated fc/acre for 0.5" Rainfall w/o Manure	0.5" Rainfall w/ Manure (fc/100ml)	Estimated fc/acre for 0.5" Rainfall w/ manure	3.0" Rainfall w/o Manure (fc/100ml)	Estimated fc/acre for 3.0" Rainfall w/o Manure	0.5" Rainfall w/o Manure (fc/100ml)	Estimated fc/acre for 0.5" Rainfall w/o Manure	3.0" Rainfall w/o Manure (fc/100ml)	Estimated fc/acre for 3.0" Rainfall w/o Manure
1	IP 1 (Greenwood Creek)	225	26,000	116	30,000	133	1,500	7	17,000	76	1,700	8
2	IP 2 (Farley Brook)	202	1,000	5	(no ag.)	(no ag.)	87	0	950	5	150	1
3	IP 3 (Labor in Vain Creek)	1300	29,000	22	32,000	25	1,500	1	26,000	20	1,800	1
4	IP 4 (Kimball Brook)	682	9,400	14	17,000	25	660	1	11,000	16	1,100	2
5	IP 5 (Saltonstall Brook)	513	6,100	12	14,000	27	540	1	6,900	13	750	1
6	IP 6	217	15,000	69	(no ag.)	(no ag.)	920	4	22,000	101	1,700	8
7	IP 7	164	4,400	27	(no ag.)	(no ag.)	550	3	4,500	27	920	6
8	IP 8	24	890	37	(no ag.)	(no ag.)	110	5	1,100	46	210	9
9	IP 9	11	280	25	(no ag.)	(no ag.)	44	4	270	24	38	3

Table 23. Model Results for Provincetown Harbor embayment drainage area subwatersheds: Hypothetical Rainfall

			Existing Conditions				Buildout Conditions			
Watershed #	Watershed Name	Area of Watershed (acres)	0.5" Rainfall (fc/100ml)	Estimated fc/acre for 0.5" Rainfall	3.0" Rainfall (fc/100ml)	Estimated fc/acre for 3.0" Rainfall	0.5" Rainfall (fc/100ml)	Estimated fc/acre for 0.5" Rainfall	3.0" Rainfall (fc/100ml)	Estimated fc/acre for 3.0" Rainfall
1	P 1	181	21,000	116	2,100	12	51,000	282	4,600	25
2	P 2 (Gosnold Street)	29	7,700	265	850	29	14,000	482	1,400	48
3	P 3	78	13,000	166	1,500	19	33,000	423	3,300	42

An additional variable was introduced for three subwatersheds in Ipswich (IP1, IP3, and IP4): land-applied manure spreading to agricultural land. A discussion of the modeling results for each watershed follows. Model output for hypothetical results are provided in Appendix C (existing land use) and D (buildout land use), and summarized below for each subwatershed.

B. BEVERLY

1. Beverly 1

Subwatershed B1 is 144 acres in size and entirely underlain by soils classified as "severe". Principal land uses in B1 include Pasture (28%), Forest (18%), Industrial (7%), and Residential Land (32%). Thirty-nine percent of the residential land is sewered, and there are 60 residential dwellings with septic systems. Because of the pollution potential ranking associated with these conditions, predicted runoff water quality in B1 under existing conditions is poor, 17,000 fc/100 ml for the 0.5 inch storm and 1,600 fc/100 ml for the 3.0 inch storm.

Under buildout conditions, the subwatershed consists largely of industrial and residential land, with a decrease in the number of residences on septic systems to 41. Because most of the land use acreage in this subwatershed is converted to industrial usage under buildout conditions, there is a corresponding increase in runoff associated with the impervious nature of industrial land, thus, concentrations of fecal coliform become more dilute in the runoff. The consequent water quality results for the model storm events show this decrease (3,200 fc/100 ml for the 0.5 inch rain event and 480 fc/100 ml for the 3.0 inch rain event).

2. Beverly 2

Subwatershed B2 is 68 acres in size and entirely underlain by soils classified as "severe". The principal land use in the subwatershed is residential (85%), and commercial (10%) with minor Industrial and Pasture land (2.5% each). Eighty-four percent of the residential land is sewered, and there are 16 septic systems in the subwatershed. Under existing conditions, the predominance of residential land together with septic systems located in "severe" soils produce conditions conducive to bacterial pollution. Modeled water quality results for the 0.5 and 3.0 inch rain events are 6,200 fc/100 ml and 900 fc/100 ml respectively.

Under buildout conditions the subwatershed is chiefly residential land (93%) with a small industrial component (7%). There are 27 septic systems in the subwatershed, an increase of 11 septic systems from existing conditions. Water quality is further degraded as a result of the additional septic systems in "severe" soils (8,600 fc/100 ml for the 0.5 inch rain event and 1,400 fc/100 ml for the 3.0 inch rain event).

3. Beverly 3

Subwatershed B3 is 117 acres in size and entirely underlain by soils classified as "severe". This subwatershed is also primarily residential (84%), although all residential land is sewered. Other land uses cover relatively little of the subwatershed (6% commercial, 3% Open Land, and 4% Forest). Modeled water quality under existing land uses is 2,000 fc/100 ml for the 0.5 inch rainfall and 320 fc/100 ml for the 3.0 inch rainfall.

Comparing these data with those of B2 for the same rainfall events illustrates the effect that sewered areas have on fecal coliform fate. Despite similarities in land use coverage, water quality is shown to be degraded for B2 than for B3. These results are further emphasized by the fact that the pasture land in B2 is not contributing fecal coliform since it is located beyond 500 feet from receiving waters.

Under buildout conditions B3 is shown to be completely developed as residential land. Water quality impacts from buildout conditions slightly improve to 1,400 fc/100 ml for the 0.5 inch storm and 290 fc/100 ml for the 3.0 inch storm. This improvement is likely due to fact that B3 is located in a sewered area, and only roadside accumulations of fecal coliform are being transported.

4. Beverly 4

Subwatershed B4 is 120 acres in size and is entirely underlain by "severe" soils. Principal land uses in this subwatershed include Open Land (62%), Forest (24%), and Residential Land (13%). All residential land in subwatershed B4 is sewered. Modeled water quality under existing land uses is 930 fc/100 ml for the 0.5 inch rainfall and 39 fc/100 ml for the 3.0 inch rainfall.

Under buildout conditions, the subwatershed consists entirely of sewered residential land. Water quality results under buildout conditions are 500 fc/100 ml for the 0.5 rainfall and 260 fc/100 ml for the 3.0 inch rainfall. The improvement of water quality under buildout conditions for the 0.5 inch rainfall is due to the fact that the open land that is converted is associated with elevated fecal coliform loadings (Open Land includes public parks and golf courses among other lands). The conditions for 3.0 inch rainfall become further degraded due to the conversion of existing roads through forested land to residential roads that are associated with elevated curbside accumulations of fecal coliforms.

5. Beverly 5

Subwatershed B5 is 120 acres in size and is chiefly underlain by soils classified as "severe" (97%), with minor "moderate" soils coverage (3%). Land uses for this subwatershed include Industrial (61%), Open Land (15%) and Residential Land (12%). All residential land is sewered. Modeled water quality under existing conditions are 530 fc/100 ml for 0.5 inch rainfall and 82 fc/100 ml for the 3.0 inch rainfall.

Under buildout conditions, B5 is shown to be completely developed as residential land, which causes water quality to become further degraded (1,800 fc/100 ml for the 0.5 inch rainfall and 340 fc/100 ml for the 3.0 inch rainfall). These increases are primarily due to the conversion of industrial land, which typically contributes relatively low quantities of fecal coliform from road surfaces, to residential land with which greater curbside accumulations of fecal coliform are associated.

6. Beverly 6

Subwatershed B6 is a small, heavily urbanized, drainage basin, 30 acres in size. It is underlain chiefly by "severe" soils (99%), and 1% "moderate" soils. Industrial and commercial land dominate this subwatershed (57% and 40% respectively). Modeled water quality results for the 0.5 and 3.0 inch rain events are 610 fc/100 ml and 91 fc/100 ml. The diluting effect of these land uses is evident when compared to other land uses, even urban residential areas, because roadside accumulations of fecal coliform are relatively low, and average road with is wider for commercial and industrial land (56 feet as compared to 22 feet) which translates into more impervious area, and thus a larger runoff:loading ratio.

Under buildout conditions, all of the industrial land and 27% of commercial land is converted to sewered residential land (86%). Water quality under buildout conditions is shown to be further degraded (1,400 fc/100 ml for the 0.5 inch rainfall and 220 fc/100 ml for the 3.0 inch rainfall event. This degradation likely occurs because of the conversion of commercial and industrial roads to residential roads which accumulate greater quantities of fecal coliform.

7. Beverly 7

Subwatershed B7 is 330 acres in size and underlain by soils classified as "severe" (96%) and "moderate" (4%). Existing land uses for B7 include Residential Land (52%), Forest (26%), Commercial (13%), Open Land (5%), and Industrial (3%). All of the residential land is sewered. Modeled water quality results for the 0.5 and 3.0 inch rainfall events are 1,200 fc/100 ml and 150 fc/100 ml respectively.

Under buildout conditions, subwatershed B7 becomes 88% sewered residential land, 9% commercial land, and 11% industrial land. There is relatively little change in the modeled water quality results for buildout conditions as compared with existing land use conditions (1,100 fc/100 ml for the 0.5 inch rainfall and 180 fc/100 ml for the 3.0 inch rainfall). The similarity between model results for existing and buildout conditions occurs primarily because the effect of increased loadings from residential roads is partly buffered by a greater ratio of runoff to loading caused by this increased imperviousness.

8. Beverly 8-23

Aggregate subwatershed B8-23 is 1,572 acres in size and underlain by soils classified as "severe" (59%) and "moderate" soils (41%). Land uses for this subwatershed include Residential Land (34%), Open Land (17%), Commercial (15%), Forest (15%), Industrial (13%), Agricultural Land (3%), and Pasture (1%). Ninety-two

percent of the residential land is sewered, and there are 40 residential dwellings occurring with septic systems. Water quality results for existing conditions are 1,100 fc/100 ml for the 0.5 inch rainfall and 150 fc/100 ml for the 3.0 inch rainfall.

Under buildout conditions, B8-23 increases in residential (61%), commercial (20%) and industrial land (18%). All open land is essentially developed, and only 1% of forested land remains. Modeled water quality results for buildout conditions are essentially the same under existing conditions (1,100 fc/100 ml for the 0.5 inch rainfall and 200 fc/100 ml for the 3.0 inch rainfall).

9. Summary of Beverly Loadings

Loadings from each subwatershed were totaled from the model output in Appendices C and D to determine the quantity of fecal coliform entering the embayment at the terminus of the Bass River under the modeled rainfall events (Table 24). As expected, loadings increased with greater subwatershed flushing (3.0 inch storm) as well as under buildout conditions.

Table 24. Total loadings to Bass River Embayment for each storm event.

	Existing Land Use 0.5 inch storm	Existing Land Use 3.0 inch storm	Buildout Land Use 0.5 inch storm	Buildout Land Use 3.0 inch storm
Total Inputs	436,000	444,000	437,000	537,000

Concentration of fecal coliform in coastal waters is a function of loadings to the receiving embayment, the pre-storm event quality of the water, and the morphometric characteristics of the embayment and its tidal prism. This evaluation was not conducted as part of this study.

C. IPSWICH

1. Ipswich 1

Subwatershed IP1 is 255 acres and is underlain primarily by "severe" soils (87%) with minor "moderate" and "slight" soil coverage (6% and 7% respectively). Predominant land uses in IP1 reflect a rural setting (19% Open Land, 18% Pasture, 22% Forest, and 19% wetlands). Seven percent of the subwatershed is residential land (mostly medium to high density), and 1% is agriculture. There are 61 septic systems in the subwatershed. Under existing conditions, modeled water quality is shown to be the poor (26,000 fc/100 ml for the 0.5 inch rainfall and 1,500 fc/100 ml for the 3.0 inch rainfall). This is due to the impact associated with inputs from septic systems into "severe" and "moderate" soils. Loadings do not occur from the pasture land areas because no livestock were modeled for this subwatershed (ICPCC, 1995).

Under buildout conditions the subwatershed is completely residentially developed, with 67 dwellings connected to septic systems and 105 sewered residences. Water quality under buildout conditions are improved for the 0.5 inch rainfall (17,000 fc/100 ml) and slightly degraded for the 3.0 inch rainfall (1,700 fc/100 ml). The 0.5 inch storm generates greater runoff from the subwatershed under buildout conditions than it does for existing conditions. This is caused by the increase in impervious area and the associated increase in runoff from built-out residential land and roads. This in turn results in a more dilute concentration of fecal coliform in the runoff.

2. Ipswich 2

Subwatershed IP2 is 202 acres in size and is underlain by soils classified as "severe" (60%), "moderate" (33%), and "slight" (7%). Existing land uses are Forest (69%), Residential (14%), Commercial (10%), and Open Land (7%). All residences within this subwatershed are sewered. Modeled water quality results are 1,000 fc/100 ml for the 0.5 inch rainfall, and 87 fc/100 ml for the 3.0 inch rainfall.

Under buildout conditions, land uses are largely residential (77%), with lesser amounts of commercial (14%) and industrial land (9%). Water quality results are shown to improve only slightly for the 0.5 inch rainfall (950 fc/100 ml), but slightly worsen for the 3.0 inch rainfall (150 fc/100 ml). This is attributable to the increased impervious surface associated with the conversion of forested and open land to residential land. A greater amount of runoff will be generated from this area under buildout conditions which, for average storms, will dilute the concentrations of fecal coliforms in the runoff. However, the amount of runoff for the 3.0 inch storm does not change as dramatically for buildout conditions as the 0.5 inch storm does because the 3.0 inch storm generates a high runoff rate for most land use intensity levels. Greater loadings occur for buildout conditions from the small increase in septic systems as well as from residential roads.

3. Ipswich 3

Subwatershed IP3 is 1,300 acres in size and is underlain by soils classified as "severe" (84%), "moderate" (11%) and "slight" (5%). Existing land uses are Forest (30%), Pasture (30%), Residential Land (10%), Open Land (2%), and Agricultural Land (1%). All of the residential land is connected to septic systems (166). There are approximately 145 livestock that live in the subwatershed (ICPCC, 1995). Modeled water quality results are 29,000 fc/100 ml for the 0.5 inch rainfall without manure, 32,000 fc/100 ml for the 0.5 inch rainfall with manure, and 1,533 fc/100 ml for the 3.0 inch rainfall without manure.

Under buildout conditions land use is entirely residential land. The number of septic systems increases from 166 to 933. Since all of the agricultural land is converted, manure-application does not occur under buildout conditions. Buildout modeled water quality results show slight change from existing conditions (26,000 fc/100 ml for the 0.5 inch rainfall and 1,800 fc/100 ml for the 3.0 inch rainfall). The slight decrease in fecal coliform concentration for the 0.5 inch

rainfall under buildout conditions is partly the result of increased contributions from the buildout number of septic systems being offset by the loss of inputs from livestock and agricultural land, and partly because many septic systems are located beyond 500 feet (Category I) from receiving waters.

4. Ipswich 4

Subwatershed IP4 is 682 acres in size and is underlain by soils classified as "severe" (58%), "moderate" (25%) and "slight" (17%). Existing land uses include Forest (52%), Residential Land (27%), Pasture (12%), Agricultural Land (4%), Commercial (2%), Open Land (1%), and Industrial (1%). There are 122 residences connected to septic systems, and there are approximately 41 livestock that live in the subwatershed (ICPCC, 1995). Modeled water quality results are 9,400 fc/100 ml for the 0.5 inch rainfall without manure, 17,000 fc/100 ml for the 0.5 inch rainfall with manure, and 660 fc/100 ml for the 3.0 inch rainfall without manure. The large number of septic systems are primarily responsible for these elevated loadings.

Land use under buildout conditions are Residential (95%) and Industrial Land (4%). The number of residential units on septic systems increases to 368. Modeled water quality under buildout conditions is degraded (11,000 fc/100 ml for the 0.5 inch rainfall and 1,100 fc/100 ml for the 3.0 inch rainfall). This occurs as a result of the loss of forest land and the addition of 246 septic systems.

5. Ipswich 5

Subwatershed IP5 is 513 acres in size and is underlain by soils classified as "severe" (69%), "moderate" (24%) and "slight" (7%). Current land uses include Forest (34%), Residential Land (26%), Commercial (10%), Pasture (10%), Agricultural Land (5%), Open Land (2%), and Industrial (1%). There are 31 residences connected to septic systems, and approximately 10 livestock that live in the subwatershed (ICPCC, 1995). Modeled water quality results for existing conditions are 6,100 fc/100 ml for the 0.5 inch rainfall without manure, 14,000 fc/100 ml for the 0.5 inch rainfall with manure, and 540 fc/100 ml for the 3.0 inch rainfall without manure. Existing water quality conditions are attributable in part to septic system inputs, and partly to livestock.

Under buildout conditions land uses become primarily residential (80%) with minor amounts of commercial land (10%). Residential units on septic increase from 31 to 120. Modeled water quality results are shown to slightly degrade under buildout conditions (6,900 fc/100 ml for the 0.5 inch rainfall and 750 fc/100 ml for the 3.0 inch rainfall). This is due to an approximate four-fold increase in the number of septic systems and a corresponding loss of agriculture and pasture (livestock) inputs.

6. Ipswich 6

Subwatershed IP6 is 217 acres in size and is underlain by soils classified as "severe" (68%), "moderate" (24%) and "slight" (4%). Land uses include Forest (52%), Residential Land (38%), Pasture (6%), and Commercial (1%). Modeled water

quality results for existing conditions are 15,000 fc/100 ml for the 0.5 inch rainfall and 920 fc/100 ml for the 3.0 inch rainfall. There are 61 residences connected to septic systems. No livestock were modeled for IP6. Existing loadings are primarily attributable to septic systems located primarily in "severe" and "moderate" soils.

Buildout land uses for IP6 are entirely residential. Residential units on septic systems increases from 61 to 159. Modeled water quality results for buildout conditions are shown to worsen as a result of the additional 98 septic systems in the subwatershed (22,000 fc/100 ml for the 0.5 inch rainfall without manure, and 1,700 fc/100 ml for the 3.0 inch rainfall).

7. Ipswich 7

Subwatershed IP7 is 164 acres in size and is underlain mostly by "severe" soils (93%), with minor "moderate" (6%) and "slight" (1%) soils. Principal land uses include Residential Land (72%), Forest (18%), and Open Land (9%). There are 8 septic systems in the subwatershed. Modeled water quality results for existing conditions are 4,400 fc/100 ml for the 0.5 inch rainfall and 550 fc/100 ml for the 3.0 inch rainfall. This is caused primarily by septic inputs into mostly "severe" soils.

Under buildout conditions, land use is almost entirely residential (97%), with a small amount of open land (2%) and commercial land (1%). Residential units on septic systems remains the same for buildout conditions (8). Modeled water quality results for buildout conditions are 4,500 fc/100 ml for the 0.5 rainfall and 920 fc/100 ml for the 3.0 inch rainfall. This small increase in runoff concentration occurs because of the conversion of forest land to residential land with which greater accumulations of fecal coliforms on roads are associated.

8. Ipswich 8

Subwatershed IP8 is 24 acres in size and is underlain by soils classified as "severe" (94%), and "moderate" (6%). Existing land uses are Residential (46%), Open Land (38%), Commercial (13%), and Forest (5%). All residences in this subwatershed are sewered. Modeled water quality results are comparatively low as a result (890 fc/100 ml for the 0.5 inch rainfall and 110 fc/100 ml for the 3.0 inch rainfall).

Under buildout conditions, land uses consist primarily of Residential (96%), with a relatively small amount of Commercial land (4%). Modeled water quality results from buildout conditions are 1,100 fc/100 ml for the 0.5 inch rainfall and 210 fc/100 ml for the 3.0 inch rainfall. This increase is due to the increase in residential roads.

9. Ipswich 9

Subwatershed IP9 is 11 acres in size and is underlain exclusively by soils classified as "severe". Existing land uses include Industrial (55%), Residential Land (27%), and Commercial (18%). All residences within this subwatershed are sewered. Modeled water quality results are 280 fc/100 ml for the 0.5 inch rainfall and 44 fc/100 ml for the 3.0 inch rainfall.

Under buildout conditions, land uses include residential (36%), commercial (36%), and industrial (27%). Consequently, modeled water quality results under buildout conditions are not significantly different (270 fc/100 ml for the 0.5 inch rainfall and 38 fc/100 ml for the 3.0 inch rainfall). This does not represent a significant change because the subwatershed remains primarily urban and all residences and commercial facilities are sewered.

10. Summary of Ipswich Loadings

The sum total of fecal coliforms discharging at the terminus of the Ipswich River into Plum Island Sound via runoff from the modeled rainfall events are shown in Table 25.

Table 25. Total loadings to Plum Island Sound from the Ipswich River for each storm event.

	Existing Land Use 0.5 inch storm	Existing Land Use 3.0 inch storm	Buildout Land Use 0.5 inch storm	Buildout Land Use 3.0 inch storm
Total Inputs	1,176,000	1,181,000	2,553,000	2,553,000

Under existing conditions, the 3.0 inch storm transports only slightly more fecal coliforms than the 0.5 inch storm does. Loadings increase under buildout conditions for both modeled storm events. For each modeled land use scenario, the first flush of the watershed transported virtually all of the fecal coliforms to coastal waters.

D. PROVINCETOWN

1. Provincetown 1

Subwatershed P1 is 181 acres in size and underlain primarily by "moderate" soils (64%), most of which is "urban land". Severe soils cover 36% of this subwatershed. Existing land uses for this subwatershed include Residential Land (58%), Commercial (27%), Open Land (12%), and Forest (4%). Provincetown is a heavily developed area dominated by residential and commercial land. There are no sewers in Provincetown, thus all residences in P1 are connected to septic systems. Because of these conditions and the pollution potential with which rankings of residential land are associated, runoff water quality is poor (21,000 fc/100 ml for the 0.5 inch rainfall and 2,100 fc/100 ml for the 3.0 inch rainfall).

Under buildout conditions, the subwatershed consists largely of residential (88%) and commercial land (12%). The number of residential units on septic systems increases from 364 to 725. Due to this increase, water quality is further degraded (51,000 fc/100 ml for the 0.5 inch storm and 4,600 fc/100 ml for the 3.0 inch storm).

2. Provincetown 2

Subwatershed P2 is 29 acres in size and underlain by soils classified as "severe" (16%) and "moderate" (84%). Existing land uses include Commercial (41%), Residential Land (38%), and Open Land (21%). There are 37 residences connected to septic systems within the subwatershed. Modeled water quality for existing conditions is 7,700 fc/100 ml for the 0.5 inch rainfall and 850 fc/100 ml for the 3.0 inch rainfall.

Under buildout conditions, residential land increases to 62%, with commercial land at 38%. The number of dwellings with septic systems increases from 37 to 90. Water quality impacts due to the increase in the number of residences on septic systems are further degraded (14,000 fc/100 ml for the 0.5 inch rainfall and 1,400 fc/100 ml for the 3.0 inch rainfall). These results illustrate the effect that septic systems have on fecal coliform concentrations for areas with intensive residential land use.

3. Provincetown 3

Subwatershed P3 is 78 acres in size and is underlain by "moderate" soils (75%), and "severe" soils (25%). Principal land uses in the subwatershed is residential (52%), commercial land (44%), and minor forested land (6%). There are 143 residences connected to septic systems in this subwatershed. Modeled water quality under existing land use is 13,000 fc/100 ml for the 0.5 inch rainfall and 1,500 fc/100 ml for the 3.0 inch rainfall.

Under buildout conditions, the subwatershed consists entirely of residential (82%) and commercial land (21%). As expected, modeled water quality worsens due to an increase from 128 residences connected to septic systems to 271. Results for buildout conditions are 33,000 fc/100 ml for the 0.5 inch rainfall and 3,300 fc/100 ml for the 3.0 inch rainfall.

4. Summary of Provincetown Loadings

The quantity of fecal coliform entering Provincetown Harbor from Subwatersheds of the Provincetown Harbor embayment areas under the modeled rainfall events are shown in Table 26.

Table 26. Total loadings to the Provincetown Harbor embayment for each storm event.

	Existing Land Use 0.5 inch storm	Existing Land Use 3.0 inch storm	Buildout Land Use 0.5 inch storm	Buildout Land Use 3.0 inch storm
Total Inputs	736,000	736,000	1,387,000	1,387,000

In this case, loadings for both rainfall events are the same for each set of land use conditions. Thus, for efficiently drained subwatersheds, the first flush is sufficient to remove all of the fecal coliforms. Buildout conditions for Provincetown

produce greater quantities of fecal coliform; a result of the large number of additional residences on septic systems.

E. Historical Comparisons

Water quality sampling for the Salem Sound 2000 and ICPCC studies, conducted by local volunteers at discharge points for some of the subwatersheds for the Bass and Ipswich River embayment drainage areas, allowed H&W to compare predicted results from the FecaLOAD model, which calculates fecal coliform loading and concentration estimates at those same discharge points, with field data and known precipitation conditions as shown in Tables 27 (Beverly) and 28 (Ipswich). For this comparison, the FecaLOAD model was run using existing land use conditions and actual precipitation measurements on the day sampling was conducted.

Associated with this type of historical comparison is potential for discrepancy between data from water quality sampling and model results. It is important to highlight that while FecaLOAD is designed to estimate average fecal coliform loadings and concentrations for a given rainfall event, the sample data to which model results were compared may or may not represent average conditions depending on when the samples were collected relative to the start of the precipitation event or whether the samples were composited to represent average concentrations. Another area in which discrepancies between modeled and sampled data may result is in the simplification of MacConnell Land Use Categories to the corresponding FecaLOAD Land Use Categories (see Table 12). In some cases, a particular FecaLOAD land use may represent one or more MacConnell Land Uses. An example of this is Open Land which is used by FecaLOAD to represent recreation areas, parks, cemeteries, abandon agriculture, power lines, areas of no vegetation, vacant undeveloped land, and institutional greenspace (see Table 12). Thus, all of these uses are associated with the same fecal coliform loading coefficient.

Water quality and precipitation data from the comprehensive sampling program conducted by the Salem Sound 2000 at discharge points (storm drains) for subwatersheds of the Bass River was used to compare model results for those areas (Salem Sound 2000 unpublished data, 1994). Historical precipitation data presented in the sampler's log were used to represent climatic conditions at the time of sampling. Thus, H&W was able to recreate the climate conditions on the day of sampling to compare model results to field data. Because FecaLOAD requires a value for rainfall within the previous five days of the modeled event, historical National Weather Service precipitation records were reviewed to determine this. Historical model output is provided in Appendix E. A summary of the data collected and modeled is shown in Table 27.

This historical comparison was also done for Ipswich. The ICPCC (1995) report presents results of fecal coliform sampling along discharge points to the Ipswich River. Also included in this report is a livestock survey which H&W used to

determine average number of livestock for each subwatershed. In addition to the concentrations of fecal coliform reported for each sample, the ICPCC (1995) report also included precipitation data on the day of sampling was included. The National Weather Service precipitation records were used to determine antecedent moisture conditions prior to the date that samples were collected. Historical model output is provided in Appendix E. A summary of the data collected and modeled is shown in Table 28.

Table 27. Historical Model Results for Bass River embayment drainage area subwatersheds

Watershed #	Watershed Name	Existing Land Use Conditions						
		Date	Rainfall (inches)	Number of Days Since Last Rain	Rainfall in Previous 5 Days (inches)	Historical Runoff Water Quality (fc/100ml)	Modeled Runoff Water Quality (fc/100ml)	Variance by Order of Magnitude
B 5	# 338	6/7/95	1.12	0	0	1,720	340	1
B 6	# 339	6/7/95	1.12	0	0	2,200	370	1
B 7	# 340	6/7/95	1.12	0	0	> 2,000	660	1

Table 28. Historical Model Results for Ipswich River embayment drainage area subwatersheds

Watershed #	Watershed Name	Existing Land Use Conditions						
		Date	Rainfall (inches)	Number of Days Since Last Rain	Rainfall in Previous 5 Days (inches)	Historical Runoff Water Quality (fc/100ml)	Modeled Runoff Water Quality (fc/100ml)	Variance by Order of Magnitude
IP 1	Greenwood Creek	7/27/93	0.65	6	0	700	1,200	1
IP 3	Labor in Vain Creek	7/27/93	0.65	7	0	170	14,000	2
IP 4	Kimball Brook	11/3/92	0.60	9	0	16,000	2,500	1
IP 4	Kimball Brook	6/6/93	0.19	5	0.65	1,600	3,500	0
IP 5	Saltonstall Brook	6/1/92	0.97	7	0	6,200	690	1
IP 5	Saltonstall Brook	8/14/92	0.09	2	1.29	790	3,200	1

This comparison to historical data shows that, with one exception, the model produced results within its calibrated intent (one order of magnitude). The lone

exception is IP3 which was modeled two orders of magnitude greater than the field data.

In the case of IP3, the model may be overstating the impact of livestock on receiving waters. Because of the large size of the subwatershed (1300 acres), some of the livestock may live sufficiently far from Labor in Vain Creek such that fewer inputs actually occur than is predicted by the model. Alternatively, if the water quality samples represent grab samples, or a snapshot of the condition of the runoff, this two-order of magnitude discrepancy may be due to differences between sampled water quality and the average water quality that the model is intended to predict. Since there is no information in the sampler's log regarding the time samples were collected relative to the beginning of the storm event or whether samples were composited to represent average conditions of the runoff, the modeled water quality may not represent the actual time the sample was collected.

X. CONCLUSIONS

The FecaLOAD model is a new tool available to watershed managers to estimate fecal coliform loads and concentrations in stormwater runoff. Modeling a biological pollutant such as fecal coliform bacteria is inherently difficult due to the complexities associated with how the pollutant responds to a wide variety of environmental conditions such as temperature, moisture, sunlight and soils. The FecaLOAD model runs for this project utilized outputs from a geographic information system (GIS), available soils and land use databases.

The results of the modeling for the twenty-one subwatersheds in the three case study communities provide some interesting findings and insight into future possible applications of the model. These findings and recommendations are summarized below:

1. The model predicts average concentrations for a specified storm event. Of the two modeled storm events, the smaller one (0.5 inches) predicts considerably higher fecal coliform concentrations than the larger storm (3.0 inches), consistent with the "first flush" phenomenon.

2. The lower concentrations associated with the larger 3.0 inch storm are largely the result of greater dilution by significantly greater runoff volumes.

3. The most significant source of fecal coliforms common to the three case study communities is residential land use (septic systems and domestic animals). In Ipswich, where agriculture and pasture land represent significant portions of subwatersheds IP1, IP3, IP4, and IP5, loadings are mostly derived from these land uses in addition to residential land.

4. The Town of Provincetown showed the highest average fecal coliform concentrations for the 0.5 inch runoff event under both existing (13,740 fc/100 ml) and buildout (32,300 fc/100 ml) conditions. The principal land use in these watersheds is high density residential with on-site septic systems and numerous pets. Soils range from moderate to severe limitations with respect to sewage disposal.

5. The Greenwood Creek watershed in Ipswich exhibited the highest concentration under existing conditions at 0.5 inches (26,200 fc/100 ml). Similar to Provincetown, this watershed is predominantly high density residential with on-site septic systems and severe soils (87% of the watershed area).

6. The lowest estimated fecal concentrations were reported in Ipswich 9, Beverly 5 and Beverly 6 watersheds. All three of these watersheds are characterized by relatively high percentages of commercial and industrial land uses (73%, 61% and 97% respectively). This is presumably due to the dilution provided by the high runoff associated with the expansive areas of paved areas common to these types of land uses, as well as the fact that they are all located in sewered areas.

7. The estimated fecal coliform concentrations are routinely two to three orders of magnitude higher than the shellfish standard of 14 colonies/100 ml. Total loading of fecal organisms is also predicted by the FecaLOAD model. These numbers may be significant depending on the receiving water characteristics. Depending upon the existing fecal coliform concentrations and the volume of the receiving water and its flushing rate, the total load of fecal organisms is what will ultimately dictate the fecal coliform concentrations in the waters overlying the shellfish beds. Therefore future uses of the FecaLOAD model should attempt to integrate receiving water volumes, flushing rates, and existing concentrations of fecal-coliform into the analysis.

8. Overall, the comparison to historical data provided a useful verification of the ability of FecaLOAD to predict fecal coliform loadings within an acceptable level of tolerance of one order of magnitude.

XI. RECOMMENDATIONS

1. Results of FecaLOAD modeling should be verified with field data whenever and wherever possible. It is therefore recommended that coastal communities in Massachusetts plan and implement a local water quality sampling program in similar fashion as the Salem Sound 2000 and the ICPCC projects.

A sampling program involves defining a watershed area and its discharge point, collecting samples during a rainfall event, recording relative climatic information, and, if possible, discharge or flow. To assist communities in implementing a sampling program, H&W has provided an example form that may be used in the field to record this information.

Watershed Name, Massachusetts

Storm Event 1

Rainfall Information

Date/Time Storm Began:

Date/Time Storm Finished:

Total Rainfall (inches):

Antecedent Moisture Information

Time since last rainfall (days):

Rainfall in previous 5 days (inches):

Sample #	Date Collected	Time Collected	Storm Flow (ft^3/s)	Concentration of fecal coliform (#/100 ml)

Storm Event 2

Rainfall Information

Date/Time Storm Began:

Date/Time Storm Finished:

Total Rainfall (inches):

Antecedent Moisture Information

Time since last rainfall (days):

Rainfall in previous 5 days (inches):

Sample #	Date Collected	Time Collected	Storm Flow (ft^3/s)	Concentration of fecal coliform (#/100 ml)

Recall that FecaLOAD provides estimates of average fecal coliform concentrations at the point of discharge from the modeled watershed. To adequately compare sampled water quality data with model output, it is important for the sample data to represent average conditions. This can be accomplished by collecting several rounds of water quality samples during a rainfall event, then compositing them in a laboratory.

To further validate the loading, runoff, and concentration estimates provided by FecaLOAD, it is recommended that the model be applied in other areas where water quality data exists or where such data can be developed.

2. Residences with septic systems that are known to conform to Title V construction standards should be associated with a Qualitative Category Ranking of I, regardless of the suitability rating of the soils in which they are sited. From a modeling standpoint, this will attenuate all fecal coliforms from Title V septic systems.

3. Agricultural and pasture lands that are known to observe BMPs should be associated with a Qualitative Category Ranking of I, regardless of the suitability rating of the soils in which they are sited. This will not attenuate all fecal coliforms from these land uses, although loadings will be substantially mitigated.

4. It is recommended that the town of Provincetown implement a stormwater sampling program at the Gosnold Street storm drain in order to verify the results of the modeling conducted for this study.

5. Communities interested in generating the data to run FecaLOAD do not need a GIS. A GIS will speed-up this process, however, the same data may be generated manually. Generating the necessary data is discuss for the automated GIS and manual methods in *Companion Guidelines for FecaLOAD* (H&W, 1996a).

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APPENDIX A

VALUES FOR FECAL COLIFORM LOADING, FECAL COLIFORM CONCENTRATION, AND ROAD WIDTH USED IN FECALOAD

APPENDIX A. Values for Fecal Coliform Loading, Concentration, and Road Width Used in FecaLOAD

Average Daily Loading of Fecal Coliform

Human Sources	Range of Values	Model Value	Reference
Septic Effluent Concentration:	10^4 - 10^7 FC/100 ml	10^6/100 ml effluent	(1)
Average Daily Discharge:	45-100 gallons /person /day	70 gallons /person /day	(2), (3), (4), (5)

Agricultural Sources	Range of Values	Model Value	Reference
Agricultural Runoff without Manure Application	10 FC/100 ml of runoff (observed in Casco Bay, Maine study)	10 FC/100 ml of runoff	(6)
Agricultural Runoff with Applied Manure:	10-20 tons /acre /year	10 tons/ac/yr	(7)
Average Daily Manure Loading Rate:	12-115 lbs/animal/day	53 lbs /animal /day	(8)
Livestock Fecal Coliform Concentration:	10^4 -10^7 FC/gram manure	10^6 FC/gram manure	(9), (10)

Median Curbside Accumulation of Fecal Coliform

Road Runoff	Range of Values	Model Value	Reference
Low Density Resid.	10^5 -10^6 FC/ft curb	8×10^5 FC/ft. curb	(12)
High Density Resid.	10^5 - 10^6 FC/ft curb	4×10^5 FC/ft. curb	(12)
Open Space	Assumed same as Low Density Resid.	8×10^5 FC/ft. curb	(12)
Commercial	10^5 - 10^6 FC/ft. curb	1×10^6 FC/ft. curb	(12)
Industrial	10^5 - 10^6 FC/ft. curb	1×10^6 FC/ft. curb	(12)
Highways	10^5 - 10^7 FC/ft. curb	2×10^6 FC/ft curb	(12)

Average Road Width Values used in Runoff Calculations

Road Width	Typical Values	Model Value	Reference
Residential	22 ft.	22 ft.	(11)
Major roads and highways	56 ft.	56 ft.	(11)
Commercial/industrial	56 ft.	56 ft.	(11)

Calculations Used in FecaLOAD

Volume of Road Runoff:

(Road width in feet) x (length in feet) x (2.3×10^{-5} acres/ft^2) = Acres of road surface.
(Acres of road surface) x (inches of rain) / (12 inches) = Acre-ft.
(Acre feet) x (325,851 gallons per acre-foot) = volume of road runoff (gallons).

Volume of Watershed Runoff: Reference (13), (14)

(Acres of land cover) x (CN-associated runoff inches for a given rainfall on that land cover) = Acre-ft.
(Acre-ft) x (325,851 gallons/acre-ft.) = Volume of Watershed Runoff (gallons).

Note: The watershed runoff calculations in the model were developed from empirical data by the Natural Resources Conservation Service (NRCS). NRCS data are applied in the model as composite "curve number" (CN) runoff values which are determined from hydrologic soil groups Reference (15).

Surface Die-Off: Reference (9)

The first order equation for calculating fecal coliform die-off is:

$$N_t = N_0 (10^{-kt})$$

where:

N_t = Number of fecal coliforms at time t (this is the number of fecal coliforms available for entrainment in surface runoff)
N_0 = Number of fecal coliforms at time 0 (such as at the time of manure application)
t = Time in days
k = Die-off rate constant. From Reference 9 (0.51 in warm months 0.36 in cold months).

References for Appendix A

(1) Converse, et al. "Bacterial and Nutrient Removal in Wisconsin At-Grade On-Site Systems." *IN* On-Site Wastewater Treatment. Proceedings of the 6th National Symposium on Individual and Small Community Sewage Systems, 16-17 December 1991, Chicago, Illinois. American Society of Agricultural Engineers, 50.

(2) Metcalf & Eddy, Inc. 1991. Wastewater engineering: treatment disposal reuse. McGraw Hill, Inc. 1991 (Septic system effluent rates range 35-50 gal./per person/day and an average occupancy of 2.4-2.8 residents/home.)

(3) US EPA. 1980. On-site wastewater treatment and disposal systems design manual.

(4) Porter, K. S. 1978. Nitrates in the Long Island comprehensive waste treatment management plan: VII Summary Documentation, Long Island Regional Planning Board, Hauppauge, New York.

(5) Massachusetts Audubon Society, 1986, Protecting and maintaining private wells.

(6) Horsley & Witten, Inc., 1996, Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, Brunswick, and Freeport, Maine.

Background coefficients were derived from sample concentrations from four H&W rounds of sampling agricultural-land runoff in Maine from May 1994 through April 1995. These areas had observed manure application approximately 7 months before the sampling project began. Samples were collected once in May 1994, once in November 1994, and twice in April 1995. The sample FC concentrations exhibited a decrease over the course of the sampling. Therefore, geometric means of FC concentrations were determined from these samples and calibrated as background coefficients for the model.

(7) Maine Department of Agriculture, Personal communication with Russel Libby, Researcher, March 1994. (Manure application range of 10 - 20 tons/acre.)

(8) Moore, J.A., M.E. Grismer, S.R. Crane, and J.R. Miner. 1982. Evaluating Dairy Waste Management Systems' Influence on Fecal Coliform Concentration in Runoff. Department of Agricultural Engineering, Agricultural Experiment Station bulletin 658, Oregon State University, Corvallis, p 15. (Average of daily manure production from known cattle weights for dairy and beef cows and horses (range of 12 lbs to 115 lbs./day).

(9) Moore, J.A., M.E. Grismer, S.R. Crane, and J.R. Miner. 1982. "Evaluating Dairy Waste Management Systems' Influence on Fecal Coliform Concentration in Runoff." Agricultural Experiment Station Bulletin No. 658, Oregon State University, Corvallis, Oregon. 1982, Table 4.

(10) Koppelman, Lee ed., 1978, Animal Waste: Non-Point Pollution. Nausau-Suffolk (NY) Regional Planning Board. 32 pp.

(11) Massachusetts Executive Office of Transportation and Commerce, Engineering Department, (personal communication, 1995)

(12) Novotney, V. and H. Olem. 1994. Water Quality: Prevention, Identification and Management of Diffuse Pollution. New York: Van Nostrand Reinhold.

(13) U.S. Department of Agriculture, 1972. Soil Conservation Service, SCS National Engineering Handbook, Section 4, Hydrology.

(14) U.S. Department of Agriculture/SCS, Amherst, MA. March 1974. Estimating Runoff: The Modified Soil Cover Complex Method,

(15) U.S. Department of Agriculture, Massachusetts Agricultural Experiment Station, May, 1984. "Soil Survey of Essex County, Massachusetts"

(16) U.S. Department of Agriculture, Maine Agricultural Experiment Station, August 1974. "Soil Survey, Cumberland County, Maine"

APPENDIX B

LAND USE DATA TABLES

BEVERLY DATA TABLES - BUILDOUT

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
IR	Pasture	Industrial	Severe	N	000-100	2.89
IR	Pasture	Industrial	Severe	N	100-500	28.62
IR	Pasture	Industrial	Severe	N	>500	8.56
IR	Forest	Industrial	Severe	N	000-100	3.99
IR	Forest	Industrial	Severe	N	100-500	14.50
IR	Forest	Industrial	Severe	N	>500	3.16
IR	Forest	Industrial	Moderate	N	100-500	0.07
IR	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	000-100	7.17
IR	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	100-500	3.24
IR	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	>500	0.07
IR	Open Land	Industrial	Severe	N	000-100	0.72
IR	Open Land	Industrial	Severe	N	100-500	1.55
IR	Open Land	Industrial	Severe	N	>500	9.99
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	000-100	2.00
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	100-500	0.91
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	>500	0.35
IR	Residential > 1/2 Acre	Industrial	Severe	N	000-100	0.04
IR	Residential > 1/2 Acre	Industrial	Severe	N	100-500	0.17
IR	Residential > 1/2 Acre	Industrial	Severe	N	>500	0.63
IR	Industrial	Industrial	Severe	N	100-500	0.23
IR	Industrial	Industrial	Severe	N	>500	10.19
IR	Urban Open	Industrial	Severe	N	100-500	0.32
IR	Urban Open	Industrial	Severe	N	>500	0.16
IR	Transportation	Industrial	Severe	N	>500	1.03
R-10	Forest	Residential < 1/4 Acre	Severe	N	100-500	0.13
R-10	Forest	Residential < 1/4 Acre	Severe	N	>500	0.13
R-10	Open Land	Residential < 1/4 Acre	Severe	N	100-500	0.83
R-10	Open Land	Residential < 1/4 Acre	Severe	N	>500	1.00
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	100-500	1.69
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	1.55
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	N	100-500	0.96
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	1.93
R-45	Pasture	Residential > 1/2 Acre	Severe	N	100-500	1.07
R-45	Forest	Residential > 1/2 Acre	Severe	N	100-500	0.94
R-45	Forest	Residential > 1/2 Acre	Severe	N	>500	3.37
R-45	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	000-100	1.00
R-45	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	100-500	3.49
R-45	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	>500	0.02
R-45	Open Land	Residential > 1/2 Acre	Severe	N	100-500	1.80
R-45	Open Land	Residential > 1/2 Acre	Severe	N	>500	1.53
R-45	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	1.14
R-45	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	9.12
R-45	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	11.24

ZONING CODE	EXISTING LANDUSE	NEW LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
IR	Pasture	Industrial	Severe	N	100-500	0.65
IR	Pasture	Industrial	Severe	N	>500	0.11
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	000-100	0.24
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	100-500	0.19
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	>500	0.96
IR	Industrial	Industrial	Severe	N	100-500	0.11
IR	Industrial	Industrial	Severe	N	>500	1.54
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	Y	>500	0.12
IR	Residential > 1/2 Acre	Industrial	Severe	Y	>500	0.45
IR	Transportation	Industrial	Severe	Y	>500	1.26
R-10	Pasture	Residential < 1/4 Acre	Severe	N	000-100	0.09
R-10	Pasture	Residential < 1/4 Acre	Severe	N	100-500	0.57
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.51
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	100-500	2.26
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	3.95
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	0.00
R-10	Pasture	Residential < 1/4 Acre	Severe	Y	000-100	0.11
R-10	Pasture	Residential < 1/4 Acre	Severe	Y	100-500	0.28
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	000-100	3.89
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	18.59
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	25.78
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	0.90
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	000-100	0.71
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	100-500	2.69
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	>500	2.34

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
CG	Open Land	Commercial	Severe	Y	>500	0.02
CG	Residential Multi-Family	Commercial	Severe	Y	>500	0.02
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	3.74
R-10	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	>500	0.59
R-10	Open Land	Residential < 1/4 Acre	Severe	Y	>500	2.14
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	0.15
R-10	Residential Multi-Family	Residential < 1/4 Acre	Severe	Y	>500	0.46
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	0.11
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	93.69
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	0.77
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	>500	0.81
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	0.26
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	>500	6.47
RSD	Forest	Residential Multi-Family	Severe	Y	>500	1.51
RSD	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	>500	0.80
RSD	Open Land	Residential Multi-Family	Severe	Y	>500	1.84
RSD	Residential Multi-Family	Residential Multi-Family	Severe	Y	>500	3.31

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
R-10	Forest	Residential < 1/4 Acre	Severe	Y	000-100-	0.79
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	5.85
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	0.04
R-10	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	000-100	0.31
R-10	Participation Recreation	Residential < 1/4 Acre	Severe	Y	000-100	0.03
R-10	Participation Recreation	Residential < 1/4 Acre	Severe	Y	100-500	1.09
R-10	Participation Recreation	Residential < 1/4 Acre	Severe	Y	>500	0.47
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.12
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	5.07
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	9.95
R-22	Forest	Residential > 1/2 Acre	Severe	Y	000-100	5.22
R-22	Forest	Residential > 1/2 Acre	Severe	Y	100-500	2.10
R-22	Forest	Residential > 1/2 Acre	Severe	Y	>500	10.70
R-22	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	>500	0.37
R-22	Participation Recreation	Residential > 1/2 Acre	Severe	Y	000-100	5.06
R-22	Participation Recreation	Residential > 1/2 Acre	Severe	Y	100-500	36.17
R-22	Participation Recreation	Residential > 1/2 Acre	Severe	Y	>500	42.79
R-22	Water	Water	Severe	Y	000-100	0.00
RSD	Forest	Residential Multi-Family	Severe	Y	000-100	0.25
RSD	Forest	Residential Multi-Family	Severe	Y	100-500	4.07
RSD	Forest	Residential Multi-Family	Severe	Y	>500	5.25
RSD	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	000-100	0.47
RSD	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	100-500	0.56
RSD	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	>500	0.08
RSD	Participation Recreation	Residential Multi-Family	Severe	Y	100-500	0.15
RSD	Participation Recreation	Residential Multi-Family	Severe	Y	>500	0.80
RSD	Residential Multi-Family	Residential Multi-Family	Severe	Y	100-500	0.02
RSD	Residential Multi-Family	Residential Multi-Family -	Severe	Y	>500	2.73

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
CG	Commercial	Commercial	Severe	Y	000-100	0.02
CG	Industrial	Commercial	Severe	Y	000-100	0.06
CG	Industrial	Commercial	Severe	Y	100-500	0.00
R-10	Forest	Residential < 1/4 Acre	Severe	Y	000-100	0.31
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	2.54
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	7.81
R-10	Participation Recreation	Residential < 1/4 Acre	Severe	Y	>500	5.96
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	0.86
R-10	Spectator Recreation	Residential < 1/4 Acre	Moderate	Y	>500	1.67
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	0.99
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	12.11
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	1.21
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	100-500	0.01
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	>500	0.17
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	000-100	0.36
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	100-500	2.49
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	>500	66.16
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	>500	0.32
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	1.14
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	0.28
R-22	Forest	Residential < 1/4 Acre	Severe	Y	>500	4.51
R-22	Participation Recreation	Residential < 1/4 Acre	Severe	Y	>500	7.80
R-22	Industrial	Residential < 1/4 Acre	Severe	Y	>500	3.51

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
	Commercial	Commercial	Severe	N	000-100	0.06
CG	Commercial	Commercial	Severe	Y	000-100	1.83
CG	Commercial	Commercial	Severe	Y	100-500	1.25
CG	Industrial	Commercial	Severe	Y	000-100	0.25
CG	Industrial	Commercial	Severe	Y	100-500	0.00
IG	Industrial	Commercial	Severe	Y	>500	0.38
IG	Industrial	Commercial	Moderate	Y	>500	0.05
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	0.03
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	0.01
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	100-500	6.29
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	>500	2.67
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	000-100	0.05
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	100-500	3.68
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	>500	12.82
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	100-500	0.08
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	>500	0.12

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
CG	Forest	Commercial	Severe	Y	100-500	0.00
CG	Forest	Commercial	Severe	Y	>500	0.50
CG	Forest	Commercial	Moderate	Y	>500	0.02
CG	Residential Multi-Family	Commercial	Severe	Y	>500	0.12
CG	Residential 1/4 to 1/2 Acre	Commercial	Severe	Y	>500	1.26
CG	Residential 1/4 to 1/2 Acre	Commercial	Moderate	Y	>500	0.98
CG	Commercial	Commercial	Severe	Y	>500	17.70
CG	Commercial	Commercial	Moderate	Y	>500	0.76
CG	Transportation	Commercial	Severe	Y	100-500	0.49
CG	Transportation	Commercial	Severe	Y	>500	7.64
CN	Commercial	Commercial	Moderate	Y	>500	0.24
IR	Forest	Industrial	Severe	Y	000-100	0.34
IR	Forest	Industrial	Severe	Y	100-500	1.97
IR	Forest	Industrial	Severe	Y	>500	0.28
IR	Forest	Industrial	Moderate	Y	>500	0.30
IR	Residential Multi-Family	Industrial	Severe	Y	000-100	1.93
IR	Residential Multi-Family	Industrial	Severe	Y	100-500	2.37
IR	Residential Multi-Family	Industrial	Severe	Y	>500	0.01
IR	Industrial	Industrial	Severe	Y	000-100	0.22
IR	Industrial	Industrial	Severe	Y	100-500	0.06
IR	Industrial	Industrial	Severe	Y	>500	2.38
IR	Industrial	Industrial	Moderate	Y	>500	0.61
IR	Transportation	Industrial	Severe	Y	>500	0.12
IR	Transportation	Industrial	Moderate	Y	>500	0.12
R-10	Forest	Residential < 1/4 Acre	Severe	Y	000-100	4.35
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	28.13
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	32.81
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	000-100	0.36
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	100-500	2.81
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	>500	0.31
R-10	Open Land	Residential < 1/4 Acre	Severe	Y	>500	3.13
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	2.11
R-10	Residential Multi-Family	Residential < 1/4 Acre	Severe	Y	100-500	0.12
R-10	Residential Multi-Family	Residential < 1/4 Acre	Severe	Y	>500	0.94
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.73
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	23.46
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	116.70
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	0.16
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	>500	0.65
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	2.05
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	100-500	0.04
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	>500	1.26
R-10	Commercial	Residential < 1/4 Acre	Moderate	Y	>500	0.00
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	000-100	0.07
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	100-500	1.92
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	>500	4.13
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	1.51
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	2.79
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	7.03
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	000-100	0.67
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	0.02
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	100-500	1.74
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	>500	10.54
R-10	Transportation	Residential < 1/4 Acre	Moderate	Y	>500	0.22
R-10	Water	Water	Severe	Y	000-100	0.00
R-45	Forest	Residential > 1/2 Acre	Severe	Y	000-100	4.23
R-45	Forest	Residential > 1/2 Acre	Severe	Y	100-500	3.09
R-45	Forest	Residential > 1/2 Acre	Severe	Y	>500	0.04
R-45	Forest	Residential > 1/2 Acre	Moderate	Y	000-100	0.59

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
R-45	Forest	Residential > 1/2 Acre	Moderate	Y	100-500	3.00
RMD	Forest	Residential Multi-Family	Severe	Y	100-500	3.03
RMD	Forest	Residential Multi-Family	Severe	Y	>500	0.00
RMD	Residential Multi-Family	Residential Multi-Family	Severe	Y	100-500	0.55
RMD	Residential Multi-Family	Residential Multi-Family	Severe	Y	>500	15.50
RMD	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Severe	Y	100-500	1.49
RMD	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Severe	Y	>500	3.30
RMD	Commercial	Residential Multi-Family	Severe	Y	>500	0.71
RMD	Industrial	Residential Multi-Family	Severe	Y	>500	0.00
RMD	Transportation	Residential Multi-Family	Severe	Y	>500	2.78

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
CG	Forest	Commercial	Moderate	Y	000-100	0.06
CG	Commercial	Commercial	Moderate	Y	000-100	0.19
CG	Industrial	Commercial	Severe	Y	000-100	0.01
CG	Industrial	Commercial	Moderate	Y	000-100	0.38
IG	Forest	Commercial	Moderate	Y	000-100	0.18
IG	Spectator Recreation	Commercial	Moderate	Y	000-100	0.09
IG	Commercial	Commercial	Moderate	Y	000-100	0.35
IG	Industrial	Commercial	Moderate	Y	000-100	1.48
CG	Forest	Commercial	Moderate	Y	000-100	0.00
CG	Residential < 1/4 Acre	Commercial	Moderate	Y	000-100	0.02
CG	Urban Open	Commercial	Moderate	Y	000-100	0.02
IG	Forest	Commercial	Moderate	Y	000-100	1.33
IG	Open Land	Commercial	Moderate	Y	000-100	0.07
IG	Spectator Recreation	Commercial	Moderate	Y	000-100	0.47
IG	Commercial	Commercial	Moderate	Y	000-100	0.40
IG	Industrial	Commercial	Moderate	Y	000-100	0.00
IG	Transportation	Commercial	Moderate	Y	000-100	0.57
IG	Spectator Recreation	Commercial	Moderate	Y	000-100	0.34
IG	Commercial	Commercial	Moderate	Y	000-100	0.00
IG	Industrial	Commercial	Moderate	Y	000-100	0.23
IG	Industrial	Commercial	Moderate	Y	000-100	0.26
IG	Residential < 1/4 Acre	Commercial	Moderate	Y	000-100	0.01
IG	Industrial	Commercial	Severe	Y	000-100	0.00
IG	Industrial	Commercial	Moderate	Y	000-100	0.87
IG	Industrial	Commercial	Moderate	Y	000-100	0.81
CG	Forest	Commercial	Moderate	Y	100-500	0.03
CG	Commercial	Commercial	Moderate	Y	100-500	0.76
CG	Industrial	Commercial	Moderate	Y	100-500	0.00
CN	Residential < 1/4 Acre	Commercial	Moderate	Y	100-500	0.32
CN	Residential 1/4 to 1/2 Acre	Commercial	Moderate	Y	100-500	0.02
IG	Cropland	Commercial	Severe	Y	100-500	1.30
IG	Forest	Commercial	Moderate	Y	100-500	0.34
IG	Spectator Recreation	Commercial	Severe	Y	100-500	0.50
IG	Spectator Recreation	Commercial	Moderate	Y	100-500	2.61
IG	Residential 1/4 to 1/2 Acre	Commercial	Severe	Y	100-500	0.05
IG	Residential 1/4 to 1/2 Acre	Commercial	Moderate	Y	100-500	0.72
IG	Commercial	Commercial	Moderate	Y	100-500	0.78
IG	Industrial	Commercial	Moderate	Y	100-500	18.13
CC	Commercial	Commercial	Moderate	Y	100-500	0.09
CG	Residential < 1/4 Acre	Commercial	Moderate	Y	100-500	1.15
CG	Urban Open	Commercial	Moderate	Y	100-500	2.55
IG	Forest	Commercial	Moderate	Y	100-500	1.36
IG	Open Land	Commercial	Moderate	Y	100-500	0.10
IG	Spectator Recreation	Commercial	Moderate	Y	100-500	0.91
IG	Commercial	Commercial	Moderate	Y	100-500	13.60
IG	Industrial	Commercial	Moderate	Y	100-500	0.77
IG	Transportation	Commercial	Moderate	Y	100-500	4.55
IG	Waste Disposal	Commercial	Moderate	Y	100-500	0.61
IG	Spectator Recreation	Commercial	Moderate	Y	100-500	0.37
IG	Commercial	Commercial	Moderate	Y	100-500	2.87
IG	Industrial	Commercial	Moderate	Y	100-500	2.23
IG	Transportation	Commercial	Moderate	Y	100-500	2.73
IG	Residential < 1/4 Acre	Commercial	Moderate	Y	100-500	0.13
IG	Industrial	Commercial	Moderate	Y	100-500	3.91

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
IG	Transportation	Commercial	Moderate	Y	100-500	0.15
IG	Residential < 1/4 Acre	Commercial	Moderate	Y	100-500	0.42
IG	Industrial	Commercial	Moderate	Y	100-500	0.85
IG	Industrial	Commercial	Moderate	Y	100-500	1.76
IG	Transportation	Commercial	Moderate	Y	100-500	0.14
CN	Cropland	Commercial	Moderate	Y	>500	0.00
CN	Residential < 1/4 Acre	Commercial	Severe	Y	>500	0.42
CN	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	3.36
CN	Residential 1/4 to 1/2 Acre	Commercial	Severe	Y	>500	1.11
CN	Residential 1/4 to 1/2 Acre	Commercial	Moderate	Y	>500	2.18
CN	Commercial	Commercial	Severe	Y	>500	1.38
CN	Urban Open	Commercial	Moderate	Y	>500	0.00
IG	Cropland	Commercial	Severe	Y	>500	1.37
IG	Cropland	Commercial	Moderate	Y	>500	0.24
IG	Spectator Recreation	Commercial	Severe	Y	>500	0.62
IG	Spectator Recreation	Commercial	Moderate	Y	>500	1.77
IG	Residential 1/4 to 1/2 Acre	Commercial	Moderate	Y	>500	0.16
IG	Commercial	Commercial	Moderate	Y	>500	0.02
IG	Industrial	Commercial	Moderate	Y	>500	18.31
CC	Spectator Recreation	Commercial	Moderate	Y	>500	1.10
CC	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	3.67
CC	Commercial	Commercial	Moderate	Y	>500	27.69
CC	Industrial	Commercial	Moderate	Y	>500	0.04
CG	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	0.59
CG	Commercial	Commercial	Moderate	Y	>500	6.84
CG	Urban Open	Commercial	Moderate	Y	>500	0.02
CN	Residential < 1/4 Acre	Commercial	Severe	Y	>500	2.31
CN	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	1.35
CN	Commercial	Commercial	Severe	Y	>500	0.04
CN	Commercial	Commercial	Moderate	Y	>500	5.28
CN	Urban Open	Commercial	Severe	Y	>500	1.16
CN	Urban Open	Commercial	Moderate	Y	>500	0.97
IG	Spectator Recreation	Commercial	Moderate	Y	>500	0.66
IG	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	4.52
IG	Commercial	Commercial	Moderate	Y	>500	15.27
IG	Industrial	Commercial	Moderate	Y	>500	7.26
CC	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	1.12
CC	Commercial	Commercial	Moderate	Y	>500	11.61
IG	Commercial	Commercial	Moderate	Y	>500	8.71
IG	Industrial	Commercial	Moderate	Y	>500	0.01
IG	Transportation	Commercial	Moderate	Y	>500	0.34
CC	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	1.55
CC	Commercial	Commercial	Moderate	Y	>500	4.99
CC	Industrial	Commercial	Moderate	Y	>500	5.47
IG	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	1.31
IG	Commercial	Commercial	Moderate	Y	>500	2.08
IG	Industrial	Commercial	Moderate	Y	>500	4.13
IG	Transportation	Commercial	Moderate	Y	>500	0.76
IG	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	0.16
IG	Industrial	Commercial	Moderate	Y	>500	0.00
CC	Forest	Commercial	Severe	Y	>500	1.32
CC	Forest	Commercial	Moderate	Y	>500	0.43
CC	Residential < 1/4 Acre	Commercial	Severe	Y	>500	2.78
CC	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	2.19

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
CC	Commercial	Commercial	Moderate	Y	>500	9.25
CC	Urban Open	Commercial	Severe	Y	>500	0.70
CC	Urban Open	Commercial	Moderate	Y	>500	3.26
CC	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	0.47
CC	Commercial	Commercial	Moderate	Y	>500	3.35
IG	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	0.20
IG	Industrial	Commercial	Moderate	Y	>500	0.09
	Commercial	Commercial	Moderate	N	000-100	0.08
	Commercial	Commercial	Moderate	N	000-100	0.01
	Commercial	Commercial	Moderate	N	000-100	0.01
IG	Commercial	Commercial	Moderate	Y	000-100	0.51
IG		Commercial	Severe	Y	000-100	3.39
IG	Cropland	Commercial	Severe	Y	000-100	0.65
IG	Cropland	Commercial	Moderate	Y	000-100	0.08
IG	Forest	Commercial	Severe	Y	000-100	1.87
IG	Forest	Commercial	Moderate	Y	000-100	0.19
IG	Industrial	Commercial	Severe	Y	000-100	1.17
IG	Industrial	Commercial	Moderate	Y	000-100	3.32
IG	Water	Commercial	Moderate	Y	000-100	0.00
IG	Commercial	Commercial	Moderate	Y	000-100	0.05
IG	Industrial	Commercial	Moderate	Y	000-100	0.56
IG	Spectator Recreation	Commercial	Moderate	Y	000-100	0.03
IG	Commercial	Commercial	Moderate	Y	000-100	0.36
IG	Commercial	Commercial	Moderate	Y	100-500	1.59
IG	Industrial	Commercial	Moderate	Y	100-500	0.09
IG		Commercial	Severe	Y	100-500	0.60
IG	Cropland	Commercial	Severe	Y	100-500	1.42
IG	Cropland	Commercial	Moderate	Y	100-500	0.05
IG	Forest	Commercial	Severe	Y	100-500	0.84
IG	Industrial	Commercial	Severe	Y	100-500	1.73
IG	Industrial	Commercial	Moderate	Y	100-500	0.47
IG	Commercial	Commercial	Moderate	Y	100-500	0.00
IG	Industrial	Commercial	Moderate	Y	100-500	0.96
IG	Commercial	Commercial	Moderate	Y	100-500	0.00
	Commercial	Commercial	Severe	Y	>500	0.00
	Commercial	Commercial	Moderate	Y	>500	0.00
CG	Forest	Commercial	Severe	Y	>500	0.18
CG	Forest	Commercial	Moderate	Y	>500	0.05
CG	Open Land	Commercial	Severe	Y	>500	0.64
CG	Open Land	Commercial	Moderate	Y	>500	0.08
CG	Residential Multi-Family	Commercial	Severe	Y	>500	0.17
CG	Commercial	Commercial	Severe	Y	>500	0.06
CG	Commercial	Commercial	Moderate	Y	>500	0.49
CN	Residential 1/4 to 1/2 Acre	Commercial	Severe	Y	>500	0.43
CN	Commercial	Commercial	Severe	Y	>500	0.92
CN	Industrial	Commercial	Severe	Y	>500	0.16
	Forest	Forest	Moderate	N	000-100	0.11
	Forest	Forest	Severe	N	000-100	1.36
	Forest	Forest	Severe	Y	>500	0.00
HD	Forest	Hospital District	Severe	Y	000-100	0.01
HD	Forest	Hospital District	Moderate	Y	000-100	0.58
HD	Urban Open	Hospital District	Severe	Y	000-100	0.12
HD	Urban Open	Hospital District	Moderate	Y	000-100	2.38
HD	Forest	Hospital District	Severe	Y	000-100	0.09

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
HD	Urban Open	Hospital District	Severe	Y	000-100	1.56
HD	Urban Open	Hospital District	Moderate	Y	000-100	0.16
HD	Forest	Hospital District	Severe	Y	100-500	2.69
HD	Forest	Hospital District	Moderate	Y	100-500	0.80
HD	Residential < 1/4 Acre	Hospital District	Moderate	Y	100-500	0.14
HD	Urban Open	Hospital District	Severe	Y	100-500	0.69
HD	Urban Open	Hospital District	Moderate	Y	100-500	5.99
HD	Forest	Hospital District	Severe	Y	100-500	0.53
HD	Residential 1/4 to 1/2 Acre	Hospital District	Severe	Y	100-500	0.18
HD	Residential 1/4 to 1/2 Acre	Hospital District	Moderate	Y	100-500	0.06
HD	Urban Open	Hospital District	Severe	Y	100-500	2.09
HD	Urban Open	Hospital District	Moderate	Y	100-500	3.42
HD	Forest	Hospital District	Severe	Y	>500	1.05
HD	Forest	Hospital District	Moderate	Y	>500	0.21
HD	Residential Multi-Family	Hospital District	Severe	Y	>500	0.25
HD	Residential Multi-Family	Hospital District	Moderate	Y	>500	0.00
HD	Commercial	Hospital District	Severe	Y	>500	0.19
HD	Commercial	Hospital District	Moderate	Y	>500	0.04
HD	Urban Open	Hospital District	Severe	Y	>500	0.74
HD	Urban Open	Hospital District	Moderate	Y	>500	0.37
HD	Forest	Hospital District	Severe	Y	>500	0.20
HD	Forest	Hospital District	Moderate	Y	>500	0.28
HD	Residential < 1/4 Acre	Hospital District	Moderate	Y	>500	0.00
HD	Urban Open	Hospital District	Severe	Y	>500	0.31
HD	Urban Open	Hospital District	Moderate	Y	>500	2.00
HD	Forest	Hospital District	Severe	Y	>500	0.14
HD	Forest	Hospital District	Moderate	Y	>500	0.18
HD	Residential 1/4 to 1/2 Acre	Hospital District	Moderate	Y	>500	0.97
HD	Urban Open	Hospital District	Severe	Y	>500	0.03
HD	Urban Open	Hospital District	Moderate	Y	>500	7.85
IR	Pasture	Industrial	Severe	N	000-100	2.66
IR	Forest	Industrial	Severe	N	000-100	5.06
IR	Open Land	Industrial	Severe	N	000-100	0.08
IR	Urban Open	Industrial	Severe	N	000-100	1.24
IR	Transportation	Industrial	Severe	N	000-100	0.40
IR	Transportation	Industrial	Moderate	N	000-100	0.34
IR	Pasture	Industrial	Severe	N	100-500	9.38
IR	Pasture	Industrial	Moderate	N	100-500	0.18
IR	Forest	Industrial	Severe	N	100-500	16.06
IR	Forest	Industrial	Moderate	N	100-500	3.67
IR	Open Land	Industrial	Severe	N	100-500	0.90
IR	Industrial	Industrial	Severe	N	100-500	1.14
IR	Urban Open	Industrial	Severe	N	100-500	10.96
IR	Urban Open	Industrial	Moderate	N	100-500	0.00
IR	Transportation	Industrial	Severe	N	100-500	1.74
IR	Transportation	Industrial	Moderate	N	100-500	8.98
IR	Pasture	Industrial	Severe	N	>500	5.78
IR	Forest	Industrial	Severe	N	>500	4.24
IR	Forest	Industrial	Moderate	N	>500	0.29
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	>500	0.11
IR	Residential > 1/2 Acre	Industrial	Severe	N	>500	0.69
IR	Industrial	Industrial	Severe	N	>500	24.04
IR	Urban Open	Industrial	Severe	N	>500	13.01
IR	Urban Open	Industrial	Moderate	N	>500	0.00

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
IR	Transportation	Industrial	Severe	N	>500	7.57
IR	Transportation	Industrial	Moderate	N	>500	6.23
IR	Forest	Industrial	Severe	Y	000-100	0.95
IR	Forest	Industrial	Moderate	Y	000-100	0.05
IR	Open Land	Industrial	Severe	Y	000-100	0.63
IR	Open Land	Industrial	Moderate	Y	000-100	1.27
IR	Spectator Recreation	Industrial	Severe	Y	000-100	0.02
IR	Residential Multi-Family	Industrial	Severe	Y	000-100	0.77
IR	Commercial	Industrial	Severe	Y	000-100	2.60
IR	Commercial	Industrial	Moderate	Y	000-100	1.54
IR	Urban Open	Industrial	Severe	Y	000-100	0.08
IR	Transportation	Industrial	Severe	Y	000-100	0.04
IR	Transportation	Industrial	Moderate	Y	000-100	0.48
IR	Forest	Industrial	Severe	Y	100-500	9.59
IR	Forest	Industrial	Moderate	Y	100-500	0.45
IR	Open Land	Industrial	Severe	Y	100-500	0.65
IR	Open Land	Industrial	Moderate	Y	100-500	2.33
IR	Spectator Recreation	Industrial	Moderate	Y	100-500	0.01
IR	Residential Multi-Family	Industrial	Severe	Y	100-500	3.65
IR	Residential Multi-Family	Industrial	Moderate	Y	100-500	0.20
IR	Residential < 1/4 Acre	Industrial	Severe	Y	100-500	0.33
IR	Commercial	Industrial	Severe	Y	100-500	1.60
IR	Commercial	Industrial	Moderate	Y	100-500	6.34
IR	Urban Open	Industrial	Severe	Y	100-500	3.35
IR	Urban Open	Industrial	Moderate	Y	100-500	0.76
IR	Transportation	Industrial	Severe	Y	100-500	0.60
IR	Transportation	Industrial	Moderate	Y	100-500	1.79
IR	Forest	Industrial	Severe	Y	>500	10.43
IR	Forest	Industrial	Moderate	Y	>500	1.39
IR	Open Land	Industrial	Severe	Y	>500	6.95
IR	Open Land	Industrial	Moderate	Y	>500	8.87
IR	Participation Recreation	Industrial	Severe	Y	>500	5.23
IR	Spectator Recreation	Industrial	Moderate	Y	>500	4.20
IR	Residential Multi-Family	Industrial	Severe	Y	>500	6.04
IR	Residential Multi-Family	Industrial	Moderate	Y	>500	2.50
IR	Residential < 1/4 Acre	Industrial	Severe	Y	>500	1.76
IR	Residential < 1/4 Acre	Industrial	Moderate	Y	>500	0.03
IR	Commercial	Industrial	Severe	Y	>500	17.84
IR	Commercial	Industrial	Moderate	Y	>500	10.70
IR	Industrial	Industrial	Severe	Y	>500	12.23
IR	Industrial	Industrial	Moderate	Y	>500	0.43
IR	Urban Open	Industrial	Severe	Y	>500	4.30
IR	Urban Open	Industrial	Moderate	Y	>500	15.01
IR	Transportation	Industrial	Severe	Y	>500	3.59
IR	Transportation	Industrial	Moderate	Y	>500	7.32
IR	Residential 1/4 to 1/2 Acre	Industrial	Severe	Y	>500	0.00
IR	Residential > 1/2 Acre	Industrial	Severe	Y	>500	2.39
IR	Transportation	Industrial	Severe	Y	>500	1.21
IR	Forest	Industrial	Severe	Y	>500	0.06
IR	Residential < 1/4 Acre	Industrial	Severe	Y	>500	0.26
	Industrial	Industrial	Moderate	N	000-100	0.12
	Industrial	Industrial	Moderate	N	000-100	0.15
	Industrial	Industrial	Moderate	N	000-100	0.59
	Industrial	Industrial	Moderate	N	000-100	0.56

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
	Industrial	Industrial	Moderate	N	100-500	0.02
	Industrial	Industrial	Moderate	N	100-500	0.00
R-45	Nonforested Freshwater Wetland	Nonforested Freshwater We	Severe	N	>500	7.44
RSD	Nonforested Freshwater Wetland	Nonforested Freshwater We	Severe	Y	>500	2.85
	Open Land	Open Land	Moderate	N	000-100	0.53
	Open Land	Open Land	Moderate	N	100-500	0.02
R-22		Residential 1/4 to 1/2 Acre	Severe	Y	000-100	0.44
R-22	Participation Recreation	Residential 1/4 to 1/2 Acre	Severe	Y	000-100	1.16
R-22	Urban Open	Residential 1/4 to 1/2 Acre	Severe	Y	000-100	0.02
R-22		Residential 1/4 to 1/2 Acre	Severe	Y	100-500	0.44
R-22	Participation Recreation	Residential 1/4 to 1/2 Acre	Severe	Y	100-500	3.79
R-22	Residential 1/4 to 1/2 Acre	Residential 1/4 to 1/2 Acre	Severe	Y	100-500	0.05
R-22	Industrial	Residential 1/4 to 1/2 Acre	Severe	Y	100-500	2.26
R-22	Urban Open	Residential 1/4 to 1/2 Acre	Severe	Y	100-500	0.56
R-6	Residential < 1/4 Acre	Residential 1/4 to 1/2 Acre	Severe	Y	>500	3.94
R-6	Residential < 1/4 Acre	Residential 1/4 to 1/2 Acre	Moderate	Y	>500	0.52
R-22	Forest	Residential 1/4 to 1/2 Acre	Severe	Y	>500	15.05
R-22	Nonforested Freshwater Wetland	Residential 1/4 to 1/2 Acre	Severe	Y	>500	0.12
R-22	Participation Recreation	Residential 1/4 to 1/2 Acre	Severe	Y	>500	7.58
R-22	Residential 1/4 to 1/2 Acre	Residential 1/4 to 1/2 Acre	Severe	Y	>500	1.31
R-22	Industrial	Residential 1/4 to 1/2 Acre	Severe	Y	>500	3.72
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	0.02
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	0.06
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	N	>500	1.99
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	4.60
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	0.00
R-10	Urban Open	Residential < 1/4 Acre	Severe	N	>500	3.48
R-10	Forest	Residential < 1/4 Acre	Severe	Y	000-100	0.68
R-10	Participation Recreation	Residential < 1/4 Acre	Moderate	Y	000-100	0.02
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	000-100	1.01
R-10	Spectator Recreation	Residential < 1/4 Acre	Moderate	Y	000-100	5.98
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.55
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	000-100	0.78
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.65
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	000-100	1.36
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	000-100	0.00
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	000-100	0.02
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	0.12
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	000-100	1.80
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	000-100	0.09
R-10	Transportation	Residential < 1/4 Acre	Moderate	Y	000-100	0.14
R-10	Forest	Residential < 1/4 Acre	Severe	Y	000-100	0.03
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	000-100	2.20
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	4.93
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	000-100	0.88
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.00
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	000-100	0.20
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	000-100	0.72
R-10		Residential < 1/4 Acre	Severe	Y	000-100	1.33
R-10	Cropland	Residential < 1/4 Acre	Severe	Y	000-100	0.06
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	000-100	0.03
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	000-100	0.00
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	0.00

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
R-10	Forest	Residential < 1/4 Acre	Severe	Y	000-100	7.41
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	2.76
R-10	Forest	Residential < 1/4 Acre	Severe	Y	000-100	0.10
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	0.02
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	1.45
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	000-100	0.76
R-6	Industrial	Residential < 1/4 Acre	Severe	Y	000-100	0.02
R-6	Industrial	Residential < 1/4 Acre	Moderate	Y	000-100	0.00
R-6	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	0.69
R-6	Urban Open	Residential < 1/4 Acre	Moderate	Y	000-100	0.11
R-10	Cropland	Residential < 1/4 Acre	Severe	Y	100-500	1.14
R-10	Cropland	Residential < 1/4 Acre	Moderate	Y	100-500	1.12
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	4.53
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	100-500	0.38
R-10	Open Land	Residential < 1/4 Acre	Severe	Y	100-500	1.21
R-10	Open Land	Residential < 1/4 Acre	Moderate	Y	100-500	0.24
R-10	Participation Recreation	Residential < 1/4 Acre	Severe	Y	100-500	0.02
R-10	Participation Recreation	Residential < 1/4 Acre	Moderate	Y	100-500	1.52
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	100-500	1.00
R-10	Spectator Recreation	Residential < 1/4 Acre	Moderate	Y	100-500	9.26
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	9.38
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	5.06
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	6.15
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	6.43
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	100-500	0.23
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	100-500	1.20
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	1.57
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	9.71
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	100-500	0.01
R-10	Transportation	Residential < 1/4 Acre	Moderate	Y	100-500	0.64
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	4.56
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	100-500	3.66
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	11.77
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	3.03
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	5.08
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	0.17
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	0.01
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	1.15
R-10		Residential < 1/4 Acre	Severe	Y	100-500	0.53
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	0.41
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	100-500	11.85
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	100-500	0.05
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	1.61
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	19.03
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	100-500	1.33
R-10	Open Land	Residential < 1/4 Acre	Severe	Y	100-500	0.01
R-10	Open Land	Residential < 1/4 Acre	Moderate	Y	100-500	0.00
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	15.43
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	0.20
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	0.31
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	1.55
R-10	Forest	Residential < 1/4 Acre	Severe	Y	100-500	2.03
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	0.51
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	0.01

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	0.05
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	0.99
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	9.31
R-6	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	0.46
R-6	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	1.03
R-10		Residential < 1/4 Acre	Severe	Y	>500	0.36
R-10	Cropland	Residential < 1/4 Acre	Severe	Y	>500	0.17
R-10	Cropland	Residential < 1/4 Acre	Moderate	Y	>500	1.44
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	10.06
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	>500	0.21
R-10	Open Land	Residential < 1/4 Acre	Severe	Y	>500	4.61
R-10	Participation Recreation	Residential < 1/4 Acre	Severe	Y	>500	0.74
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	7.78
R-10	Spectator Recreation	Residential < 1/4 Acre	Moderate	Y	>500	4.94
R-10	Residential Multi-Family	Residential < 1/4 Acre	Severe	Y	>500	0.41
R-10	Residential Multi-Family	Residential < 1/4 Acre	Moderate	Y	>500	0.06
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	3.60
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	8.03
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	78.02
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	>500	3.45
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	>500	6.52
R-10	Commercial	Residential < 1/4 Acre	Moderate	Y	>500	0.00
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	>500	1.21
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	>500	0.29
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	17.10
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	>500	12.32
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	>500	2.95
R-10	Transportation	Residential < 1/4 Acre	Moderate	Y	>500	1.31
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	3.50
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	>500	0.04
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	1.15
R-10	Spectator Recreation	Residential < 1/4 Acre	Moderate	Y	>500	0.08
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	27.19
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	3.21
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	1.88
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	>500	0.18
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	0.19
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	5.69
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	15.38
R-10	Nonforested Freshwater Wetland	Residential < 1/4 Acre	Severe	Y	>500	0.57
R-10	Open Land	Residential < 1/4 Acre	Severe	Y	>500	0.96
R-10	Open Land	Residential < 1/4 Acre	Moderate	Y	>500	0.21
R-10	Participation Recreation	Residential < 1/4 Acre	Severe	Y	>500	0.06
R-10	Residential Multi-Family	Residential < 1/4 Acre	Severe	Y	>500	0.62
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	1.02
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	21.00
R-10	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	2.97
R-10	Commercial	Residential < 1/4 Acre	Severe	Y	>500	1.83
R-10	Industrial	Residential < 1/4 Acre	Severe	Y	>500	74.21
R-10	Industrial	Residential < 1/4 Acre	Moderate	Y	>500	0.83
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	1.09
R-10	Transportation	Residential < 1/4 Acre	Severe	Y	>500	0.04
R-10	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	0.34
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	0.98

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	-- ACRES
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	1.13
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	0.10
R-10	Forest	Residential < 1/4 Acre	Moderate	Y	>500	0.03
R-10	Open Land	Residential < 1/4 Acre	Severe	Y	>500	2.40
R-10	Open Land	Residential < 1/4 Acre	Moderate	Y	>500	0.31
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	19.66
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	0.47
R-10	Urban Open	Residential < 1/4 Acre	Moderate	Y	>500	3.03
R-10	Forest	Residential < 1/4 Acre	Severe	Y	>500	1.67
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	0.13
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	2.69
R-10	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	>500	0.68
R-10	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	0.57
R-10	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	2.51
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	3.74
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	4.23
R-6	Commercial	Residential < 1/4 Acre	Moderate	Y	>500	0.04
R-6	Urban Open	Residential < 1/4 Acre	Moderate	Y	>500	0.31
R-6	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	2.18
	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.29
	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.11
	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	000-100	0.09
R-45	Cropland	Residential > 1/2 Acre	Severe	N	>500	41.53
R-45	Forest	Residential > 1/2 Acre	Severe	N	>500	16.34
R-45	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	13.95
RMD	Spectator Recreation	Residential Multi-Family	Moderate	Y	000-100	0.31
RMD	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Moderate	Y	000-100	0.06
RMD	Commercial	Residential Multi-Family	Moderate	Y	000-100	0.58
RMD	Residential < 1/4 Acre	Residential Multi-Family	Severe	Y	000-100	0.17
RMD	Spectator Recreation	Residential Multi-Family	Moderate	Y	100-500	2.61
RMD	Residential Multi-Family	Residential Multi-Family	Severe	Y	100-500	0.25
RMD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	100-500	3.85
RMD	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Moderate	Y	100-500	1.70
RMD	Commercial	Residential Multi-Family	Moderate	Y	100-500	0.36
RMD	Residential < 1/4 Acre	Residential Multi-Family	Severe	Y	100-500	0.38
RMD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	100-500	1.31
RMD	Forest	Residential Multi-Family	Severe	Y	>500	0.56
RMD	Forest	Residential Multi-Family	Moderate	Y	>500	0.27
RMD	Residential Multi-Family	Residential Multi-Family	Severe	Y	>500	1.00
RMD	Residential < 1/4 Acre	Residential Multi-Family	Severe	Y	>500	0.01
RMD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	14.98
RMD	Commercial	Residential Multi-Family	Severe	Y	>500	1.96
RMD	Commercial	Residential Multi-Family	Moderate	Y	>500	0.89
RMD	Urban Open	Residential Multi-Family	Severe	Y	>500	0.16
RMD	Transportation	Residential Multi-Family	Severe	Y	>500	0.03
RHD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	19.35
RHD	Commercial	Residential Multi-Family	Moderate	Y	>500	3.54
RMD	Forest	Residential Multi-Family	Moderate	Y	>500	0.00
RMD	Spectator Recreation	Residential Multi-Family	Moderate	Y	>500	1.30
RMD	Residential < 1/4 Acre	Residential Multi-Family	Severe	Y	>500	10.98
RMD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	48.44
RMD	Commercial	Residential Multi-Family	Moderate	Y	>500	7.61
RMD	Industrial	Residential Multi-Family	Moderate	Y	>500	0.96

ZONING CODE	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
RMD	Urban Open	Residential Multi-Family	Moderate	Y	>500	9.65
RHD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	15.59
RHD	Commercial	Residential Multi-Family	Moderate	Y	>500	2.19
RHD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	14.68
RHD	Commercial	Residential Multi-Family	Moderate	Y	>500	0.47
RHD	Industrial	Residential Multi-Family	Moderate	Y	>500	0.17
RSD	Forest	Residential Multi-Family	Severe	Y	>500	50.13
RSD	Open Land	Residential Multi-Family	Severe	Y	>500	6.87
RSD	Residential Multi-Family	Residential Multi-Family	Severe	Y	>500	33.33
RMD	Forest	Residential Multi-Family	Severe	Y	>500	2.32
RMD	Forest	Residential Multi-Family	Moderate	Y	>500	0.26
RMD	Residential < 1/4 Acre	Residential Multi-Family	Severe	Y	>500	3.20
RMD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	0.20
RMD	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Severe	Y	>500	0.62
RMD	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Moderate	Y	>500	0.62
RMD	Urban Open	Residential Multi-Family	Severe	Y	>500	0.34
RMD	Urban Open	Residential Multi-Family	Moderate	Y	>500	1.15
RHD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	4.13
RHD	Commercial	Residential Multi-Family	Moderate	Y	>500	0.82
RMD	Residential < 1/4 Acre	Residential Multi-Family	Moderate	Y	>500	0.06
	Spectator Recreation	Spectator Recreation	Moderate	N	000-100	0.19
	Spectator Recreation	Spectator Recreation	Moderate	N	000-100	0.00
	Transportation	Transportation	Moderate	N	000-100	0.08
	Transportation	Transportation	Moderate	N	100-500	0.05
	Urban Open	Urban Open	Severe	N	000-100	0.06
	Water Based Recreation	Water Based Recreation	Moderate	N	000-100	0.26
	Water Based Recreation	Water Based Recreation	Severe	N	000-100	0.08
	Water Based Recreation	Water Based Recreation	Moderate	N	000-100	0.01
IG	Water Based Recreation	Water Based Recreation	Moderate	Y	000-100	0.96
R-6	Water Based Recreation	Water Based Recreation	Severe	Y	000-100	0.30
R-6	Water Based Recreation	Water Based Recreation	Moderate	Y	000-100	0.04
IG	Water Based Recreation	Water Based Recreation	Moderate	Y	100-500	0.67

Roads Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	2,199
High Density Residential	
Multi-family Residential	
Major Roads/Highways	
Commercial	
Industrial	
Open Land	
Agriculture	
Pasture	
Forest	241
Wetlands	119
Water (bridges)	
Recreation	

Roads Length Summary	Road Length (feet)
Low Density Residential	51
Medium Density Residential	11,785
High Density Residential	
Multi-family Residential	
Major Roads/Highways	
Commercial	299
Industrial	
Open Land	
Agriculture	
Pasture	241
Forest	
Wetlands	
Water (bridges)	
Recreation	

Beverly 3 Roads

Roads Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	17,253
High Density Residential	
Multi-family Residential	522
Major Roads/Highways	
Commercial	1,896
Industrial	
Open Land	114
Agriculture	
Pasture	
Forest	557
Wetlands	
Water (bridges)	
Recreation	

Beverly 4 Roads

Roads Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	2,322
High Density Residential	
Multi-family Residential	50
Major Roads/Highways	
Commercial	
Industrial	
Open Land	
Agriculture	
Pasture	
Forest	145
Wetlands	
Water (bridges)	
Recreation	211

Roads Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	
High Density Residential	3,062
Multi-family Residential	
Major Roads/Highways	
Commercial	
Industrial	12,314
Open Land	515
Agriculture	
Pasture	
Forest	832
Wetlands	
Water (bridges)	
Recreation	

Beverly 6 Roads

Roads Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	
High Density Residential	
Multi-family Residential	
Major Roads/Highways	
Commercial	1,320
Industrial	3,869
Open Land	
Agriculture	
Pasture	
Forest	14
Wetlands	
Water (bridges)	
Recreation	

Roads Length Summary	Road Length (feet)
Low Density Residential	0
Medium Density Residential	26,333
High Density Residential	0
Multi-family Residential	2,093
Major Roads/Highways	0
Commercial	2,842
Industrial	7,676
Open Land	1,095
Agriculture	
Pasture	
Forest	7,347
Wetlands	
Water (bridges)	
Recreation	

Roads Length Summary	Road Length (feet)
Low Density Residential	1,048
Medium Density Residential	30,466
High Density Residential	71,134
Multi-family Residential	7,776
Major Roads/Highways	
Commercial	44,542
Industrial	23,454
Open Land	19,092
Agriculture	3,032
Pasture	15
Forest	9,882
Wetlands	
Water (bridges)	19
Recreation	1,438

IPSWICH DATA TABLES - BUILDOUT

ZONING	LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
RRA	Forest	Residential > 1/2 Acre	Severe	N	000-100	4.15
RRA	Open Land	Residential > 1/2 Acre	Severe	N	000-100	0.80
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	0.00
RRA	Cropland	Residential > 1/2 Acre	Severe	N	100-500	1.20
RRA	Cropland	Residential > 1/2 Acre	Moderate	N	100-500	0.28
RRA	Pasture	Residential > 1/2 Acre	Severe	N	100-500	5.46
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	100-500	0.61
RRA	Forest	Residential > 1/2 Acre	Severe	N	100-500	19.52
RRA	Forest	Residential > 1/2 Acre	Moderate	N	100-500	1.51
RRA	Open Land	Residential > 1/2 Acre	Severe	N	100-500	1.58
RRA	Open Land	Residential > 1/2 Acre	Slight	N	100-500	0.45
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	0.94
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	100-500	1.59
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	11.07
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	100-500	0.32
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	100-500	2.70
RRA	Cropland	Residential > 1/2 Acre	Severe	N	>500	0.71
RRA	Cropland	Residential > 1/2 Acre	Moderate	N	>500	0.23
RRA	Pasture	Residential > 1/2 Acre	Severe	N	>500	5.16
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	>500	5.95
RRA	Forest	Residential > 1/2 Acre	Severe	N	>500	0.49
RRA	Forest	Residential > 1/2 Acre	Moderate	N	>500	0.03
RRA	Open Land	Residential > 1/2 Acre	Severe	N	>500	0.02
RRA	Open Land	Residential > 1/2 Acre	Slight	N	>500	0.10
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	1.26
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	0.02
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	0.02
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	0.06
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	0.30
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	100-500	1.16
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	100-500	0.57
RRA	Forest	Residential > 1/2 Acre	Severe	Y	100-500	3.52
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	100-500	0.00
RRA	Open Land	Residential > 1/2 Acre	Severe	Y	100-500	0.05
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	0.05
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	100-500	0.01
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	0.69
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	Y	100-500	0.29
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	>500	21.84
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	>500	2.72
RRA	Pasture	Residential > 1/2 Acre	Slight	Y	>500	2.35
RRA	Forest	Residential > 1/2 Acre	Severe	Y	>500	26.88
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	>500	0.33
RRA	Forest	Residential > 1/2 Acre	Slight	Y	>500	0.45
RRA	Open Land	Residential > 1/2 Acre	Severe	Y	>500	1.46
RRA	Open Land	Residential > 1/2 Acre	Slight	Y	>500	1.89
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	26.76
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	>500	4.89
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	8.22
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	Y	>500	1.29
RRA	Salt Wetland	Salt Wetland	Severe	N	000-100	29.80
RRA	Salt Wetland	Salt Wetland	Severe	N	100-500	19.80
RRA	Salt Wetland	Salt Wetland	Moderate	N	100-500	0.03
RRA	Salt Wetland	Salt Wetland	Severe	N	>500	1.12
RRA	Salt Wetland	Salt Wetland	Moderate	N	>500	0.00
RRA	Water	Water	Severe	N	000-100	0.00

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
B	Commercial	Commercial	Severe	Y	000-100	0.41
B	Residential < 1/4 Acre	Commercial	Severe	Y	100-500	1.03
B	Commercial	Commercial	Severe	Y	100-500	5.47
B	Residential < 1/4 Acre	Commercial	Severe	Y	>500	5.09
B	Residential < 1/4 Acre	Commercial	Moderate	Y	>500	7.16
B	Residential 1/4 to 1/2 Acre	Commercial	Severe	Y	>500	1.43
B	Commercial	Commercial	Severe	Y	>500	7.70
B	Commercial	Commercial	Moderate	Y	>500	0.54
I	Residential < 1/4 Acre	Industrial	Severe	Y	>500	6.07
I	Residential < 1/4 Acre	Industrial	Moderate	Y	>500	4.67
I	Residential < 1/4 Acre	Industrial	Slight	Y	>500	1.32
I	Commercial	Industrial	Severe	Y	>500	5.98
I	Commercial	Industrial	Moderate	Y	>500	0.21
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	0.26
IR	Forest	Residential < 1/4 Acre	Severe	Y	>500	0.95
IR	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	1.35
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	36.30
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	49.79
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Slight	Y	>500	13.90
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	>500	7.62
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	Y	>500	0.04
IR	Commercial	Residential < 1/4 Acre	Severe	Y	>500	0.14
IR	Commercial	Residential < 1/4 Acre	Moderate	Y	>500	0.09
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	0.02
IR	Urban Open	Residential < 1/4 Acre	Moderate	Y	>500	3.18
RRA	Forest	Residential > 1/2 Acre	Severe	Y	000-100	2.98
RRA	Forest	Residential > 1/2 Acre	Severe	Y	100-500	9.43
RRA	Urban Open	Residential > 1/2 Acre	Severe	Y	100-500	2.88
RRA	Forest	Residential > 1/2 Acre	Severe	Y	>500	15.06
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	>500	3.85
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	0.35
RRA	Urban Open	Residential > 1/2 Acre	Severe	Y	>500	6.79

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	000-100	5.02
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	100-500	0.07
RRA	Cropland	Residential > 1/2 Acre	Severe	N	000-100	0.04
RRA	Pasture	Residential > 1/2 Acre	Severe	N	000-100	36.80
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	000-100	0.35
RRA	Pasture	Residential > 1/2 Acre	Slight	N	000-100	0.19
RRA	Forest	Residential > 1/2 Acre	Severe	N	000-100	37.86
RRA	Forest	Residential > 1/2 Acre	Moderate	N	000-100	2.32
RRA	Forest	Residential > 1/2 Acre	Slight	N	000-100	0.04
RRA	Open Land	Residential > 1/2 Acre	Severe	N	000-100	1.35
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	0.59
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	1.62
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	000-100	0.00
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	000-100	0.58
RRA		Residential > 1/2 Acre	Severe	N	100-500	1.70
RRA		Residential > 1/2 Acre	Moderate	N	100-500	0.76
RRA		Residential > 1/2 Acre	Slight	N	100-500	1.13
RRA	Cropland	Residential > 1/2 Acre	Severe	N	100-500	2.31
RRA	Cropland	Residential > 1/2 Acre	Slight	N	100-500	2.03
RRA	Pasture	Residential > 1/2 Acre	Severe	N	100-500	152.11
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	100-500	27.59
RRA	Pasture	Residential > 1/2 Acre	Slight	N	100-500	11.30
RRA	Forest	Residential > 1/2 Acre	Severe	N	100-500	152.85
RRA	Forest	Residential > 1/2 Acre	Moderate	N	100-500	50.53
RRA	Forest	Residential > 1/2 Acre	Slight	N	100-500	4.50
RRA	Open Land	Residential > 1/2 Acre	Severe	N	100-500	1.22
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	7.25
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	100-500	1.81
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	100-500	2.23
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	42.32
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	100-500	5.12
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	100-500	2.60
RRA		Residential > 1/2 Acre	Severe	N	>500	1.63
RRA		Residential > 1/2 Acre	Slight	N	>500	1.16
RRA	Cropland	Residential > 1/2 Acre	Severe	N	>500	0.08
RRA	Cropland	Residential > 1/2 Acre	Slight	N	>500	3.90
RRA	Pasture	Residential > 1/2 Acre	Severe	N	>500	130.31
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	>500	12.82
RRA	Pasture	Residential > 1/2 Acre	Slight	N	>500	13.06
RRA	Forest	Residential > 1/2 Acre	Severe	N	>500	105.98
RRA	Forest	Residential > 1/2 Acre	Moderate	N	>500	13.05
RRA	Forest	Residential > 1/2 Acre	Slight	N	>500	19.85
RRA	Open Land	Residential > 1/2 Acre	Severe	N	>500	3.08
RRA	Participation Recreation	Residential > 1/2 Acre	Severe	N	>500	0.44
RRA	Spectator Recreation	Residential > 1/2 Acre	Severe	N	>500	14.00
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	10.52
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	1.01
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	3.32
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	33.99
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	10.40
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	3.04
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	>500	1.10
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	>500	2.83
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	>500	0.27
	Salt Wetland	Salt Wetland	Severe	N	000-100	0.56
RRA	Salt Wetland	Salt Wetland	Severe	N	000-100	283.23
RRA	Salt Wetland	Salt Wetland	Moderate	N	000-100	3.46
RRA	Salt Wetland	Salt Wetland	Slight	N	000-100	0.10
RRA	Salt Wetland	Salt Wetland	Severe	N	100-500	66.42
RRA	Salt Wetland	Salt Wetland	Moderate	N	100-500	4.01
RRA	Salt Wetland	Salt Wetland	Slight	N	100-500	0.07
RRA	Salt Wetland	Salt Wetland	Severe	N	>500	0.04
RRA	Water	Water	Severe	N	000-100	0.00

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
B	Commercial	Commercial	Severe	Y	>500	0.41
I	Open Land	Industrial	Severe	N	000-100	0.88
I	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	000-100	0.51
I	Residential 1/4 to 1/2 Acre	Industrial	Slight	N	000-100	0.01
I	Urban Open	Industrial	Severe	N	000-100	0.40
I	Pasture	Industrial	Slight	N	100-500	0.02
I	Open Land	Industrial	Severe	N	100-500	3.48
I	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	100-500	2.49
I	Residential 1/4 to 1/2 Acre	Industrial	Slight	N	100-500	0.45
I	Industrial	Industrial	Severe	N	100-500	0.69
I	Pasture	Industrial	Severe	N	>500	3.80
I	Pasture	Industrial	Slight	N	>500	0.03
I	Open Land	Industrial	Severe	N	>500	0.80
I	Residential 1/4 to 1/2 Acre	Industrial	Severe	N	>500	1.63
I	Residential 1/4 to 1/2 Acre	Industrial	Slight	N	>500	0.10
I	Industrial	Industrial	Severe	N	>500	0.35
I	Open Land	Industrial	Severe	Y	000-100	0.32
I	Residential < 1/4 Acre	Industrial	Severe	Y	000-100	1.08
I	Residential 1/4 to 1/2 Acre	Industrial	Severe	Y	000-100	0.04
I	Residential 1/4 to 1/2 Acre	Industrial	Slight	Y	000-100	0.00
I	Commercial	Industrial	Severe	Y	000-100	0.00
I	Industrial	Industrial	Severe	Y	000-100	1.66
I	Urban Open	Industrial	Severe	Y	000-100	1.01
I	Transportation	Industrial	Severe	Y	000-100	1.51
I	Open Land	Industrial	Severe	Y	100-500	0.62
I	Open Land	Industrial	Slight	Y	100-500	0.16
I	Residential < 1/4 Acre	Industrial	Severe	Y	100-500	3.28
I	Residential < 1/4 Acre	Industrial	Slight	Y	100-500	0.53
I	Residential 1/4 to 1/2 Acre	Industrial	Severe	Y	100-500	1.15
I	Residential 1/4 to 1/2 Acre	Industrial	Slight	Y	100-500	0.29
I	Commercial	Industrial	Severe	Y	100-500	0.07
I	Industrial	Industrial	Severe	Y	100-500	4.31
I	Urban Open	Industrial	Severe	Y	100-500	0.85
I	Transportation	Industrial	Severe	Y	100-500	1.85
I	Transportation	Industrial	Slight	Y	100-500	0.22
I	Residential < 1/4 Acre	Industrial	Severe	Y	>500	1.68
I	Residential < 1/4 Acre	Industrial	Moderate	Y	>500	0.05
I	Residential < 1/4 Acre	Industrial	Slight	Y	>500	0.02
I	Commercial	Industrial	Severe	Y	>500	0.11
I	Industrial	Industrial	Severe	Y	>500	0.03
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.10
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	000-100	1.25
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Slight	N	000-100	0.04
IR	Pasture	Residential < 1/4 Acre	Severe	N	100-500	0.21
IR	Pasture	Residential < 1/4 Acre	Slight	N	100-500	0.65
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	100-500	1.26
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Slight	N	100-500	0.98
IR	Pasture	Residential < 1/4 Acre	Severe	N	>500	2.66
IR	Pasture	Residential < 1/4 Acre	Slight	N	>500	0.03
IR	Forest	Residential < 1/4 Acre	Severe	N	>500	0.50
IR	Forest	Residential < 1/4 Acre	Moderate	N	>500	0.04
IR	Forest	Residential < 1/4 Acre	Slight	N	>500	0.14
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	0.00
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Slight	N	>500	0.01
IR	Commercial	Residential < 1/4 Acre	Severe	N	>500	1.56
IR	Commercial	Residential < 1/4 Acre	Moderate	N	>500	0.71
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	3.63
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	000-100	0.01
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Slight	Y	000-100	0.13

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.24
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Slight	Y	000-100	0.02
IR	Commercial	Residential < 1/4 Acre	Severe	Y	000-100	0.29
IR	Transportation	Residential < 1/4 Acre	Severe	Y	000-100	0.11
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	7.14
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	1.97
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Slight	Y	100-500	10.55
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	0.33
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Slight	Y	100-500	2.45
IR	Commercial	Residential < 1/4 Acre	Severe	Y	100-500	1.41
IR	Transportation	Residential < 1/4 Acre	Severe	Y	100-500	0.38
IR	Transportation	Residential < 1/4 Acre	Slight	Y	100-500	0.00
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	10.03
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	16.37
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Slight	Y	>500	9.11
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Slight	Y	>500	0.39
IR	Commercial	Residential < 1/4 Acre	Severe	Y	>500	1.78
IR	Industrial	Residential < 1/4 Acre	Severe	Y	>500	0.27
IR	Transportation	Residential < 1/4 Acre	Severe	Y	>500	0.00
RRA	Cropland	Residential > 1/2 Acre	Severe	N	000-100	0.39
RRA	Cropland	Residential > 1/2 Acre	Slight	N	000-100	0.78
RRA	Pasture	Residential > 1/2 Acre	Severe	N	000-100	0.50
RRA	Pasture	Residential > 1/2 Acre	Slight	N	000-100	0.03
RRA	Forest	Residential > 1/2 Acre	Severe	N	000-100	2.83
RRA	Forest	Residential > 1/2 Acre	Moderate	N	000-100	4.43
RRA	Forest	Residential > 1/2 Acre	Slight	N	000-100	0.57
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	N	000-100	0.18
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	N	000-100	0.00
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	0.80
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	000-100	2.31
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	000-100	0.39
RRA	Cropland	Residential > 1/2 Acre	Severe	N	100-500	0.52
RRA	Cropland	Residential > 1/2 Acre	Moderate	N	100-500	1.98
RRA	Cropland	Residential > 1/2 Acre	Slight	N	100-500	10.68
RRA	Pasture	Residential > 1/2 Acre	Severe	N	100-500	8.15
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	100-500	0.09
RRA	Pasture	Residential > 1/2 Acre	Slight	N	100-500	2.20
RRA	Forest	Residential > 1/2 Acre	Severe	N	100-500	14.59
RRA	Forest	Residential > 1/2 Acre	Moderate	N	100-500	13.83
RRA	Forest	Residential > 1/2 Acre	Slight	N	100-500	3.72
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	4.23
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	100-500	0.62
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	100-500	1.99
RRA	Cropland	Residential > 1/2 Acre	Severe	N	>500	2.56
RRA	Cropland	Residential > 1/2 Acre	Moderate	N	>500	2.68
RRA	Cropland	Residential > 1/2 Acre	Slight	N	>500	2.57
RRA	Pasture	Residential > 1/2 Acre	Severe	N	>500	11.25
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	>500	4.00
RRA	Pasture	Residential > 1/2 Acre	Slight	N	>500	0.75
RRA	Forest	Residential > 1/2 Acre	Severe	N	>500	130.64
RRA	Forest	Residential > 1/2 Acre	Moderate	N	>500	42.17
RRA	Forest	Residential > 1/2 Acre	Slight	N	>500	11.39
RRA	Open Land	Residential > 1/2 Acre	Severe	N	>500	0.40
RRA	Open Land	Residential > 1/2 Acre	Slight	N	>500	0.17
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	29.93
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	5.71
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	3.87
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	1.89
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	0.34

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	2.64
RRA	Commercial	Residential > 1/2 Acre	Severe	N	>500	1.15
RRA	Commercial	Residential > 1/2 Acre	Moderate	N	>500	0.36
RRA	Cropland	Residential > 1/2 Acre	Severe	Y	000-100	0.08
RRA	Cropland	Residential > 1/2 Acre	Moderate	Y	000-100	0.60
RRA	Cropland	Residential > 1/2 Acre	Slight	Y	000-100	0.25
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	000-100	3.05
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	000-100	0.21
RRA	Pasture	Residential > 1/2 Acre	Slight	Y	000-100	3.43
RRA	Forest	Residential > 1/2 Acre	Severe	Y	000-100	9.60
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	000-100	3.35
RRA	Forest	Residential > 1/2 Acre	Slight	Y	000-100	1.89
RRA	Nonforested Freshwater Wetland	Residential > 1/2 Acre	Severe	Y	000-100	2.17
RRA	Nonforested Freshwater Wetland	Residential > 1/2 Acre	Slight	Y	000-100	0.94
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	000-100	0.06
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	000-100	0.11
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	000-100	0.03
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	000-100	0.87
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	000-100	1.21
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	000-100	0.38
RRA	Cropland	Residential > 1/2 Acre	Severe	Y	100-500	0.40
RRA	Cropland	Residential > 1/2 Acre	Moderate	Y	100-500	0.66
RRA	Cropland	Residential > 1/2 Acre	Slight	Y	100-500	1.65
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	100-500	14.26
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	100-500	1.13
RRA	Pasture	Residential > 1/2 Acre	Slight	Y	100-500	10.00
RRA	Forest	Residential > 1/2 Acre	Severe	Y	100-500	24.23
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	100-500	20.45
RRA	Forest	Residential > 1/2 Acre	Slight	Y	100-500	3.78
RRA	Nonforested Freshwater Wetland	Residential > 1/2 Acre	Severe	Y	100-500	2.55
RRA	Nonforested Freshwater Wetland	Residential > 1/2 Acre	Moderate	Y	100-500	0.50
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	100-500	0.07
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	1.15
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	4.92
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	11.37
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	100-500	2.55
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	3.64
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	0.58
RRA	Cropland	Residential > 1/2 Acre	Severe	Y	>500	0.22
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	>500	8.39
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	>500	2.26
RRA	Pasture	Residential > 1/2 Acre	Slight	Y	>500	7.03
RRA	Forest	Residential > 1/2 Acre	Severe	Y	>500	36.04
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	>500	18.05
RRA	Forest	Residential > 1/2 Acre	Slight	Y	>500	10.49
RRA	Nonforested Freshwater Wetland	Residential > 1/2 Acre	Severe	Y	>500	0.03
RRA	Open Land	Residential > 1/2 Acre	Severe	Y	>500	0.11
RRA	Open Land	Residential > 1/2 Acre	Slight	Y	>500	0.68
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	>500	2.59
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	>500	2.58
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	3.20
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	>500	7.30
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	>500	0.17
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	0.17
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	Y	>500	6.77

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
RRA	Forest	Residential > 1/2 Acre	Severe	N	000-100	0.58
RRA	Forest	Residential > 1/2 Acre	Slight	N	000-100	0.21
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	0.73
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	000-100	0.04
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	000-100	0.03
RRA	Cropland	Residential > 1/2 Acre	Severe	N	100-500	1.28
RRA	Cropland	Residential > 1/2 Acre	Moderate	N	100-500	0.45
RRA	Forest	Residential > 1/2 Acre	Severe	N	100-500	10.57
RRA	Forest	Residential > 1/2 Acre	Moderate	N	100-500	1.81
RRA	Forest	Residential > 1/2 Acre	Slight	N	100-500	2.38
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	2.51
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	100-500	1.45
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	100-500	0.70
RRA	Cropland	Residential > 1/2 Acre	Severe	N	>500	1.93
RRA	Cropland	Residential > 1/2 Acre	Moderate	N	>500	0.11
RRA	Pasture	Residential > 1/2 Acre	Severe	N	>500	6.68
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	>500	3.77
RRA	Pasture	Residential > 1/2 Acre	Slight	N	>500	1.52
RRA	Forest	Residential > 1/2 Acre	Severe	N	>500	30.42
RRA	Forest	Residential > 1/2 Acre	Moderate	N	>500	12.46
RRA	Forest	Residential > 1/2 Acre	Slight	N	>500	3.02
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	16.41
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	1.52
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	1.14
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	3.20
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	3.40
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	0.32
RRA	Commercial	Residential > 1/2 Acre	Severe	N	>500	10.16
RRA	Urban Open	Residential > 1/2 Acre	Severe	N	>500	0.93
RRA	Urban Open	Residential > 1/2 Acre	Moderate	N	>500	0.17
RRA	Forest	Residential > 1/2 Acre	Severe	Y	000-100	2.56
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	000-100	0.47
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	000-100	1.65
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	000-100	0.74
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	000-100	4.03
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	000-100	0.08
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	000-100	0.02
RRA	Commercial	Residential > 1/2 Acre	Severe	Y	000-100	1.26
RRA	Commercial	Residential > 1/2 Acre	Moderate	Y	000-100	0.61
RRA	Commercial	Residential > 1/2 Acre	Slight	Y	000-100	0.02
RRA	Industrial	Residential > 1/2 Acre	Severe	Y	000-100	0.37
RRA	Industrial	Residential > 1/2 Acre	Moderate	Y	000-100	0.45
RRA	Cropland	Residential > 1/2 Acre	Severe	Y	100-500	1.18
RRA	Cropland	Residential > 1/2 Acre	Moderate	Y	100-500	5.60
RRA	Cropland	Residential > 1/2 Acre	Slight	Y	100-500	0.11
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	100-500	0.28
RRA	Pasture	Residential > 1/2 Acre	Slight	Y	100-500	0.01
RRA	Forest	Residential > 1/2 Acre	Severe	Y	100-500	18.29
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	100-500	4.28
RRA	Forest	Residential > 1/2 Acre	Slight	Y	100-500	1.71
RRA	Residential Multi-Family	Residential > 1/2 Acre	Moderate	Y	100-500	0.25
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	100-500	1.28
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	0.57
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	10.36
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	0.50
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	100-500	4.34
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	4.81
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	0.99
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	Y	100-500	2.26
RRA	Commercial	Residential > 1/2 Acre	Severe	Y	100-500	3.52
RRA	Commercial	Residential > 1/2 Acre	Moderate	Y	100-500	2.25
RRA	Commercial	Residential > 1/2 Acre	Slight	Y	100-500	0.57

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
B	Nonforested Freshwater Wetland	Commercial	Severe	N	100-500	0.25
B	Forest	Commercial	Severe	N	>500	0.14
B	Nonforested Freshwater Wetland	Commercial	Severe	N	>500	2.73
B	Nonforested Freshwater Wetland	Commercial	Severe	Y	000-100	0.36
B	Nonforested Freshwater Wetland	Commercial	Moderate	Y	000-100	0.18
B	Commercial	Commercial	Moderate	Y	000-100	0.13
B	Cropland	Commercial	Severe	Y	100-500	0.17
B	Cropland	Commercial	Moderate	Y	100-500	0.11
B	Nonforested Freshwater Wetland	Commercial	Severe	Y	100-500	1.42
B	Nonforested Freshwater Wetland	Commercial	Moderate	Y	100-500	0.88
B	Residential Multi-Family	Commercial	Moderate	Y	100-500	0.04
B	Residential < 1/4 Acre	Commercial	Moderate	Y	100-500	0.01
B	Commercial	Commercial	Severe	Y	100-500	0.24
B	Commercial	Commercial	Moderate	Y	100-500	8.04
B	Cropland	Commercial	Severe	Y	>500	3.11
B	Cropland	Commercial	Moderate	Y	>500	0.34
B	Forest	Commercial	Severe	Y	>500	3.84
B	Forest	Commercial	Moderate	Y	>500	1.31
B	Nonforested Freshwater Wetland	Commercial	Severe	Y	>500	3.05
B	Nonforested Freshwater Wetland	Commercial	Moderate	Y	>500	0.18
B	Open Land	Commercial	Severe	Y	>500	3.64
B	Open Land	Commercial	Moderate	Y	>500	0.15
B	Residential Multi-Family	Commercial	Severe	Y	>500	0.20
B	Residential Multi-Family	Commercial	Moderate	Y	>500	0.15
B	Residential > 1/2 Acre	Commercial	Severe	Y	>500	0.40
B	Residential > 1/2 Acre	Commercial	Moderate	Y	>500	0.08
B	Commercial	Commercial	Severe	Y	>500	7.15
B	Commercial	Commercial	Moderate	Y	>500	10.04
B	Urban Open	Commercial	Severe	Y	>500	0.58
B	Urban Open	Commercial	Moderate	Y	>500	0.06
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	000-100	3.81
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Moderate	N	000-100	0.05
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Slight	N	000-100	0.02
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	100-500	9.86
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Moderate	N	100-500	0.01
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Slight	N	100-500	0.00
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	>500	17.22
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Moderate	N	>500	0.12
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	000-100	7.16
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Moderate	Y	000-100	0.18
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	100-500	5.94
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Moderate	Y	100-500	0.18
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	Y	>500	9.93
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Moderate	Y	>500	0.78
IR	Forest	Residential < 1/4 Acre	Severe	Y	000-100	1.17
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	1.27
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	0.46
IR	Pasture	Residential < 1/4 Acre	Severe	Y	100-500	0.04
IR	Forest	Residential < 1/4 Acre	Severe	Y	100-500	1.67
IR	Forest	Residential < 1/4 Acre	Moderate	Y	100-500	0.76
IR	Residential Multi-Family	Residential < 1/4 Acre	Moderate	Y	100-500	2.80
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	3.97
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	0.12
IR	Commercial	Residential < 1/4 Acre	Moderate	Y	100-500	0.02
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	1.21
IR	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	0.71
IR	Pasture	Residential < 1/4 Acre	Severe	Y	>500	0.56
IR	Pasture	Residential < 1/4 Acre	Moderate	Y	>500	0.47
IR	Residential Multi-Family	Residential < 1/4 Acre	Moderate	Y	>500	0.30
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	2.43
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	2.13
RRA	Cropland	Residential > 1/2 Acre	Severe	N	000-100	0.27

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
RRA	Industrial	Residential > 1/2 Acre	Severe	Y	100-500	0.52
RRA	Industrial	Residential > 1/2 Acre	Moderate	Y	100-500	3.40
RRA	Cropland	Residential > 1/2 Acre	Severe	Y	>500	4.63
RRA	Cropland	Residential > 1/2 Acre	Moderate	Y	>500	7.04
RRA	Cropland	Residential > 1/2 Acre	Slight	Y	>500	0.15
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	>500	24.67
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	>500	11.28
RRA	Pasture	Residential > 1/2 Acre	Slight	Y	>500	1.36
RRA	Forest	Residential > 1/2 Acre	Severe	Y	>500	54.82
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	>500	15.70
RRA	Forest	Residential > 1/2 Acre	Slight	Y	>500	7.17
RRA	Open Land	Residential > 1/2 Acre	Severe	Y	>500	0.02
RRA	Residential Multi-Family	Residential > 1/2 Acre	Severe	Y	>500	0.39
RRA	Residential Multi-Family	Residential > 1/2 Acre	Moderate	Y	>500	0.82
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	>500	1.33
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	>500	4.31
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	19.98
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	>500	3.37
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	>500	5.02
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	14.83
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	>500	1.75
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	Y	>500	2.66
RRA	Commercial	Residential > 1/2 Acre	Severe	Y	>500	2.41
RRA	Commercial	Residential > 1/2 Acre	Moderate	Y	>500	2.38
RRA	Industrial	Residential > 1/2 Acre	Severe	Y	>500	0.00
RRA	Industrial	Residential > 1/2 Acre	Moderate	Y	>500	0.13
RRA	Urban Open	Residential > 1/2 Acre	Severe	Y	>500	1.16
RRA	Urban Open	Residential > 1/2 Acre	Moderate	Y	>500	2.11
RRA	Water	Water	Severe	N	000-100	0.01

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
B	Commercial	Commercial	Severe	Y	000-100	0.27
B	Commercial	Commercial	Severe	Y	100-500	0.14
	Forest	Forest	Severe	N	000-100	0.07
	Forest	Forest	Moderate	N	000-100	0.03
	Forest	Forest	Slight	N	000-100	0.01
IR	Commercial	Residential < 1/4 Acre	Severe	Y	000-100	0.77
IR	Commercial	Residential < 1/4 Acre	Severe	Y	100-500	1.03
	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe		000-100	0.04
	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate		000-100	0.24
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	3.31
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	000-100	2.17
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	11.36
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	8.79
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	4.20
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	1.87
RRA	Pasture	Residential > 1/2 Acre	Severe	N	000-100	1.21
RRA	Forest	Residential > 1/2 Acre	Severe	N	000-100	3.00
RRA	Forest	Residential > 1/2 Acre	Moderate	N	000-100	3.79
RRA	Forest	Residential > 1/2 Acre	Slight	N	000-100	1.16
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	000-100	1.04
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	000-100	0.06
	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	000-100	1.34
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	000-100	2.89
RRA	Pasture	Residential > 1/2 Acre	Severe	N	100-500	4.87
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	100-500	1.86
RRA	Pasture	Residential > 1/2 Acre	Slight	N	100-500	3.89
RRA	Forest	Residential > 1/2 Acre	Severe	N	100-500	21.38
RRA	Forest	Residential > 1/2 Acre	Moderate	N	100-500	10.01
RRA	Forest	Residential > 1/2 Acre	Slight	N	100-500	1.92
RRA	Nonforested Freshwater Wetland	Nonforested Freshwater Wetland	Severe	N	100-500	0.57
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	6.46
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	100-500	7.05
RRA	Pasture	Residential > 1/2 Acre	Slight	N	>500	0.89
RRA	Forest	Residential > 1/2 Acre	Severe	N	>500	56.85
RRA	Forest	Residential > 1/2 Acre	Moderate	N	>500	4.03
RRA	Forest	Residential > 1/2 Acre	Slight	N	>500	0.79
RRA	Pasture	Residential > 1/2 Acre	Severe	N	>500	0.33
RRA	Pasture	Residential > 1/2 Acre	Moderate	N	>500	0.01
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	0.19
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	0.01
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	000-100	0.03
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	000-100	0.27
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	000-100	0.46
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	000-100	0.03
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	100-500	0.00
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	100-500	1.26
RRA	Forest	Residential > 1/2 Acre	Severe	Y	100-500	3.02
RRA	Pasture	Residential > 1/2 Acre	Moderate	Y	100-500	0.02
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	0.47
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	0.11
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	100-500	1.02
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	100-500	2.80
RRA	Forest	Residential > 1/2 Acre	Severe	Y	>500	5.42
RRA	Forest	Residential > 1/2 Acre	Moderate	Y	>500	1.76
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	>500	0.90
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Moderate	Y	>500	1.23
	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	0.02
	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	000-100	0.03
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	000-100	0.89
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	000-100	0.44
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	100-500	5.44
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	100-500	6.32
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	N	>500	9.09
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Moderate	N	>500	3.03
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Slight	N	>500	0.10
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	0.01
	Salt Wetland	Salt Wetland	Severe	N	000-100	0.52
RRA	Salt Wetland	Salt Wetland	Severe	N	000-100	2.03
RRA	Salt Wetland	Salt Wetland	Moderate	N	000-100	0.03
	Salt Wetland	Salt Wetland	Severe	N	100-500	0.00
RRA	Salt Wetland	Salt Wetland	Severe	N	100-500	0.52

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
B	Residential < 1/4 Acre	Commercial	Severe	Y	000-100	0.29
B	Commercial	Commercial	Severe	Y	000-100	0.22
B	Residential < 1/4 Acre	Commercial	Severe	Y	100-500	0.53
B	Commercial	Commercial	Severe	Y	100-500	0.05
	Residential 1/4 to 1/2 Acre	Residential 1/4 to 1/2 Acre	Severe	N	000-100	0.68
	Residential 1/4 to 1/2 Acre	Residential 1/4 to 1/2 Acre	Severe	Y	000-100	0.09
	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe		000-100	1.63
	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe		100-500	0.16
	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.12
IR	Water Based Recreation	Water Based Recreation	Severe	Y	000-100	1.12
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	5.16
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.61
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	0.03
IR	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	100-500	3.44
IR	Water Based Recreation	Water Based Recreation	Severe	Y	100-500	0.80
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	21.65
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	100-500	0.43
IR	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	Y	100-500	0.11
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	3.14
IR	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	0.06
IR	Forest	Residential < 1/4 Acre	Severe	Y	>500	1.90
IR	Spectator Recreation	Residential < 1/4 Acre	Severe	Y	>500	0.53
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	16.00
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	Y	>500	6.84
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	>500	0.73
IR	Urban Open	Residential < 1/4 Acre	Moderate	Y	>500	2.35
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	000-100	5.23
RRA	Forest	Residential > 1/2 Acre	Severe	Y	100-500	0.70
RRA	Water Based Recreation	Water Based Recreation	Severe	Y	100-500	0.55
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	100-500	4.33
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	100-500	25.28
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	100-500	0.10
RRA	Pasture	Residential > 1/2 Acre	Severe	Y	>500	0.26
RRA	Forest	Residential > 1/2 Acre	Severe	Y	>500	27.80
RRA	Residential < 1/4 Acre	Residential > 1/2 Acre	Severe	Y	>500	6.23
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	15.18
RRA	Residential 1/4 to 1/2 Acre	Residential > 1/2 Acre	Slight	Y	>500	1.41
RRA	Residential > 1/2 Acre	Residential > 1/2 Acre	Severe	Y	>500	6.36
	Spectator Recreation	Spectator Recreation	Severe		000-100	0.61
	Spectator Recreation	Spectator Recreation	Severe		100-500	0.09
	Urban Open	Urban Open	Severe		000-100	0.76
	Urban Open	Urban Open	Severe		100-500	0.10
	Water Based Recreation	Water Based Recreation	Severe	N	000-100	0.11

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
B	Commercial	Commercial	Severe	Y	000-100	0.64
B	Commercial	Commercial	Severe	Y	100-500	0.08
B	Urban Open	Commercial	Severe	Y	000-100	0.02
IR	Forest	Residential < 1/4 Acre	Severe	Y	000-100	0.34
IR	Forest	Residential < 1/4 Acre	Severe	Y	100-500	0.01
IR	Forest	Residential < 1/4 Acre	Moderate	Y	000-100	0.01
IR	Forest	Residential < 1/4 Acre	Moderate	Y	100-500	0.15
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	0.05
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	6.00
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	>500	4.95
IR	Commercial	Residential < 1/4 Acre	Severe	Y	000-100	0.86
IR	Commercial	Residential < 1/4 Acre	Severe	Y	100-500	1.70
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	000-100	5.03
IR	Urban Open	Residential < 1/4 Acre	Severe	Y	100-500	2.96
IR	Urban Open	Residential < 1/4 Acre	Moderate	Y	100-500	1.16

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
B	Residential < 1/4 Acre	Commercial	Severe	Y	100-500	0.00
B	Commercial	Commercial	Severe	Y	000-100	0.42
B	Commercial	Commercial	Severe	Y	100-500	1.27
B	Industrial	Commercial	Severe	Y	000-100	0.84
B	Industrial	Commercial	Severe	Y	100-500	1.90
I	Residential < 1/4 Acre	Industrial	Severe	Y	000-100	0.03
I	Residential < 1/4 Acre	Industrial	Severe	Y	100-500	0.03
I	Industrial	Industrial	Severe	Y	000-100	1.16
I	Industrial	Industrial	Severe	Y	100-500	1.97
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	000-100	1.66
IR	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	Y	100-500	1.65
IR	Commercial	Residential < 1/4 Acre	Severe	Y	100-500	0.00
IR	Industrial	Residential < 1/4 Acre	Severe	Y	100-500	0.26

Road Length Summary	Road Length (feet)
Low Density Residential	2,120
Medium Density Residential	4,075
High Density Residential	
Multi-family Residential	
Major Roads/Highways	
Commercial	
Industrial	
Open Land	
Agriculture	
Pasture	1,629
Forest	1,562
Wetlands	
Water (bridges)	
Recreation	

Road Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	845
High Density Residential	20,486
Multi-family Residential	
Major Roads/Highways	
Commercial	4,087
Industrial	
Open Land	
Agriculture	
Pasture	
Forest	
Wetlands	
Water (bridges)	
Recreation	

Road Length Summary	Road Length (feet)
Low Density Residential	7,316
Medium Density Residential	2,547
High Density Residential	
Multi-family Residential	
Major Roads/Highways	
Commercial	
Industrial	
Open Land	
Agriculture	963
Pasture	14,938
Forest	8,974
Wetlands	2,054
Water (bridges)	98
Recreation	2,023

Road Length Summary	Road Length (feet)
Low Density Residential	820
Medium Density Residential	11,580
High Density Residential	11,290
Multi-family Residential	
Major Roads/Highways	
Commercial	1,404
Industrial	1,040
Open Land	802
Agriculture	663
Pasture	2,823
Forest	6,381
Wetlands	
Water (bridges)	
Recreation	

Road Length Summary	Road Length (feet)
Low Density Residential	4,613
Medium Density Residential	3,985
High Density Residential	2,131
Multi-family Residential	228
Major Roads/Highways	
Commercial	
Industrial	
Open Land	798
Agriculture	279
Pasture	504
Forest	3,309
Wetlands	1,278
Water (bridges)	
Recreation	

Road Length Summary	Road Length (feet)
Low Density Residential	1,424
Medium Density Residential	1,699
High Density Residential	5,573
Multi-family Residential	
Major Roads/Highways	
Commercial	
Industrial	
Open Land	
Agriculture	
Pasture	
Forest	2,663
Wetlands	352
Water (bridges)	
Recreation	

Road Length Summary	Road Length (feet)
Low Density Residential	1,562
Medium Density Residential	4,741
High Density Residential	8,735
Multi-family Residential	
Major Roads/Highways	
Commercial	
Industrial	
Open Land	405
Agriculture	
Pasture	
Forest	33
Wetlands	
Water (bridges)	
Recreation	786

Road Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	
High Density Residential	2,258
Multi-family Residential	
Major Roads/Highways	
Commercial	474
Industrial	
Open Land	
Agriculture	
Pasture	
Forest	
Wetlands	
Water (bridges)	
Recreation	

Road Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	
High Density Residential	228
Multi-family Residential	
Major Roads/Highways	
Commercial	55
Industrial	470
Open Land	
Agriculture	
Pasture	
Forest	
Wetlands	
Water (bridges)	
Recreation	

APPENDIX C

EXISTING MODELING

PROVINCETOWN DATA TABLES - BUILDOUT

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
CR	Residential < 1/4 Acre	Commercial	Moderate	N	000-100	0.30
CR	Commercial	Commercial	Moderate	N	000-100	5.15
CR	Residential < 1/4 Acre	Commercial	Moderate	N	100-500	2.78
CR	Commercial	Commercial	Moderate	N	100-500	8.30
CR	Residential < 1/4 Acre	Commercial	Moderate	N	>500	1.54
CR	Commercial	Commercial	Moderate	N	>500	1.55
CR	Commercial	Commercial	Severe	N	000-100	0.04
CP	Residential < 1/4 Acre	Commercial	Severe	N	>500	0.05
CP	Urban Open	Commercial	Severe	N	>500	0.02
	Commercial	Commercial	Moderate	N	000-100	0.71
	Commercial	Commercial	Severe	N	000-100	0.50
RB	Residential Multi-Family	Residential < 1/4 Acre	Moderate	N	000-100	0.28
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	000-100	0.28
RB	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	N	000-100	0.04
RB	Commercial	Residential < 1/4 Acre	Moderate	N	000-100	1.92
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	000-100	5.38
RG	Commercial	Residential < 1/4 Acre	Moderate	N	000-100	0.05
RB	Residential Multi-Family	Residential < 1/4 Acre	Moderate	N	100-500	0.98
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	100-500	0.79
RB	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Moderate	N	100-500	0.06
RB	Commercial	Residential < 1/4 Acre	Moderate	N	100-500	5.69
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	100-500	10.86
RG	Commercial	Residential < 1/4 Acre	Moderate	N	100-500	0.14
RB	Residential Multi-Family	Residential < 1/4 Acre	Moderate	N	>500	0.75
RB	Commercial	Residential < 1/4 Acre	Moderate	N	>500	2.16
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	>500	0.00
	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.17
RB	Residential Multi-Family	Residential < 1/4 Acre	Severe	N	000-100	0.06
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	1.52
RB	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	000-100	3.66
RB	Commercial	Residential < 1/4 Acre	Severe	N	000-100	1.21
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.46
RG	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.10
RB	Forest	Residential < 1/4 Acre	Severe	N	100-500	2.76
RB	Residential Multi-Family	Residential < 1/4 Acre	Severe	N	100-500	0.62
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	100-500	6.25
RB	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	100-500	6.65
RB	Commercial	Residential < 1/4 Acre	Severe	N	100-500	2.57
RB	Urban Open	Residential < 1/4 Acre	Severe	N	100-500	0.05
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	100-500	0.10
RG	Residential 1/4 to 1/2 Acre	Residential < 1/4 Acre	Severe	N	100-500	0.00
RB	Forest	Residential < 1/4 Acre	Severe	N	>500	0.58
RB	Residential Multi-Family	Residential < 1/4 Acre	Severe	N	>500	0.34
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	>500	1.10
RB	Commercial	Residential < 1/4 Acre	Severe	N	>500	0.14
	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	000-100	0.04
RW	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	000-100	4.63
RW	Commercial	Residential Multi-Family	Moderate	N	000-100	1.58
RW	Participation Recreation	Residential Multi-Family	Moderate	N	100-500	0.09
RW	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	100-500	24.40
RW	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Moderate	N	100-500	0.14

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
RW	Commercial	Residential Multi-Family	Moderate	N	100-500	7.14
RW	Spectator Recreation	Residential Multi-Family	Moderate	N	>500	0.65
RW	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	>500	10.81
RW	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Moderate	N	>500	1.46
RW	Commercial	Residential Multi-Family	Moderate	N	>500	6.48
RW	Urban Open	Residential Multi-Family	Moderate	N	>500	0.78
RWB	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	>500	2.49
RWB	Commercial	Residential Multi-Family	Moderate	N	>500	1.28
RW	Residential < 1/4 Acre	Residential Multi-Family	Severe	N	100-500	0.14
RW	Commercial	Residential Multi-Family	Severe	N	100-500	0.02
RW	Forest	Residential Multi-Family	Severe	N	>500	3.37
RW	Spectator Recreation	Residential Multi-Family	Severe	N	>500	0.72
RW	Residential < 1/4 Acre	Residential Multi-Family	Severe	N	>500	11.42
RW	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Severe	N	>500	3.12
RW	Residential > 1/2 Acre	Residential Multi-Family	Severe	N	>500	1.01
RW	Commercial	Residential Multi-Family	Severe	N	>500	1.88
RW	Urban Open	Residential Multi-Family	Severe	N	>500	13.71
RWB	Residential < 1/4 Acre	Residential Multi-Family	Severe	N	>500	0.17
RWB	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Severe	N	>500	0.05
RWB	Commercial	Residential Multi-Family	Severe	N	>500	0.02
	Residential Multi-Family	Residential Multi-Family	Moderate	N	000-100	0.02
	Residential Multi-Family	Residential Multi-Family	Severe	N	000-100	0.07
CR	Water Based Recreation	Water Based Recreation	Moderate	N	000-100	2.40
RB	Water Based Recreation	Water Based Recreation	Moderate	N	000-100	0.24
	Water Based Recreation	Water Based Recreation	Moderate	N	000-100	0.42
CR	Water Based Recreation	Water Based Recreation	Moderate	N	100-500	1.13
RB	Water Based Recreation	Water Based Recreation	Moderate	N	100-500	0.15
CR	Water Based Recreation	Water Based Recreation	Severe	N	000-100	0.00
RB	Water Based Recreation	Water Based Recreation	Severe	N	000-100	0.21
	Water Based Recreation	Water Based Recreation	Severe	N	000-100	0.01
RB	Water Based Recreation	Water Based Recreation	Severe	N	100-500	0.15

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
CR	Commercial	Commercial	Moderate	N	000-100	1.74
CR	Residential < 1/4 Acre	Commercial	Moderate	N	100-500	1.45
CR	Commercial	Commercial	Moderate	N	100-500	3.66
CR	Urban Open	Commercial	Moderate	N	100-500	0.93
CR	Residential < 1/4 Acre	Commercial	Moderate	N	>500	0.27
CR	Commercial	Commercial	Moderate	N	>500	2.61
CR	Commercial	Commercial	Severe	N	000-100	0.01
CR	Commercial	Commercial	Severe	N	>500	0.00
	Commercial	Commercial	Moderate	N	000-100	0.40
	Commercial	Commercial	Severe	N	000-100	0.00
RW	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	100-500	2.92
RW	Commercial	Residential Multi-Family	Moderate	N	100-500	0.15
RW	Urban Open	Residential Multi-Family	Moderate	N	100-500	0.26
RW	Spectator Recreation	Residential Multi-Family	Moderate	N	>500	0.07
RW	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	>500	2.68
RW	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Moderate	N	>500	2.11
RW	Commercial	Residential Multi-Family	Moderate	N	>500	3.19
RW	Urban Open	Residential Multi-Family	Moderate	N	>500	1.91
RW	Residential < 1/4 Acre	Residential Multi-Family	Severe	N	100-500	0.04
RW	Urban Open	Residential Multi-Family	Severe	N	100-500	0.00
RW	Residential < 1/4 Acre	Residential Multi-Family	Severe	N	>500	1.50
RW	Residential 1/4 to 1/2 Acre	Residential Multi-Family	Severe	N	>500	0.06
RW	Commercial	Residential Multi-Family	Severe	N	>500	0.07
RW	Urban Open	Residential Multi-Family	Severe	N	>500	2.98
CR	Water Based Recreation	Water Based Recreation	Moderate	N	000-100	0.02
CR	Water Based Recreation	Water Based Recreation	Severe	N	000-100	0.00

ZONING	EXISTING LANDUSE	BUILDOUT LANDUSE	SOIL	SEWERED	PROXIMITY TO WATER	ACRES
	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.04
	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	000-100	0.81
	Commercial	Commercial	Severe	N	000-100	0.03
	Commercial	Commercial	Moderate	N	000-100	1.19
CR	Residential < 1/4 Acre	Commercial	Moderate	N	100-500	2.36
CR	Commercial	Commercial	Severe	N	000-100	0.03
CR	Commercial	Commercial	Moderate	N	000-100	4.82
CR	Commercial	Commercial	Moderate	N	100-500	7.22
RB	Forest	Residential < 1/4 Acre	Severe	N	100-500	1.33
RB	Forest	Residential < 1/4 Acre	Severe	N	>500	3.11
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	100-500	2.57
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	>500	0.89
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	000-100	0.68
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	100-500	0.83
RB	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	>500	0.51
RB	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	N	100-500	1.21
RB	Residential > 1/2 Acre	Residential < 1/4 Acre	Severe	N	>500	0.00
RB	Commercial	Residential < 1/4 Acre	Severe	N	000-100	0.50
RB	Commercial	Residential < 1/4 Acre	Severe	N	100-500	3.35
RB	Commercial	Residential < 1/4 Acre	Severe	N	>500	1.69
RB	Commercial	Residential < 1/4 Acre	Moderate	N	000-100	3.05
RB	Commercial	Residential < 1/4 Acre	Moderate	N	100-500	2.86
RB	Commercial	Residential < 1/4 Acre	Moderate	N	>500	0.01
RG	Forest	Residential < 1/4 Acre	Severe	N	100-500	0.11
RG	Forest	Residential < 1/4 Acre	Severe	N	>500	0.13
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	000-100	0.00
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	100-500	4.03
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Severe	N	>500	0.01
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	000-100	1.72
RG	Residential < 1/4 Acre	Residential < 1/4 Acre	Moderate	N	100-500	6.93
RG	Commercial	Residential < 1/4 Acre	Severe	N	000-100	0.00
RG	Commercial	Residential < 1/4 Acre	Moderate	N	000-100	1.69
RG	Commercial	Residential < 1/4 Acre	Moderate	N	100-500	1.15
RW	Residential < 1/4 Acre	Residential Multi-Family	Severe	N	100-500	0.03
RW	Residential < 1/4 Acre	Residential Multi-Family	Severe	N	>500	0.00
RW	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	100-500	7.28
RW	Residential < 1/4 Acre	Residential Multi-Family	Moderate	N	>500	9.64
RW	Commercial	Residential Multi-Family	Severe	N	100-500	0.00
RW	Commercial	Residential Multi-Family	Severe	N	>500	0.32
RW	Commercial	Residential Multi-Family	Moderate	N	000-100	0.85
RW	Commercial	Residential Multi-Family	Moderate	N	100-500	3.20
RW	Commercial	Residential Multi-Family	Moderate	N	>500	1.90
SD	Commercial	Open Land	Severe	N	000-100	0.03

Roads Length Summary	Road Length (feet)
Low Density Residential	137
Medium Density Residential	1,764
High Density Residential	19,135
Multi-family Residential	205
Major Roads/Highways	
Commercial	8,580
Industrial	
Open Land	1,043
Agriculture	
Pasture	
Forest	68
Wetlands	
Water (bridges)	
Recreation	

Roads Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	230
High Density Residential	1,784
Multi-family Residential	
Major Roads/Highways	
Commercial	2,334
Industrial	
Open Land	629
Agriculture	
Pasture	
Forest	
Wetlands	
Water (bridges)	
Recreation	

Roads Length Summary	Road Length (feet)
Low Density Residential	
Medium Density Residential	
High Density Residential	8,477
Multi-family Residential	
Major Roads/Highways	
Commercial	6,846
Industrial	
Open Land	
Agriculture	
Pasture	
Forest	
Wetlands	
Water (bridges)	
Recreation	

BEVERLY EXISTING MODELING

WATERSHED NAME:	Beverly 1
LAND USE CONDITIONS:	Existing Land Use
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	4,755		
Industrial	90,543		
Open Space	0		
Sewered Residential	4,866	Loading Accounted for in Road Runoff	
Forest	8,691	0	1
Residential on Septic Systems	43,080	103,034	63,188
Agriculture	0		
Pasture	0	0	
Residential Roads	14,161	1,676	3,126
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	166,096	104,710	16,656

WATERSHED NAME:	**Beverly 1**
LAND USE CONDITIONS:	**Existing Land Use**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	44,471		
Industrial	560,236		
Open Space	0		
Sewered Residential	235,582	Loading Accounted for in Road Runoff	
Forest	123,534	4	1
Residential on Septic Systems	689,283	103,034	3,949
Agriculture	0		
Pasture	0	0	
Residential Roads	84,968	1,676	521
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	1,738,074	104,714	1,592

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 2
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	37,215	392	2,111
Industrial	14,337		
Open Space	0		
Sewered Residential	13,504	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	10,970	26,896	64,775
Agriculture	0		
Pasture	1,552	0	
Residential Roads	76,223	9,019	3,126
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	153,801	36,307	6,237

WATERSHED NAME:	**Beverly 2**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	331,635	392	352
Industrial	88,713		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	175,525	26,896	4,048
Agriculture	0		
Pasture	9,312	0	
Residential Roads	457,336	9,019	521

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,062,521	36,307	903

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 3
LAND USE CONDITIONS:	Existing Land Use
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	64,686	2,484	2,111
Industrial	0		
Open Space	1,932	87	3,126
Sewered Residential	26,679	Loading Accounted for in Road Runoff	
Forest	5,013	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	114,469	13,337	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
212,779	15,908	1,975

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Beverly 3**
LAND USE CONDITIONS:	**Existing Land Use**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	500,797	2,484	352
Industrial	0		
Open Space	43,922	87	521
Sewered Residential	47,045	Loading Accounted for in Road Runoff	
Forest	44,332	1	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	686,816	13,337	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,322,911	15,909	318

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 4
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	24,858	161	3,126
Sewered Residential	4,858	Loading Accounted for in Road Runoff	
Forest	10,237	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	15,275	1,788	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
55,228	1,949	932

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Beverly 4**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	783,629	161	521
Sewered Residential	307,001	Loading Accounted for in Road Runoff	
Forest	154,451	6	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	91,653	1,788	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,336,734	1,954	39

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 5
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	923		
Industrial	835,311	16,131	2,111
Open Space	8,126	392	3,126
Sewered Residential	3,886	Loading Accounted for in Road Runoff	
Forest	9,477	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	19,719	1,118	1,497
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	877,442	17,642	531

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Beverly 5**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	8,635		
Industrial	5,130,641	16,131	352
Open Space	178,597	392	521
Sewered Residential	135,937	Loading Accounted for in Road Runoff	
Forest	98,057	2	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	118,314	1,118	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
5,670,180	17,644	82

WATERSHED NAME:	Beverly 6
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Land Use Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	77,494	1,729	2,111
Industrial	214,878	5,068	2,111
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	101	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	0		

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
292,473	6,798	614

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Beverly 6**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Land Use Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	652,249	1,729	352
Industrial	1,317,666	5,068	352
Open Space	0		
Sewered Residential	358	Loading Accounted for in Road Runoff	
Forest	715	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	0		

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,970,988	6,798	91

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 7
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	251,317	3,723	2,111
Industrial	207,509	10,056	2,111
Open Space	11,739	834	3,126
Sewered Residential	46,792	Loading Accounted for in Road Runoff	
Forest	70,713	1	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	183,061	20,830	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	771,130	35,444	1,214

WATERSHED NAME:	Beverly 7
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	2,194,347	3,723	352
Industrial	1,260,367	10,056	352
Open Space	196,975	834	521
Sewered Residential	772,161	Loading Accounted for in Road Runoff	
Forest	658,265	14	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	1,098,364	20,830	771
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	6,180,479	35,457	152

WATERSHED NAME:	Beverly 8-23
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,848,064	58,350	2,111
Industrial	2,224,876	30,725	2,111
Open Space	206,611	15,644	3,126
Sewered Residential	139,486	Loading Accounted for in Road Runoff	
Forest	126,224	2	1
Residential on Septic Systems	27,046	59,630	58,251
Agriculture	33,258	156	300
Pasture	97	0	
Residential Roads	711,120	52,816	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	5,316,781	217,323	1,080

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Beverly 8-23**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	14,836,675	58,350	352
Industrial	13,694,330	30,725	352
Open Space	3,245,167	15,644	521
Sewered Residential	2,065,309	Loading Accounted for in Road Runoff	
Forest	1,383,197	38	1
Residential on Septic Systems	432,730	59,630	3,641
Agriculture	817,482	7,952	300
Pasture	580	0	
Residential Roads	4,266,718	52,816	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
40,742,186	225,154	146

IPSWICH EXISTING MODELING

WATERSHED NAME:	Ipswich 1
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	13,183		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	25,507	1	1
Residential on Septic Systems	24,823	109,000	116,012
Agriculture	657	7	300
Pasture	10,491	0	
Residential Roads	39,895	4,721	3,126

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
114,557	113,728	26,229

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 1**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	13,183		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	25,507	1	1
Residential on Septic Systems	24,823	109,000	116,012
Agriculture	657	18,014	724,258
Pasture	10,491	0	
Residential Roads	39,895	4,721	3,126

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
114,557	131,735	30,382

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 1**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	435,052		
Sewered Residential	509,786	Loading Accounted for in Road Runoff	
Forest	307,524	9	1
Residential on Septic Systems	397,169	109,000	7,251
Agriculture	33,514	381	300
Pasture	62,944	0	
Residential Roads	239,371	4,721	521

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,985,359	114,110	1,519

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 2**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	161,813	5,354	2,111
Industrial	0		
Open Space	3,861		
Sewered Residential	7,717	Loading Accounted for in Road Runoff	
Forest	37,712	1	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	137,370	8,121	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	348,473	13,477	1,022

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 2
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	161,813	5,354	2,111
Industrial	0		
Open Space	3,861		
Sewered Residential	7,717	Loading Accounted for in Road Runoff	
Forest	37,712	1	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	137,370	8,121	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
348,473	13,477	1,022

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 2**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,288,796	5,354	352
Industrial	0		
Open Space	127,424		
Sewered Residential	1,244,490	Loading Accounted for in Road Runoff	
Forest	603,389	23	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	824,217	8,121	771
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	4,088,317	13,498	87

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 3
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	19,114	1,542	3,126
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	162,947	4	1
Residential on Septic Systems	180,277	239,060	35,035
Agriculture	8,472	26	300
Pasture	96,229	338,937	300,482,628
Residential Roads	63,517	7,516	3,126
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	530,555	587,084	29,235

WATERSHED NAME:	Ipswich 3
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	19,114	1,542	3,126
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	162,947	4	1
Residential on Septic Systems	180,277	239,060	35,035
Agriculture	8,472	56,177	653,803
Pasture	96,229	338,937	300,482,628
Residential Roads	63,517	7,516	3,126

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
530,555	643,235	32,031

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 3
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	261,979	1,542	521
Sewered Residential	3,470,109	Loading Accounted for in Road Runoff	
Forest	2,029,227	64	1
Residential on Septic Systems	2,884,433	239,060	2,190
Agriculture	152,985	1,315	300
Pasture	578,715	316,680	5,504,912
Residential Roads	381,101	7,516	521

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
9,758,549	566,175	1,533

WATERSHED NAME:	Ipswich 4
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	78,087	1,839	2,111
Industrial	80,567	1,362	2,111
Open Space	7,848	611	3,126
Sewered Residential	32,637	Loading Accounted for in Road Runoff	
Forest	136,871	4	1
Residential on Septic Systems	86,147	159,254	48,841
Agriculture	11,335	80	300
Pasture	18,196	38,752	61,788,691
Residential Roads	152,561	13,570	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
604,250	215,472	9,421

WATERSHED NAME:	Ipswich 4
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	78,087	1,839	2,111
Industrial	80,567	1,362	2,111
Open Space	7,848	611	3,126
Sewered Residential	32,637	Loading Accounted for in Road Runoff	
Forest	136,871	4	1
Residential on Septic Systems	86,147	159,254	48,841
Agriculture	11,335	174,998	654,370
Pasture	18,196	38,752	61,788,691
Residential Roads	152,561	13,570	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	604,250	390,390	17,069

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 4**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	653,171	1,839	352
Industrial	495,314	1,362	352
Open Space	119,523	611	521
Sewered Residential	3,160,690	Loading Accounted for in Road Runoff	
Forest	1,779,014	58	1
Residential on Septic Systems	1,378,350	159,254	3,053
Agriculture	385,960	4,092	300
Pasture	109,924	44,448	1,389,636
Residential Roads	915,368	13,570	771
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	8,997,313	225,234	661

WATERSHED NAME:	Ipswich 5
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	225,272		
Industrial	42,317		
Open Space	8,180	608	3,126
Sewered Residential	27,211	Loading Accounted for in Road Runoff	
Forest	68,922	2	1
Residential on Septic Systems	42,700	101,387	62,732
Agriculture	8,403	75	300
Pasture	3,251	5,155	25,636,509
Residential Roads	70,562	7,413	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
496,819	114,639	6,096

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 5
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	225,272		
Industrial	42,317		
Open Space	8,180	608	3,126
Sewered Residential	27,211	Loading Accounted for in Road Runoff	
Forest	68,922	2	1
Residential on Septic Systems	42,700	101,387	62,732
Agriculture	8,403	145,230	580,777
Pasture	3,251	5,155	25,636,509
Residential Roads	70,562	7,413	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	496,819	259,794	13,815

WATERSHED NAME:	Ipswich 5
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	2,106,953		
Industrial	261,838		
Open Space	131,196	608	521
Sewered Residential	1,571,205	Loading Accounted for in Road Runoff	
Forest	889,654	29	1
Residential on Septic Systems	683,201	101,387	3,921
Agriculture	347,718	3,826	300
Pasture	19,745	17,736	1,729,654
Residential Roads	423,372	7,413	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
6,434,882	130,999	538

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 6
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	10,248		
Industrial	0		
Open Space	0		
Sewered Residential	10,598	Loading Accounted for in Road Runoff	
Forest	47,902	1	1
Residential on Septic Systems	58,789	99,301	44,627
Agriculture	0		
Pasture	0	0	
Residential Roads	56,001	4,414	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	183,538	103,716	14,930

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 6
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	10,248		
Industrial	0		
Open Space	0		
Sewered Residential	10,598	Loading Accounted for in Road Runoff	
Forest	47,902	1	1
Residential on Septic Systems	58,789	99,301	44,627
Agriculture	0		
Pasture	0	0	
Residential Roads	56,001	4,414	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
183,538	103,716	14,930

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 6
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	95,849		
Industrial	0		
Open Space	0		
Sewered Residential	1,014,822	Loading Accounted for in Road Runoff	
Forest	594,932	19	1
Residential on Septic Systems	940,623	99,301	2,789
Agriculture	0		
Pasture	0	0	
Residential Roads	336,008	4,414	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
2,982,235	103,734	919

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 7
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,293		
Industrial	0		
Open Space	11,588	908	3,126
Sewered Residential	31,450	Loading Accounted for in Road Runoff	
Forest	8,467	0	1
Residential on Septic Systems	3,516	16,532	124,209
Agriculture	0		
Pasture	0	0	
Residential Roads	96,843	7,991	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
153,158	25,431	4,387

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 7**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,293		
Industrial	0		
Open Space	11,588	908	3,126
Sewered Residential	31,450	Loading Accounted for in Road Runoff	
Forest	8,467	0	1
Residential on Septic Systems	3,516	16,532	124,209
Agriculture	0		
Pasture	0	0	
Residential Roads	96,843	7,991	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	153,158	25,431	4,387

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 7
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	12,089		
Industrial	0		
Open Space	175,325	908	521
Sewered Residential	272,411	Loading Accounted for in Road Runoff	
Forest	133,353	5	1
Residential on Septic Systems	56,264	16,532	7,763
Agriculture	0		
Pasture	0	0	
Residential Roads	581,059	7,991	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,230,502	25,436	546

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 8
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	22,911	621	2,111
Industrial	0		
Open Space	2,490		
Sewered Residential	2,987	Loading Accounted for in Road Runoff	
Forest	138	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	14,541	824	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
43,068	1,445	887

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 8
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	22,911	621	2,111
Industrial	0		
Open Space	2,490		
Sewered Residential	2,987	Loading Accounted for in Road Runoff	
Forest	138	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	14,541	824	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
43,068	1,445	887

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 8**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	188,235	621	352
Industrial	0		
Open Space	82,171		
Sewered Residential	4,570	Loading Accounted for in Road Runoff	
Forest	2,216	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	87,248	824	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
364,440	1,445	105

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 9
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	8,703	72	2,111
Industrial	60,883	616	2,111
Open Space	0		
Sewered Residential	918	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	1,468	83	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
71,972	771	283

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 9**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	7

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	8,703	72	2,111
Industrial	60,883	616	2,111
Open Space	0		
Sewered Residential	918	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	1,468	83	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
71,972	771	283

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 9
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	78,376	72	352
Industrial	375,271	616	352
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	8,810	83	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
462,457	771	44

PROVINCETOWN EXISTING MODELING

WATERSHED NAME:	Provincetown 1
LAND USE CONDITIONS:	Existing Land Use
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	364,719	11,240	2,111
Industrial	0		
Open Space	12,343	795	3,126
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	2,257	0	1
Residential on Septic Systems	142,682	492,411	91,178
Agriculture	0		
Pasture	0	0	
Residential Roads	136,790	8,508	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	658,791	512,953	20,571

WATERSHED NAME:	**Provincetown 1**
LAND USE CONDITIONS:	**Existing Land Use**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	2,939,612	11,240	352
Industrial	0		
Open Space	225,971	795	521
Sewered Residential	60,038	Loading Accounted for in Road Runoff	
Forest	31,737	1	1
Residential on Septic Systems	2,282,912	492,411	5,699
Agriculture	0		
Pasture	0	0	
Residential Roads	820,740	8,508	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
6,361,009	512,954	2,131

WATERSHED NAME:	Provincetown 2
LAND USE CONDITIONS:	Existing Land Use
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	92,962	3,058	2,111
Industrial	0		
Open Space	5,726	479	3,126
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	14,976	32,423	57,201
Agriculture	0		
Pasture	0	0	
Residential Roads	12,970	826	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
126,634	36,786	7,675

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Provincetown 2**
LAND USE CONDITIONS:	**Existing Land Use**
RAINFALL CONDITIONS:	**Hypothetical Rainfall Conditions**

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	741,187	3,058	352
Industrial	0		
Open Space	79,593	479	521
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	239,609	32,423	3,575
Agriculture	0		
Pasture	0	0	
Residential Roads	77,820	826	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,138,209	36,786	854

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Provincetown 3
LAND USE CONDITIONS:	Existing Land Use
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	268,621	8,968	2,111
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	1,274	0	1
Residential on Septic Systems	53,698	173,787	85,506
Agriculture	0		
Pasture	0	0	
Residential Roads	54,591	3,094	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
378,183	185,849	12,984

WATERSHED NAME:	Provincetown 3
LAND USE CONDITIONS:	Existing Land Use
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	2,136,115	8,968	352
Industrial	0		
Open Space	0		
Sewered Residential	42,027	Loading Accounted for in Road Runoff	
Forest	20,377	1	1
Residential on Septic Systems	859,160	173,787	5,344
Agriculture	0		
Pasture	0	0	
Residential Roads	327,546	3,094	250
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	3,385,225	185,850	1,450

HORSLEY & WITTEN, INC.

APPENDIX D

BUILDOUT MODELING

BEVERLY BUILDOUT MODELING

WATERSHED NAME:	Beverly 1
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	786,514	316	2,111
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	52,177	102,651	51,978
Agriculture	0		
Pasture	0	0	
Residential Roads	14,161	1,676	3,126

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
852,853	104,642	3,242

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 1
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	4,865,817	316	352
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	834,830	102,651	3,249
Agriculture	0		
Pasture	0	0	
Residential Roads	84,968	1,676	521

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
5,785,615	104,642	478

WATERSHED NAME:	Beverly 2
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	55,624	550	2,111
Open Space	0		
Sewered Residential	15,014	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	10,020	46,401	122,348
Agriculture	0		
Pasture	0	0	
Residential Roads	76,999	4,364	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
157,656	51,315	8,599

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 2
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	342,884	550	352
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	160,319	46,401	7,647
Agriculture	0		
Pasture	0	0	
Residential Roads	461,992	4,364	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
965,195	51,315	1,405

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 3
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	31,265	2,484	2,111
Industrial	0		
Open Space	0		
Sewered Residential	31,265	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	149	599	105,936
Agriculture	0		
Pasture	0	0	
Residential Roads	118,790	6,733	1,497
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	181,470	9,815	1,429

WATERSHED NAME:	Beverly 3
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	188,208	2,484	352
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	2,390	599	6,621
Agriculture	0		
Pasture	0	0	
Residential Roads	712,743	6,733	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
903,340	9,815	287

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 4
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	0		
Sewered Residential	37,660	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	17,562	1,042	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
55,222	1,042	499

WATERSHED NAME:	Beverly 4
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	105,370	1,042	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
105,370	1,042	261

WATERSHED NAME:	Beverly 5
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	202,226	16,131	2,111
Industrial	0		
Open Space	0		
Sewered Residential	32,642	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	28,394	1,609	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
263,262	17,741	1,780

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 5
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,214,596	16,131	352
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	170,361	1,609	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,384,957	17,741	338

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 6
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	60,210	3,399	2,111
Industrial	0		
Open Space	0		
Sewered Residential	6,992	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	16,798	952	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
84,001	4,351	1,368

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 6
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	420,543	3,399	352
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	100,791	952	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
521,334	4,351	220

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 7
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	329,126	15,342	2,111
Industrial	137,788	3,581	2,111
Open Space	0		
Sewered Residential	78,492	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	187,461	11,354	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
732,866	30,277	1,091

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 7
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	2,434,604	15,342	352
Industrial	844,159	3,581	352
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	1,124,764	11,354	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
4,403,527	30,277	182

HORSLEY & WITTEN, INC.

	AW	AX	AY	AZ
1	WATERSHED NAME:	Beverly 8-23		
2	LAND USE CONDITIONS:	Buildout Land Use Conditions		
3	RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions		
4				
5		HYDROLOGIC INPUTS		
6		Rain Event (inches) =	0.50	
7		Time Since Last Rainfall (days) =	1	
8		Total Rainfall in Previous Five Days (inches) =	1.00	
9		Time of Year (season) =	spring	
10		Days since Manure Applied =	N/A	
11				
12		FecaLOAD MODEL OUTPUT		
13	LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
14				
15	Commercial	2,163,768	58,350	2,111
16				
17	Industrial	2,895,434	30,725	2,111
18				
19	Open Space	10,233	1,096	3,126
20				
21	Sewered Residential	239,492	Loading Accounted for in Road Runoff	
22				
23	Forest	399	0	1
24				
25	Residential on Septic Systems	111,957	164,486	38,816
26				
27	Agriculture	0		
28				
29	Pasture	0	0	
30				
31	Residential Roads	897,806	63,397	4,624
32				
33		Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
34				
35		6,319,089	318,053	1,330
36				
37				
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46	*HORSLEY & WITTEN, INC.*			

IPSWICH BUILDOUT MODELING

WATERSHED NAME:	Ipswich 1
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	0		
Sewered Residential	28,626	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	90,356	110,013	32,168
Agriculture	0		
Pasture	0	0	
Residential Roads	60,445	7,152	3,126

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
179,427	117,165	17,252

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 1
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	1,445,692	110,013	2,010
Agriculture	0		
Pasture	0	0	
Residential Roads	362,670	7,152	521

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,808,362	117,165	1,712

WATERSHED NAME:	Ipswich 2
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	266,437	10,653	2,111
Industrial	175,330	1,338	2,111
Open Space	0		
Sewered Residential	42,084	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	104,740	9,165	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
588,590	21,156	950

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 2
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	2,045,004	10,653	352
Industrial	1,081,713	1,338	352
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	628,438	9,165	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
3,755,155	21,156	149

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 3
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	631		
Sewered Residential	1,138	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	1,266,393	1,468,446	30,635
Agriculture	0		
Pasture	0	0	
Residential Roads	237,999	28,161	3,126

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,506,161	1,496,607	26,252

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 3
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	3,787		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	20,262,284	1,468,446	1,915
Agriculture	0		
Pasture	0	0	
Residential Roads	1,427,997	28,161	521

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
21,694,068	1,496,607	1,823

WATERSHED NAME:	Ipswich 4
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	7,373	438	2,111
Industrial	459,603	11,404	2,111
Open Space	0		
Sewered Residential	82,755	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	462,220	447,557	25,582
Agriculture	0		
Pasture	0	0	
Residential Roads	176,561	16,875	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,188,512	476,274	10,587

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 4
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	50,585	438	352
Industrial	2,817,037	11,404	352
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	7,395,514	447,557	1,599
Agriculture	0		
Pasture	0	0	
Residential Roads	1,059,364	16,875	771
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	11,322,500	476,274	1,111

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 5
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	262,264	2,890	2,111
Industrial	0		
Open Space	0		
Sewered Residential	78,443	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	163,143	144,256	23,361
Agriculture	0		
Pasture	0	0	
Residential Roads	103,934	11,186	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	607,784	158,332	6,883

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 5
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	2,331,695	2,890	352
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	2,610,284	144,256	1,460
Agriculture	0		
Pasture	0	0	
Residential Roads	623,601	11,186	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
5,565,580	158,332	752

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 6
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,939		
Industrial	0		
Open Space	0		
Sewered Residential	14,283	Loading Accounted for in Road Runoff	
Forest	27	0	1
Residential on Septic Systems	216,379	246,873	30,143
Agriculture	0		
Pasture	0	0	
Residential Roads	73,151	7,549	4,624
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	305,779	254,422	21,983

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 6
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	18,134		
Industrial	0		
Open Space	0		
Sewered Residential	896	Loading Accounted for in Road Runoff	
Forest	434	0	1
Residential on Septic Systems	3,462,058	246,873	1,884
Agriculture	0		
Pasture	0	0	
Residential Roads	438,905	7,549	771

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
3,920,428	254,422	1,715

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 7
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	7,307	178	2,111
Industrial	0		
Open Space	6,888	682	3,126
Sewered Residential	42,344	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	3,516	16,532	124,209
Agriculture	0		
Pasture	0	0	
Residential Roads	98,962	9,852	4,624

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
159,018	27,244	4,526

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 7
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	60,869	178	352
Industrial	0		
Open Space	71,680	682	521
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	56,264	16,532	7,763
Agriculture	0		
Pasture	0	0	
Residential Roads	593,772	9,852	771
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	782,585	27,244	920

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 8
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	90

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	7,301	310	2,111
Industrial	0		
Open Space	0		
Sewered Residential	6,305	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	16,068	911	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
29,674	1,221	1,087

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 8
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	90

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	55,260	310	352
Industrial	0		
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	96,405	911	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
151,665	1,221	213

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 9
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	90

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	23,920	277	2,111
Industrial	30,287	205	2,111
Open Space	0		
Sewered Residential	969	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	1,743	99	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
56,919	581	270

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 9
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	90

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	212,085	277	352
Industrial	186,921	205	352
Open Space	0		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	10,458	99	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
409,464	581	38

HORSLEY & WITTEN, INC.

PROVINCETOWN BUILDOUT MODELING

WATERSHED NAME:	Provincetown 1
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	146,224	3,747	2,111
Industrial	0		
Open Space	2,239	265	3,126
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	217,370	953,004	115,832
Agriculture	0		
Pasture	0	0	
Residential Roads	137,028	7,766	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
502,861	964,782	50,689

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Provincetown 1
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,210,426	3,747	352
Industrial	0		
Open Space	13,434	265	521
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	3,477,916	953,004	7,240
Agriculture	0		
Pasture	0	0	
Residential Roads	822,169	7,766	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
5,523,946	964,782	4,614

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Provincetown 2
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	70,278	1,529	2,111
Industrial	0		
Open Space	5		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	24,371	58,878	63,829
Agriculture	0		
Pasture	0	0	
Residential Roads	24,536	1,391	1,497

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
119,190	61,798	13,698

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Provincetown 2
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	593,162	1,529	352
Industrial	0		
Open Space	179		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	389,935	58,878	3,989
Agriculture	0		
Pasture	0	0	
Residential Roads	147,216	1,391	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,130,492	61,798	1,444

WATERSHED NAME:	Provincetown 3
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	0.50
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	128,309	4,484	2,111
Industrial	0		
Open Space	8		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	87,382	351,188	106,182
Agriculture	0		
Pasture	0	0	
Residential Roads	76,635	4,344	1,497

	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	292,335	360,016	32,537

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Provincetown 3
LAND USE CONDITIONS:	Buildout Land Use Conditions
RAINFALL CONDITIONS:	Hypothetical Rainfall Conditions

HYDROLOGIC INPUTS

Rain Event (inches) =	3.00
Time Since Last Rainfall (days) =	1
Total Rainfall in Previous Five Days (inches) =	1.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,011,930	4,484	352
Industrial	0		
Open Space	269		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	0		
Residential on Septic Systems	1,398,118	351,188	6,636
Agriculture	0		
Pasture	0	0	
Residential Roads	459,809	4,344	250

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
2,870,126	360,016	3,314

HORSLEY & WITTEN, INC.

APPENDIX E

HISTORICAL MODELING

BEVERLY HISTORICAL MODELING

WATERSHED NAME:	Beverly 5
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall (6/7/95)

HYDROLOGIC INPUTS

Rain Event (inches) =	1.12
Time Since Last Rainfall (days) =	0
Total Rainfall in Previous Five Days (inches) =	0.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	1,499		
Industrial	1,307,323	16,131	943
Open Space	12,238	392	1,396
Sewered Residential	4,026	Loading Accounted for in Road Runoff	
Forest	16,121	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	44,171	1,118	668
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	1,385,378	17,642	336

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 6
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Land Use Conditions (6/7/95)

HYDROLOGIC INPUTS

Rain Event (inches) =	1.12
Time Since Last Rainfall (days) =	0
Total Rainfall in Previous Five Days (inches) =	0.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	139,154	1,729	943
Industrial	346,531	5,068	943
Open Space	0		
Sewered Residential	7	Loading Accounted for in Road Runoff	
Forest	213	0	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	0		

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
485,904	6,798	370

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Beverly 7
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall Conditions (6/7/95)

HYDROLOGIC INPUTS

Rain Event (inches) =	1.12
Time Since Last Rainfall (days) =	0
Total Rainfall in Previous Five Days (inches) =	0.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	436,740	3,723	943
Industrial	392,124	10,056	943
Open Space	20,483	834	1,396
Sewered Residential	32,756	Loading Accounted for in Road Runoff	
Forest	129,382	1	1
Residential on Septic Systems	0		
Agriculture	0		
Pasture	0	0	
Residential Roads	410,056	20,830	2,064

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
1,421,541	35,444	659

HORSLEY & WITTEN, INC.

IPSWICH HISTORICAL MODELING

WATERSHED NAME:	Ipswich 1
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall Conditions (7/27/93)

HYDROLOGIC INPUTS

Rain Event (inches) =	0.65
Time Since Last Rainfall (days) =	6
Total Rainfall in Previous Five Days (inches) =	0.00
Time of Year (season) =	spring
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	10,547		
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	25,435	0	1
Residential on Septic Systems	19,858	728	969
Agriculture	526	6	300
Pasture	13,638	0	
Residential Roads	51,864	4,721	2,405
	Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
	121,868	5,456	1,183

HORSLEY & WITTEN, INC.

WATERSHED NAME:	**Ipswich 1**
LAND USE CONDITIONS:	**Existing Land Use Conditions**
RAINFALL CONDITIONS:	**Historical Rainfall Conditions (8/20/93)**

HYDROLOGIC INPUTS

Rain Event (inches) =	0.00
Time Since Last Rainfall (days) =	2
Total Rainfall in Previous Five Days (inches) =	0.92
Time of Year (season) =	summer
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial			
Industrial			
Open Space			
Sewered Residential		Loading Accounted for in Road Runoff	
Forest			
Residential on Septic Systems			
Agriculture			
Pasture			
Residential Roads			

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
0	0	0

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 3
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall Conditions (7/27/93)

HYDROLOGIC INPUTS

Rain Event (inches) =	0.65
Time Since Last Rainfall (days) =	7
Total Rainfall in Previous Five Days (inches) =	0.00
Time of Year (season) =	summer
Days since Manure Applied =	N/A

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	0		
Industrial	0		
Open Space	22,121	1,542	2,405
Sewered Residential	0	Loading Accounted for in Road Runoff	
Forest	159,253	3	1
Residential on Septic Systems	144,222	175	32
Agriculture	9,878	21	300
Pasture	125,083	285,180	316,030,779
Residential Roads	82,572	7,516	2,405

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
543,129	294,436	14,323

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 4
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall Conditions (6/6/93)

HYDROLOGIC INPUTS

Rain Event (inches) =	0.19
Time Since Last Rainfall (days) =	5
Total Rainfall in Previous Five Days (inches) =	0.65
Time of Year (season) =	spring
Days since Manure Applied =	unknown

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	63,817	1,839	5,556
Industrial	69,998	1,362	5,556
Open Space	4,645	611	8,227
Sewered Residential	32,637	Loading Accounted for in Road Runoff	
Forest	111,394	4	1
Residential on Septic Systems	86,147	2,898	889
Agriculture	8,688	80	300
Pasture	6,925	38,752	61,788,691
Residential Roads	57,973	13,570	12,167

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
442,224	59,116	3,532

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 4
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall Conditions (11/3/92)

HYDROLOGIC INPUTS

Rain Event (inches) =	0.60
Time Since Last Rainfall (days) =	9
Total Rainfall in Previous Five Days (inches) =	0.00
Time of Year (season) =	spring
Days since Manure Applied =	unknown

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	71,675	1,839	1,759
Industrial	71,273	1,362	1,759
Open Space	8,344	611	2,605
Sewered Residential	26,109	Loading Accounted for in Road Runoff	
Forest	125,934	3	1
Residential on Septic Systems	68,917	53	20
Agriculture	10,776	64	300
Pasture	21,829	38,752	77,235,864
Residential Roads	183,074	13,570	3,853

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
587,932	56,254	2,528

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 5
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall Conditions (6/1/92)

HYDROLOGIC INPUTS

Rain Event (inches) =	0.97
Time Since Last Rainfall (days) =	7
Total Rainfall in Previous Five Days (inches) =	0.00
Time of Year (season) =	spring
Days since Manure Applied =	unknown

FecaLOAD MODEL OUTPUT

LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	180,217		
Industrial	33,854		
Open Space	12,403	608	1,611
Sewered Residential	21,769	Loading Accounted for in Road Runoff	
Forest	79,431	1	1
Residential on Septic Systems	34,160	249	192
Agriculture	8,771	60	300
Pasture	6,301	5,155	32,045,637
Residential Roads	136,890	7,413	2,383

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
513,796	13,486	693

HORSLEY & WITTEN, INC.

WATERSHED NAME:	Ipswich 5
LAND USE CONDITIONS:	Existing Land Use Conditions
RAINFALL CONDITIONS:	Historical Rainfall Conditions (8/14/92)

HYDROLOGIC INPUTS

Rain Event (inches) =	0.09
Time Since Last Rainfall (days) =	2
Total Rainfall in Previous Five Days (inches) =	1.29
Time of Year (season) =	spring
Days since Manure Applied =	unknown

	FecaLOAD MODEL OUTPUT		
LAND USE	Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
Commercial	225,272		
Industrial	42,317		
Open Space	3,966	608	17,368
Sewered Residential	27,211	Loading Accounted for in Road Runoff	
Forest	51,448	2	1
Residential on Septic Systems	42,700	37,238	23,040
Agriculture	6,930	75	300
Pasture	590	5,155	25,636,509
Residential Roads	12,701	7,413	25,687

Total Watershed Runoff (gallons)	Total fc Loading (millons)	Average fc Concentration in Runoff (fc/100 ml)
413,135	50,490	3,229

HORSLEY & WITTEN, INC.