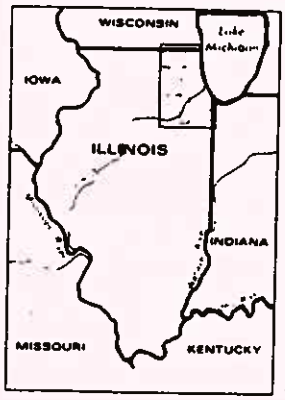
MODEL STORMWATER DRAINAGE AND DETENTION ORDINANCE

A GUIDE FOR LOCAL OFFICIALS

ANOTHER IN THE SERIES OF PLANNING AIDS FROM THE:
NORTHEASTERN ILLINOIS PLANNING COMMISSION



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In 1957, following a decade of rapid urbanization in the Chicago suburban area, the Illinois General Assembly created the Northeastern Illinois Planning Commission (NIPC) to conduct comprehensive planning for the six-county greater Chicago region.

The Commission has three statutory charges: conduct research and collect data for planning; assist local government; and prepare comprehensive plans and policies to guide the development of the counties of Cook, DuPage, Kane, Lake, McHenry and Will.

By necessity, regional planning deals with general development policies not local land use detail. NIPC supports and coordinates county and municipal planning. The Commission has advisory powers only and relies upon voluntary compliance with its plans and policies.

northeastern illinois planning commission

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Addendum to NIPC's Model Stormwater Drainage and Detention Ordinance

New Information on Stormwater Runoff Design Methods

The Northeastern Illinois Planning Commission (NIPC) recently completed an evaluation of existing and alternative hydrologic methods used for urban development site designs. This study, prompted in part by questions regarding the use of Bulletin 70 rainfall information with design storm methods such as TR55, was funded by the Illinois Department of Transportation, Division of Water Resources.

There are several conclusions in the report that may be of interest to those using the Model Stormwater Drainage and Detention Ordinance.

Onsite Detention Volumes: The analysis concludes that common design methods (SCS methods, rational method, and ILLUDAS) are highly variable in their estimates of detention volumes for different types of development in northeastern Illinois. Based on comparisons with a calibrated watershed model, it appears that SCS methods, in conjunction with Bulletin 70 rainfall, predict realistic detention storage requirements for high impervious land uses but over-predict detention requirements for low impervious land uses. The modified rational formula, with conservative runoff coefficients, predicts realistic detention requirements for low impervious land uses but under-predicts detention requirements for high impervious land uses. ILLUDAS over-predicts detention volumes for low impervious land uses but may under-predict detention volumes for high impervious land uses. A simple alternative methodology for estimating realistic detention volumes is provided in the report. The methodology is based on a 2-year release rate of 0.04 cfs/acre and a 100-year release rate of 0.15 cfs/acre as recommended in the model ordinance. Provided future funding is available, the methodology will be expanded to allow for other release rates commonly used in northeastern Illinois.

Comparison of Bulletin 70 and TP40 Rainfall Data: Based on previous analyses, NIPC staff concluded that design rainfall estimates presented in Bulletin 70 are reasonable for northeastern Illinois. This investigation concludes that both peak flows and detention volumes are significantly under-predicted when using TP40 rainfall. The analysis also shows that peak flow rates are significantly over-estimated when using the SCS Type II rainfall distribution in combination with Bulletin 70. Use of the Huff rainfall distributions appears to result in reasonable peak flow estimates.

The results of this evaluation are documented in a report entitled ***Investigation of Hydrologic Design Methods for Urban Development in Northeastern Illinois.***

The report is available through the NIPC publications office at (312) 454-0400. There is an $8.50 charge for the report to cover the cost of printing.

endum to Model Stormwater Drainage and Detention Ordinance - 7/94

lated Requirements for Stormwater Best Management Practices (BMPs)

ıblication of the *Model Stormwater Drainage and Detention Ordinance* in 1990, there has antial progress both nationally and locally in implementing stormwater quality best t practices (BMPs). Based on this experience, and with feedback provided by local s and the development community, several needed clarifications, revisions, and additions l ordinance have been identified. Recommended changes to specific ordinance sections l in this addendum, with additions highlighted in **bold.**

ıidance and design recommendations are available in two recent NIPC publications. The ***ɣement Practice Guidebook for Urban Development*** ($6.00) provides an overview of s and basic design guidance. A more in-depth manual, ***Urban Stormwater Best ıt Practices for Northeastern Illinois*** ($42.00), was developed to accompany a course ign. This manual provides detailed design criteria. Both publications are available from blications Department at (312) 454-0400.

ORDINANCE	COMMENTARY
- Definitions	
gement Practice (BMP): A sed to control the adverse related effects of development. ude structural devices (e.g., r strips, infiltration trenches, and basins) designed to remove educe runoff rates and volumes, aquatic habitats. BMPs also -structural approaches, such as cation efforts to prevent the household chemicals into storm	
off- Pollutants: Contaminants ound in urban runoff which have to adversely affect uses in re- erbodies. Pollutants of concern ment, heavy metals, petroleum- anic compounds, nutrients, nanding organics (BOD), alt, and pathogens.	Urban Runoff Pollutants: Adverse effects of runoff pollutants include toxicity to fish and aquatic life, sediment contamination, excessive growth of aquatic plants (eutrophication), impairment of water supplies, beach closings, and destruction of sensitive wetland plant communities.
in: A detention basin designed portion of its bottom area as a	Wetland Basin: While much of the bottom area of a wetland basin can be used for recreational purposes (similar to a dry basin), a significant portion will be vegetated as a wetland and/or excavated as a stilling basin.

600.0 Water Quality and Multiple Uses

The drainage system should be designed to minimize adverse water quality impacts downstream and on the property itself. Detention basins shall incorporate design features to capture stormwater runoff pollutants. **In particular, designers shall give preference to wet bottom and wetland designs and all flows from the development shall be routed through the basin (i.e., low flows shall not be bypassed).** Retention and infiltration of stormwater shall be promoted throughout the property's drainage system to reduce the volume of stormwater runoff and to reduce the quantity of runoff pollutants.

The drainage system should incorporate multiple uses where practicable. Uses considered compatible with stormwater management include open space, aesthetics, aquatic habitat, recreation (boating, trails, playing fields), wetlands and water quality mitigation. The applicant should avoid using portions of the property exclusively for stormwater management.

705.1 Wet Basin Depths: Wet basins shall be at least three feet deep, excluding nearshore banks and safety ledges. If fish habitat is to be provided they shall be at least ten feet deep over twenty-five percent of the bottom area to prevent winter freeze-out.

600.0 Water Quality and Multiple Uses

Replace first paragraph with the following: **Stormwater system designs should be in conformance with Illinois EPA stormwater permitting requirements. In particular, a state National Pollutant Discharge Elimination System (NPDES) Permit for Construction Site Activities is required for land disturbances of five or more acres. Permit requirements for a "stormwater pollution prevention plan" specifically reference the need for stormwater detention, vegetated swales and natural depressions, infiltration measures, and velocity dissipation devices to control runoff pollutants and to maintain pre-development hydrologic conditions.**

Good drainage system design strives to develop a drainage plan which accomplishes the multiple objectives of recreation, open space, aesthetics, and water quality while safely conveying and storing stormwater from a property. **While recreation is encouraged, particularly for residential sites, water contact activities (e.g., swimming) generally should be discouraged in detention basins due to the occurrence of potential human pathogens (i.e., fecal coliform bacteria) in stormwater runoff.**

The design philosophy of this ordinance recognizes a tradeoff. By isolating runoff pollutants in facilities like sediment basins, and preventing them from impairing uses in downstream waterbodies, the use of certain stormwater facilities may be constrained. However, pollutant control is greatly facilitated and the burden for mitigating development impacts is placed on developers and new residents rather than on society as a whole. Local constraints can be minimized by certain non-structural BMPs, such as source control programs for residents.

705.1 Wet Detention Basin Depths: Wet basins need to be deep enough to discourage aquatic plant growth **in interior areas intended to be open water**, unless wetland creation is envisioned by the local government. Local governments wishing to encourage wetland ~~recreation~~ should change this section to allow shallower depths **in the interior of the basin** as needed

for the establishment of wetland vegetation. The fish habitat recommendations were developed by the Illinois Department of Conservation. **To facilitate future maintenance needs of wet basins, stilling/sedimentation basins (similar to section 706.4) may be required to isolate large sediment particles in a manageable area for dredging.**

'06.0 **Wetland and** Dry Detention Basin Design: In addition to the other requirements of his ordinance, **wetland and** dry basins shall be designed to remove stormwater pollutants, to be safe, to be aesthetically pleasing and as much as feasible to be available for multiple uses.

706.0 **Wetland and** Dry Detention Basin Design: The use of dry basins for stormwater detention will be **constrained** ~~complicated~~ by ~~the more~~ restrictive low flow release rates~~ this model ordinance recommends. Detention times will increase relative to most existing ordinance requirements and a larger percentage of storms will be detained~~ which result~~ing~~ in standing water for longer periods of time. **As a consequence, traditional dry basins will generally be inappropriate for most development types, except low density residential which generates relatively little runoff.** ~~Dry basin designs should recognize this fact and address it by planning to minimize the amount of basin area which has standing water by creating~~ **A preferred alternative to a dry basin is a wetland basin which can have both** "wet" and "dry" zones within the basin.

'06.1 **Wetland and** Dry Basin Drainage: **Wetland and** dry basins shall be designed so that ~~eighty percent~~ **the portion** of their bottom area **which is intended to be dry** shall have standing water no longer than seventy-two hours for all runoff events less than the 100-year event. Underdrains directed to the outlet ~~control shall~~ may be used ~~if necessary~~ to accomplish this requirement. **Grading plans shall clearly distinguish the <u>wet/wetland</u> portion of the basin bottom from the <u>dry</u> portion.**

706.1 **Wetland and** Dry Basin Drainage: To avoid aesthetic and maintenance problems, it is very important that **the** dry **portion of the** basin~~s~~ not have standing water unintentionally as a result of poor drainage. The maximum inundation time of 72 hours was chosen to ensure the viability of **turf** grass based on recommendations received from NIPC's Stormwater Management Technical Advisory Committee.

Two-level designs for **wetland** ~~dry~~ basins should be ~~considered~~ required. The lower wetter portion **should** ~~may~~ be managed as a wetland **or open water area** ~~and maintenance should be provided to remove accumulated sediment, as needed~~. **The wetland portion of the basin is intended to be a low-maintenance area, requiring occasional mowing or burning to maintain vegetation diversity and to control the proliferation of woody vegetation. Additional maintenance to remove accumulated sediment may be needed on an**

infrequent basis (i.e., every 10-20 years). Sediment, similar to street sweeping debris, should be disposed appropriately (e.g., in a landfill).

706.3 Inlet and Outlet Orientation: To the extent feasible, the distance between detention inlets and outlets shall be maximized. If possible, they should be at opposite ends of the basin. **There should be no low flow bypass between the inlet and outlet and paved low flow channels shall not be used.**

706.3 Inlet and Outlet Orientation: Maximizing the distance between inlets and outlets will prevent the short-circuiting of flows through a basin. Short-circuiting is counter productive to the removal of stormwater pollutants. Short-circuiting can be avoided by **designing elongated basins (ideal length:width ratio of at least 3:1),** or by the use of baffles or berms in the basin bottom. **Because low flows and the "first flush" of storm runoff often contain the most concentrated pollutants, it is critical that all flows be routed through the basin to provide opportunities for effective pollutant removal.**

New Subsection

706.4 Stilling/Sedimentation Basins: A stilling/sedimentation basin should be constructed at each major inlet to a wetland or dry basin. The volume of the basins should be at least 500 ft^3 per acre of impervious surface in the drainage area. Side slopes of the basins shall be no steeper than 3 horizontal to 1 vertical and basin depths should be at least 3 feet to minimize resuspension of accumulated sediment.

706.4 Stilling/Sedimentation Basins: These basins are intended to both dissipate the erosive energy of stormwater inlets and settle out large sediment particles in an isolated area to facilitate future maintenance. The recommended design volume is based on the objective of removing 50 percent of the annual suspended solids load. While most fine sediment particles will pass through this basin, most of the larger solids will settle. Sediment removal will be required infrequently. Sediment quality will be similar to street sweeping debris and disposal should be handled accordingly.

708.3 On-stream Detention:

e. shall require the implementation of an effective nonpoint source management program throughout the upstream watershed **which shall include at a minimum: runoff reduction BMPs consistent with Section 500.0 of this ordinance; 2-year detention/sedimentation basins for all development consistent with Section 709.4; and a program to control nonpoint sources at the source for prior developments constructed without appropriate stormwater BMPs.**

708.3 On-stream Detention:

e. Streams, wetlands, and other waters of the U.S. are not intended to be modified to become sinks or depositional zones for controllable nonpoint source pollution. Where regional, on-stream detention is determined to be in the public interest, nonpoint source BMPs must be implemented in the upstream watershed to minimize adverse water quality impacts. In addition to structural BMPs, watershed residents should be educated about the need to manage nonpoint impacts at the source through effective controls on discharges of household chemicals, used motor oil, and pesticides.

709.0 ~~Drainage into~~ **Protection of** Wetlands **and Depressional Storage Areas** - Wetlands **and other depressional storage areas** shall be protected from damaging modifications and adverse changes in runoff quality and quantity associated with land developments. In addition to the other requirements of this ordinance, the following requirements shall be met for all developments whose drainage flows into wetlands **and depressional storage areas (as appropriate):**

709.0 ~~Drainage into~~ **Protection of** Wetlands **and Depressional Storage Areas** - Wetlands provide valuable habitat, water quality, and hydrologic functions which may be adversely affected by development activities. Adverse impacts can result from direct modifications, the introduction of urban runoff pollutants, as well as changes in runoff rates. Changes in hydrology, in particular, can affect the delicate balance which exists in sensitive wetlands and result in loss of habitat diversity. For these reasons, wetlands should be protected from urban runoff changes by the measures specified in this ordinance and moderate to high quality wetlands should not be modified to accommodate stormwater detention.

Non-wetland depressional storage areas are areas in the pre-development landscape (e.g., in farm fields) which are undrained or very poorly drained. While not providing important habitat values, these depressions often store considerable volumes of runoff for extended time periods (e.g., weeks) and provide important pollutant removal benefits.

709.1 Detention in Wetlands **and Depressional Storage Areas:** Existing wetlands shall not be modified for the purposes of stormwater detention unless it is demonstrated that the existing wetland is low in quality and the proposed modifications will maintain or improve its habitat and ability to perform beneficial functions. Existing ~~depressional~~ storage **and release rate characteristics of** ~~in~~ wetlands **and other depressional storage areas** shall be maintained and the volume of detention storage provided to meet the requirements of this section shall be in addition to this existing storage.

709.1 Detention in Wetlands **and Depressional Storage Areas:** Low quality wetlands, with adequate protection and mitigation, can be beneficially utilized for detention, **consistent with the mitigation requirements of this section.** Low quality wetlands are those which have been substantially disturbed. This disturbance is usually reflected in a low diversity of habitat and the presence of only insensitive plant species (e.g., a monoculture of cattails). Certain modifications of low quality wetlands, such as the limited excavation of open water areas, may actually enhance their value. **It is important, however, that the storage functions of wetlands and depressional storage areas be preserved, <u>in addition</u> to meeting the detention requirements of this ordinance.**

711.a Vegetated Filter Strips and Swales - To effectively filter stormwater pollutants and promote infiltration of runoff, sites should be designed to maximize the use of vegetated filter strips and swales. Wherever practicable, runoff from impervious surfaces should be directed onto filter strips and swales before being routed to a storm sewer or detention basin.

711.a Vegetated Filter Strips and Swales- Existing subdivision codes often discourage filter strips and swales by mandating curbs and gutters and direct discharge of runoff into storm sewers. A more effective, often lower-cost alternative is to route runoff through slotted curbs (or curb stops) onto vegetated strips. In this preferred design, many landscaped areas would occupy the

lower portions of the site (e.g., rather than raised islands) and effectively filter and infiltrate stormwater from impervious surfaces. A simple application of a filter strip in a residential setting is a lawn which receives runoff from rooftops, driveways, and (ideally) streets. Swales are cost effective options to storm sewers in many settings, such as office campuses, industrial parks, low density-single-family developments, and multifamily uses.

Both swales and filter strips are most effective when well vegetated and when slopes are relatively flat.

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Ralph Cianchetti, *Vice President Park District of Highland Park*
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August 7, 1990

To the Public Officials and Citizens of Northeastern Illinois:

I am pleased to present to you this Model Stormwater Drainage and Detention Ordinance.

This ordinance was prepared by Commission staff with valuable assistance from the Stormwater Management Technical Advisory Committee and the Division of Water Resources of the Illinois Department of Transportation.

The policy basis for this ordinance comes from the Regional Overbank Flooding and Stormwater Drainage Policy Plan, the Areawide Water Quality Management Plan, and more recent guidance from the Stormwater Management Policy Advisory Committee.

The technical basis for this ordinance reflects new insights gained from recent evaluations of stormwater detention effectiveness and a reevaluation of rainfall data in the state. These evaluations have led to the conclusion that many existing detention and drainage requirements in northeastern Illinois may not be adequate to prevent adverse effects on flooding, erosion, and water quality due to new development.

It is hoped that this model ordinance will assist local governments in better planning stormwater management systems. In that connection, I urge that special attention be given to the establishment of maintenance responsibilities, a subject of growing concern to many individuals. I also suggest that units of government which have already adopted similar ordinances review the attached model and determine what changes are necessary to reinforce their minimum requirements.

Sincerely,

Sheila H. Schultz

Sheila H. Schultz
President

MODEL STORMWATER DRAINAGE AND DETENTION ORDINANCE

Northeastern Illinois Planning Commission
400 West Madison Street
Chicago, Illinois 60606

July 1990

is another in a series of planning aids and manuals prepared by the Northeastern Illinois Planning mission as a service to local governments under a section of its enabling act which authorizes the mission to "prepare and make available to units of government standards for planning and regulatory ıances, practices, and procedures." This ordinance has been prepared as a model to assist local of government in developing their own regulations. Background information has been included to ide a perspective for the officials who may be called upon to interpret the basic requirements. This el ordinance is also available on 5 1/4" diskettes in WordPerfect at no charge to local governments.

preparation of this suggested ordinance and commentary was financed in part through funds from llinois Department of Transportation, Division of Water Resources. The contents do not necessarily ct the position of the Illinois Department of Transportation.

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I. INTRODUCTION

The Model Stormwater Drainage and Detention Ordinance, with commentary, has been prepared for consideration by local governments in northeastern Illinois. It was developed in recognition of the continuing damages which have resulted from inadequate local drainage systems which were not designed to address comprehensive watershed-level water resources management objectives. Urbanization in northeastern Illinois has proceeded dramatically since the Metropolitan Water Reclamation District of Greater Chicago (MWRD) and numerous communities outside Cook County pioneered the implementation of detention in the early 1970's. Their aggressive efforts have helped to mitigate the impact new urbanization has had on increased flooding in the region. However, recent evaluations of the effectiveness of detention strategies have indicated that many existing detention requirements may not be adequate to prevent increases in flooding, especially in the lower reaches of watersheds (Dreher et al., 1989; Bartels, 1987).

In addition, as watersheds urbanize, the volume, frequency and duration of runoff events of a given magnitude increase. If these changes are not mitigated through drainage system planning and detention design, streams often will attempt to adjust to increases in bankfull flows resulting in bank erosion and scouring and the destruction of habitat. Damages caused by bank erosion can be very difficult and expensive to repair.

Recently, the issue of water quality also has become more urgent. In northeastern Illinois nearly all of our urban streams are in the two lowest (out of four) categories for attainment of beneficial uses and water quality (Table I-1), even where there are no treatment plant discharges. The loss of these stream uses is a detriment to the economy and quality of life in northeastern Illinois. Urban stormwater quality management will soon be mandated based on the Clean Water Act of 1987 and draft regulations published by the United States Environmental Protection Agency (USEPA) on December 7, 1988. Detention basins, and stormwater management generally, will be a principal focus for mandatory best management practices to remove pollutants from stormwater. It also appears likely that National Pollutant Discharge Elimination System (NPDES) permits will soon be required for many of our stormwater outfalls.

Finally, the issue of the loss of the beneficial uses of our streams in northeastern Illinois as a result of physical modification has received greater attention. In Illinois there currently is no regulation to prevent the complete realignment of a stream and the resulting destruction of aquatic habitat.

The purpose of this model ordinance is to recommend drainage and detention criteria and requirements which address each of the above issues by meeting the following objectives:

- prevent increases in downstream flooding due to new urbanization;
- prevent increases in the magnitude and frequency of small flood events (i.e., the 2-year event) which contribute to increased bank erosion;
- prevent increases in drainage-related damages due to inadequate design of local drainage systems;
- prevent the loss of beneficial stream uses due to degraded stormwater quality; and
- prevent the loss of beneficial stream uses due to adverse hydrologic and hydraulic impacts of urbanization.

Table I-1. STREAM USE ATTAINMENT IN NORTHEASTERN ILLINOIS

Watershed	Watershed Area (mi^2)	Use Support/ Degree of Impairment	Population Density[1] 1985	WQI[2]	% Stream Channelized
Addison Creek	23.8	Nonsupport	4521	54.2	82.0
Midlothian Cr.	20.0	Partial/Moderate	3179	43.7	54.5
Salt Creek	121.0	Partial/Moderate[3]	3048	76.9	29.0
East Br. Dupage	82.0	Partial/Moderate[3]	2875	65.8	78.0
West Fork N. Br.	28.6	Partial/Moderate	2789	60.5	85.2
Willow Creek	20.1	Partial/Moderate	2648	70.0	58.8
Flag Creek	19.7	Partial/Moderate	2633	69.7	82.3
Tinley Creek	20.0	Partial/Moderate	2266	16.5	0.0
Butterfield Cr.	25.8	Partial/Moderate	2225	30.1	44.5
Thorn Creek	26.3	Partial/Moderate	2196	65.2	53.0
North Creek	11.9	Partial/Moderate	2008	34.8	40.3
Poplar Creek	44.5	Partial/Minor	1587	13.9	26.3
Skokie River	22.0	Partial/Minor	1559	50.9	64.9
West Br. Dupage	125.0	Partial/Moderate[3]	1371	65.2	40.3
Deer Creek	26.7	Partial/Moderate	1215	46.0	66.3
Rock Run	14.4	Partial/Moderate	1141	31.4	70.0
Lily Cache Cr.	44.1	Partial/Moderate[3]	1035	29.7	45.2
Middle Fork N. Br.	28.0	Partial/Moderate[3]	1022	89.3	61.2
Indian Creek	38.0	Partial/Minor	972	30.7	63.5
Bull Creek	11.9	Partial/Moderate	816	16.0	10.1
Spring Creek	19.9	Partial/Moderate	762	13.2	28.0
Flint Creek	37.7	Partial/Moderate	756	42.3	20.7
Hickory Creek	90.6	Partial/Minor[3]	601	50.4	11.4
Long Run Creek	22.6	Full	551	28.4	63.4
Waubonsee Cr.	11.9	Full	470	13.7	57.0
Mill Cr. (DesPl.)	45.5	Partial/Moderate	382	37.8	32.9
Boone Creek	23.3	Partial/Minor	377	8.9	36.3
Tyler Creek	40.4	Partial/Minor	349	9.3	43.6
Blackberry Cr.	65.0	Full[3]	340	19.1	NA
Mill Creek (Fox)	31.0	Full	222	14.1	25.0
Nippersink Cr.	92.0	Full	202	14.8	13.6

[1] persons per square mile
[2] WQI is an index based on water chemistry; values >50 indicate frequent violations of Illinois water quality standards
[3] averaged over stream length

This model ordinance presents a regulatory approach to stormwater management which emphasizes conservative approaches to stormwater drainage and detention which should be effective throughout northeastern Illinois. It should not be considered a substitute, however, for a planning approach to stormwater management. NIPC has long stressed that the best way to manage stormwater quantity and quality is to study existing and future problems on a watershed basis and then prepare plans and regulations specific to a watershed's needs. In the absence of such detailed local planning studies, NIPC feels the recommendations in this ordinance will achieve the above objectives based on the current state of the art in stormwater management.

II. HOW TO USE THIS MODEL ORDINANCE

This model detention ordinance has been designed to be an independent, self-sufficient ordinance. However, it is recognized that the majority of local governments do not have independent detention ordinances but rather add ordinance provisions to their subdivision ordinance, building code or zoning ordinance. This ordinance can be used to accommodate any of these options simply by excluding language which is redundant with existing local government codes.

This document provides language which hopefully will ease the burden of any community wishing to revise its ordinance requirements for drainage and detention. This model ordinance also suggests some approaches to detention and stormwater management which are new to northeastern Illinois but commonly used nationally. It is hoped that these new concepts and approaches will be attractive to local governments wishing to adopt a more comprehensive and effective approach to stormwater management. Further, it is recommended that this ordinance be considered as one component of a comprehensive regulatory approach to watershed management which also addresses needs for floodplain management, wetland, lake, and stream protection, and soil erosion and sediment control. Each of these topics is addressed in other NIPC model ordinances.

III. LEGAL AND REGULATORY BACKGROUND

A. Illinois Drainage Law

1. Civil Law Rule - Essentially states adhere to one of three types of drainage law: the common enemy rule, the civil law rule (also known as the natural flow rule), and the reasonable use rule.

The common enemy rule states that a landowner has an unlimited privilege to deal with surface water on his land as he pleases, regardless of the harm his actions may cause other landowners. By the same token, the adjoining property owners can "fight back" and repel waters coming on to their properties however they may choose. Most states which continue to adhere to this rule have modified it so that a landowner can obstruct surface waters only to the extent that the obstruction is incidental to ordinary use of the land and is not installed maliciously or negligently.

The civil law rule, in its original form, holds that a landowner could not interfere with the natural flow of surface waters. Owners of lower-lying land (in legal terminology the "servient estate") were burdened by an "easement" which required them to accept all surface waters naturally flowing from higher land (in legal terminology "dominant estate"). On the other hand, the dominant estate owner could do nothing which increased the flow of waters to servient estates. Because this prohibition impeded agricultural development, the Illinois Court, In Peck versus Herrington (109 Ill. 611 (1884)) and in a series of later cases, declared and gradually defined a "good husbandry exception" to the civil law rule.

The good husbandry exception allowed the owner of the dominant estate to construct drains on his land, in order to promote appropriate agricultural practices, even though such drains increased the flow of water onto the servient estate. Whether the drains consisted of surface ditches or underground tile drains made no difference (Lambert versus Alcorn, 144, Ill. 313, 33 N.E. 53 (1893)). Even under the good husbandry exception, however, the dominant estate owner could not divert the natural course of drainage; that is, he could not cast waters onto lower land which otherwise would have naturally flowed in another direction nor could he discharge runoff at a spot different from the natural drainage outlet (Dayton versus Drainage Commission, 128 Ill. 271, 21 N.E. 198 (1889)). The amount of water which could be drained on to lower land, was limited only by the carrying capacity of the stream into which the surface waters were eventually discharged (People versus Peeler, 290 Ill. 451 (1919)).

The reasonable use rule, unlike either the common enemy or civil law doctrines, is based on tort law rather than property law. Thus, the guiding concept of this rule is "fair play" rather than "who owns what." The essence of the reasonable use rule is that a person may drain his property only in a manner which is not unreasonably injurious to the interests of other landowners. To determine reasonableness, the courts of jurisdictions subscribing to this rule apply a "balancing test"; they attempt to devise a fair and equitable solution to the specific facts and circumstances of a particular case. The upshot is that the reasonable use rule is unquestionably the most flexible of the three approaches, and arguably the most adaptable to changing contemporary conditions.

2. Templeton versus Huss - In 1974, in the landmark case of Templeton versus Huss (57 Ill. 2d 134, 311 N.E. 2d 141) the Illinois Supreme Court very substantially modified the civil law rule of drainage in Illinois. To better explain this modification, the following is a brief reiteration of the facts of that case.

The plaintiff, Mr. Templeton, owned farm land in Macon County. The individual defendants, Mr. Huss and others, had developed adjoining farm land into a residential subdivision. The municipal defendant, the Village of Oreana, had approved the plats for Huss's development and had accepted the dedication of the subdivision's streets and catch basins. Templeton charged that Huss's development had increased both the amount and rate of surface water runoff flowing onto his land, to his detriment; and, further, that the village knew or should have known, at the time it approved the plat and accepted the dedication of public improvements, that these increases in runoff flow would result. Significantly, the appellate court affirmed judgment for the defendants because Templeton could not prove that the water from Huss's development "was directed from its natural source or outlet or flowed other than in the general course of natural drainage"--in other words, the plaintiff could not show "diversion."

In its opinion reversing the appellate court's decision, the supreme court noted, first, that in Illinois interference with drainage through natural seepage is to be treated legally in the same manner as interference with lateral drainage flow. Therefore, in accordance with the court's interpretation of the civil rule as modified by the good husbandry exception, that interference cannot go "beyond a range consistent with the policy of reasonableness of use." Secondly, but just as importantly, the court held that if the increase in the flow of surface waters is unreasonable, it is legally irrelevant whether that increase was caused by diversion from another watershed (previously a critical factor) or by "the installation of septic tanks, the grading and paving of streets, or the construction of houses, basements and appurtenances."

3. Post-Templeton Decisions - Although some commentators state flatly that Templeton has made Illinois a "reasonable use rule" rather than a "civil law rule" state, technically speaking that is probably going too far. There are post-Templeton decisions which quite clearly state (see, for example, Bossler versus Countryside Gardens, 358 N.E. 2d 352 (1976)) that Illinois still follows the civil law rule. But in practical terms, especially in urban and developing areas, the effect of Templeton's reasonable use modification of the civil law rule is hardly distinguishable from the pure reasonable use rule.

) see how Templeton has been applied, it is instructive to look at two later cases. In Delano versus ollins, 364 N.E. 2d 716, decided in 1977, the litigants were owners of adjoining lots in a single-family area Leland Grove. Defendant Collins hauled in 116 truckloads of fill onto his lot, and subsequently built house thereon. But he did not alter the elevation of his lot at his boundaries, nor did his filling activities ause runoff to flow off his lot at a point different from where it had flowed off previously. Plaintiff sued ecause after Collins' actions whenever it rained heavily, runoff began to accumulate on his lots. onetheless, the court held for Mr. Collins, apparently concluding that his actions were not unreasonable. urther, the court noted that the Templeton decision does not require one to maintain a lot in an nimproved condition for another's benefit.

Powell versus Village of Mt. Zion, 410 N.E. 2d 525 (1980), the plaintiffs were homeowners whose asements had been flooded due to the backup of the village's sanitary sewer system. The defendants ere a developer who had allowed runoff from his subdivision to enter the sanitary sewer system thereby ausing it to backup, and the village which, in addition to other actions, had failed to inspect the ubdivider's work and had permitted him to connect his sewer system to the village's. The court held that empleton was applicable even though, in this situation, runoff was flowing through a sewer, not over the urface. Thus, the developer "had a duty not to unduly burden the sanitary system with an unreasonable nount of runoff from the land." As for the village, the court stated that if, in fact, it had not complied with e inspection and approval provisions of its own subdivision control ordinance, but nonetheless had ccepted the faulty subdivision sewer system, then it too could be held liable for the damages it had aused.

. **Statutory Authority**

Municipal Authority - Authorization for municipalities to enact ordinances to better manage stormwater unoff and avoid undue flooding cannot be found in any one section of the Municipal Code (Ill. Rev. Stats. hapter 24), but must be "pieced together" from the sections listed below (as well as from more general r broader statutory authorizations). The totality of authority granted municipalities, though, is clearly ufficient to permit enactment of effective stormwater control measures. Moreover, in light of Section 1-2-1 f the Municipal Code (The corporate authorities of each municipality may pass all ordinances and make ll rules and regulations proper or necessary to carry into effect the powers granted to municipalities"), e fact that the authority is scattered would not pose any serious impediment to passage of a "free-tanding ordinance" as opposed to a series of amendments to the local zoning, subdivision, and building rdinances.

. Zoning, Sections 11-13-1 et seq.

ne of the basic purposes of zoning, as set out in the purpose clause of the enabling legislation, is "that e hazards to persons and damage to property resulting from the accumulation or runoff of storm or oodwaters may be lessened or avoided." To accomplish this purpose, municipalities can exercise their oning powers in all the usual ways including division of territory into districts, classification and regulation f land uses, elimination of nonconformities, and establishment of set-back lines along "storm or oodwater runoff channel or basin."

. Set-Back Lines, Section 11-14-1

lunicipalities may also exact set-back requirements, apparently independent of their zoning regulations,) control buildings along "storm or floodwater channel within the municipality."

. Subdivision Regulations, Sections 11-12-5, 11-12-6, 11-12-12

Municipalities may enact a comprehensive plan and an official map, and prescribe regulations to enforce them. Those regulations may prescribe reasonable standards for "stormwater drainage, water supply and distribution, sanitary sewers, and sewage collection and treatment." No subdivision plat can be recorded until it is in compliance with the municipal subdivision regulations, including the provisions thereof affecting "storm and floodwater runoff channels and basins."

d. Building Codes, Section 11-30-2, 11-30-8

In order to lessen or avoid "the hazards to persons and damage to property resulting from flooding," municipalities may enact construction regulations including provisions designed to preserve drainage channels.

e. Public Lands, Section 11-105-1

Municipalities may accept, maintain, and regulate various types of public land including "areas enclosing floodplains, floodwater runoff channels, and detention ponds or basins."

f. Culverts, Drains, Sections 11-109-1

Municipalities may construct, repair, and regulate the use of culverts, drains, sewers, and cesspools.

g. Drainage, Flood Control, Sections 11-110-11

Municipalities, to improve drainage, may design, build, and maintain drains, ditches, levees, pumping machinery, and so forth.

h. On-site Detention Chapter 85, Section 1711 et seq.

Any municipality or county with the power to issue building permits may require that buildings include "facilities for the orderly runoff or retention of rain and melting snow." The statute indicates that such facilities might include "retention ponds, retention tanks, pools located on and a part of the roof of buildings and permeable pavements." Building plans can be required to include a statement by a civil engineer that the facilities are adequate to prevent harmful runoff. The statute requires the local governing authorities to consider such factors as the permeability and water absorbing quality of the soil and the adequacy of existing waterways.

i. County Stormwater Management Plans, Chapter 34, Section 25.14c.

Municipalities in DuPage, Kane, Lake, McHenry, and Will counties may be bound by stormwater management regulations adopted by county boards as part of the programs authorized by P.A. 85-905 and P.A. 85-1266.

2. <u>County Authority</u> - In addition to the "on-site detention" provisions noted above (which applies to both municipalities and counties), counties, like municipalities, have various powers which, when viewed together, appear sufficient to adequately control stormwater runoff. Of those powers, the four most important are as follows:

a. Zoning C.34, Section 3151

Counties may enact zoning ordinances in much the same manner as municipalities. The county zoning enabling act, like its municipal "cousin," lists the avoidance or lessening of hazards resulting from the accumulation or runoff of storm or floodwaters as one of the major purposes of zoning. Also, the county

zoning act specifically authorizes the establishment of setback lines along storm or floodwater runoff channels and basins. It should be noted, though, that municipal zoning measures supercede county zoning ordinances within corporate limits.

b. Subdivision Controls C.34, Section 414

Counties may enact subdivision regulations including provisions governing storm or floodwater runoff channels and basins. Counties may require developers to post a performance bond to insure that required improvements are properly installed. Further plats may not be recorded unless they evidence compliance with applicable subdivision regulations.

c. Building Codes C.34 Section 422

Counties may enact building codes to insure that structures are built in such a way that they are "reasonably safe from hazards of . . . flooding."

d. Northeastern Illinois Counties

As a result of the passage of P.A. 85-905 and P.A. 85-1266, DuPage, Kane, Lake, McHenry and Will Counties were granted broad authority to manage and mitigate the effects of urbanization on stormwater drainage. These new laws allow the above counties to form stormwater management planning committees with equal county board and municipal representation and to develop countywide stormwater plans for county board approval and to direct the plans' implementation and revision. The laws call for consolidation of the existing stormwater management framework into unified, countywide structures and for establishment of minimum standards for floodplain and stormwater management.

The county boards may adopt the completed stormwater management plans by ordinance. After adoption, the county board may prescribe by ordinance reasonable rules and regulations for floodplain management and for governing the location, width, course and release rate of all stormwater runoff channels, streams and basins in the county, in accordance with the adopted stormwater management plan. Upon approval of such regulations, they shall apply both in unincorporated and incorporated areas of the county. Municipalities have the option of retaining local control of stormwater management provided they enact and enforce ordinances which the stormwater planning committee finds are at least as stringent and consistent with the county plan.

As of March, 1990, DuPage, Kane and Lake Counties had formed stormwater management planning committees.

C. Basic Legal Issues Related to Stormwater Management

1. Governmental Responsibility/Liability - In both Templeton and Powell versus Village of Mt. Zion, municipal corporations as well as private developers were named as defendants. In Templeton, the supreme court refused to dismiss a count of plaintiff's complaint alleging liability on the part of the Village of Oreana because it "knew or should have known that the alterations of the course of nature made by (the developer) would cause water to flow onto plaintiff's land in a greater amount than would normally flow thereon in the course of nature." In effect the court held that, if a proposed development would result in an unreasonable increase in runoff to the detriment of other property owners, then the village had a legally-binding duty to deny approval of that development and to refuse the dedication of streets, catch basins, and similar improvements.

In Powell the court clearly stated that a municipality may incur tort liability for failing to abide by its own subdivision regulations pertaining to sanitary and storm sewers. The court held that, if the village

accepted a faulty sewer system, it could be sued for damages caused by asserting a common law immunity; "municipalities do not have a common law immunity pertaining to sewer systems." Moreover, the court held that, if the developer had obtained a permit for his sewer system from the Illinois Environmental Protection Agency, the village was still obliged to review and "pass judgement" on the developer's proposal.

Note that while both of these cases involve municipalities, there is no reason to believe that the same principles would not apply to counties or other units of government.

2. Substantive Due Process - A stormwater control ordinance is a "police power" measure because it is intended to protect the health, safety, and welfare of the citizens of the governmental unit which enacts it. Courts presume that police power measures are valid, but they can be overturned if they do not conform to the constitutional guarantee of substantive due process. Substantive due process requires that a police power measure be reasonable. "Reasonableness" does not demand that the police power ordinance be "ideal," but it does require (1) that it have a valid objective and (2) that the provisions of the ordinance be logically related to the attainment of the objective.

There are at least two ways to increase the likelihood that the validity of a police power ordinance will be judicially upheld. The first way is to carefully draft and set out in the ordinance a detailed statement of its purposes. Second, the drafters of stormwater control ordinances should provide (perhaps in an appendix) the scientific/engineering data underlying the requirements of the ordinance itself and permit compliance with those requirements by a variety of methods. This will make it much more difficult for affected parties to convincingly allege that the ordinance requirements are arbitrary or capricious.

3. Taking Without Compensation - The 5th Amendment to the U.S. Constitution, also in Illinois' 1970 State Constitution, Article 1, Section 2, made applicable to the states by the 14th Amendment, prohibits the taking of private property for public use without just compensation. This constitutional issue might arise in regard to stormwater control if the provisions of the ordinance are so stringent that they effectively deny affected property owners any economic or practical use of their land. This does not mean, however, that a stormwater control ordinance cannot rather severely restrict permissible land uses, construction methods, subdivision design, and so forth, providing those restrictions are reasonable and appropriate to the local drainage conditions.

Since police power ordinances are presumed to be valid, the landowner would have the burden of proving that enforcement of the regulations, as applied to him, amounted to an uncompensated exercise of the governmental unit's eminent domain powers. Still, the drafters of stormwater ordinances must recognize that, if protection can be provided only by keeping designated areas as "pure" open space, public acquisition, by purchase or condemnation, might be necessary.

4. Equal Protection - Not uncommonly, people tend to think of the equal protection clause of the 14th Amendment only in the context of racial or sexual discrimination. In fact, that clause is applicable to any police power measure. The equal protection clause does not prohibit classification nor the imposition of different rules for different classes so long as (1) the objectives to be achieved by the classification are legally valid, and (2) the regulations applicable to each class are reasonably related to the attainment of those valid objectives. Like the guarantee of substantive due process, then, the equal protection clause demands that the purposes of any stormwater control ordinance be legally valid and that any classification or zoning of land, or any other regulatory provisions, be logically and reasonably related to achieving those stated purposes.

5. Procedural Due Process - An ordinance must not only afford affected persons substantive due process, but procedural due process as well. Basically, this requirement is very easily met; the ordinance simply must establish mechanisms to ensure that persons whom the ordinance will directly impact are:

ɔtified and, (2) given an opportunity to be heard. For example, if actions were to be taken against dividual who was erecting a prohibited structure in a drainage channel, that individual, per the terms ɜ ordinance, must be notified of such pending actions (probably by first class mail) and allowed to ınt his view of the matter at a hearing.

ɜdural due process also encompasses the requirement that local ordinances be enacted and ced in accordance with applicable State enabling legislation. In general, the procedural requirements ıe enactment of municipal ordinances are set forth in Divisions 2 and 3 of Article I of the Illinois ɔipal Code (Ill. Rev. Stats., Chap. 24); special attention should be directed to Section 24-1-2-4 which fies mandatory ordinance publication requirements. Unfortunately, Chapter 34 does not contain any ɔarable compilation of ordinance enactment/enforcement requirements generally applicable to ties.

rdinance which is to be enacted pursuant to specific enabling legislation -- such as the acts ɔrizing municipal and county zoning or subdivision controls -- must also conform to the particular ɜdural requirements of those acts. Thus, for example, if a municipality were to pass stormwater ıgement regulations pursuant to its zoning powers, any amendment to those regulations would have ɜet the specific notice and protest provisions of Section 24-11-13-14.

further point: Both municipalities and counties may adopt technical codes (such as the BOCA ing Code) by reference, and conceivably they could amend such codes to emphasize flood proofing ılated measures. Again, though, to avoid procedural due process challenges, the procedural ırements of the enabling legislation (24-1-3-2; 34-652; 85-1001 et seq.) must be strictly followed. In ɔular, the appropriate number of copies of the code must be made available for inspection, and any ılty clause must be set forth in full in the adopting ordinance.

Vater Quality Regulation

ılation of stormwater quality in Illinois currently is under the jurisdiction of the Illinois Environmental ɜction Agency (IEPA) which, through federal delegation, has the authority to require National Pollutant ıarge Elimination System (NPDES) permits from stormwater discharges which contribute to violations ater quality standards.

December 7, 1988, the U.S. Environmental Protection Agency (U.S. EPA) proposed additional lations for stormwater discharges to waters of the United States. The proposed rule calls for NPDES ıits for certain types of stormwater-only discharges. The new strategy proposes requirements for strial discharges and discharges from municipalities over 100,000 population. Municipalities under 000 population would not be required to apply for permits until October 1992.

strial stormwater discharges into the waters of the United States would be required to submit NPDES ıit applications. Of particular note is the proposed requirements for all non-residential construction over one acre and all residential construction sites over five acres to obtain an NPDES permit, unless discharge into municipal storm sewers.

ıdition to filing for NPDES permits, both industries and municipalities would be required to take steps orrect and prevent polluted stormwater from reaching receiving streams. A cross connection tification and elimination program would be required as would specific management programs to rol pollutants in construction and urban runoff.

nties and municipalities may also use their police powers to deal with stormwater quality problems ɜting the beneficial uses of streams and lakes within their jurisdiction. The exercise of these powers ıld be based on the clearly stated purpose of preventing the loss of aquatic habitat, recreation, and

aesthetic uses of streams. The IEPA's "Assessment of Nonpoint Source Impacts on Illinois Water Resources" has identified stormwater quality impacts on all of the urban streams in northeastern Illinois (IEPA, 1988).

IV. APPLICABILITY AND FEE IN LIEU OF DETENTION

Currently, most detention ordinances provide an exception procedure which allows properties under a certain size (usually < 5 acres residential and < 1 acre non-residential) to be exempt from detention requirements (Dreher, 1989). The reasoning behind such exemptions is the presumed minimal impact of such small sites, the problem that detention may be difficult to implement for small parcels due to site limitations, and the minuscule size of release orifices which may lead to maintenance problems.

Complaints are sometimes heard regarding the large number of detention facilities which result from an on-site detention policy. Typically, maintenance can be performed more efficiently for fewer, larger facilities. The small size of on-site basins also often limits the possibility of multi-purpose use. The concept of fee in lieu of detention can provide a mechanism to reduce the number of small basins in a community or watershed. Fee in lieu allows a land developer to pay a fee instead of constructing onsite detention. The local government uses the money derived from fees to construct larger regional facilities.

Several examples of fee in lieu of detention exist around Illinois. Winnebago County/Rockford, Elgin, and Tinley Park have attempted programs of this type. A key component of all these programs is the fact that the stormwater management authority in each case had completed advance planning to determine regional detention basin sites and had in many instances acquired those sites in advance of receiving developer fees. Each of the stormwater management agencies also had developed and adopted the necessary administrative program for determining, collecting and distributing fees.

The Winnebago County/Rockford program consists of the following steps:

1) Watershed stormwater control studies are prepared to identify regional detention sites.

2) While the watershed studies are being completed, "opportunity regionalization" is implemented to allow the county to take advantage of regionalization opportunities which present themselves as part of the development process.

3) Where the county elects to implement regionalization, developers are required to pay a fee in lieu of detention. In the watershed of a regional detention basin, properties which are not yet developed have a lien placed on them equivalent to their share of the cost to build the regional facility.

In summary, it is essential that a community complete the following tasks before implementing a fee in lieu of detention program.

1. Establish the administrative framework for collecting fees and determining where and how they will be spent.

2. Initiate watershed stormwater management studies to determine where regional facilities should be built and how stormwater will be safely conveyed to the facilities.

3. Appropriate funds for "opportunity regionalization."

ımount will be computed and how fees will be guaranteed from properties (i.e., nents).

nal detention sites and proceed with construction when development indicates

REASES IN RUNOFF VOLUMES AND RATES

ıce recommends a hierarchy for the selection of drainage system components. the objective of minimizing the increase in post-development runoff quantities ases in downstream flooding and erosion and to provide capture of stormwater ans for accomplishing this objective include retention of existing depressional vales and natural channels instead of storm sewers, and infiltrative practices. ı of the model ordinance is not to mandate the use of the above measures but use if site conditions are appropriate. Site designers are required to evaluate nage features and implement them where practicable.

epression Storage

'atershed consists of topographic features such as natural depressions and ormwater runoff and delay its release to conduits and streams. Some as release rainfall excess only via evaporation or by slow infiltration into ıng runoff from contributing to the flood peak for most events. Storage behind l or railway embankments also acts as depression storage. The loss of this esult of site grading or the removal of constrictions can have serious impacts site runoff.

effectiveness found that less than three-quarters inch of depression storage 'shed coupled with higher natural channel roughness factors reduced 100-year at the bottom of the watershed. The frequency and duration of the 2-year itions was also reduced by about 10 percent (Dreher, 1989). An investigation t on Butterfield Creek in Cook County, Illinois produced similar results pointing n storage. This study found that about one inch of depression storage over d reduced 100-year flood peaks by about 27 percent. (Bartels, 1987).

e is advocated as part of a total stormwater management program in many Maryland, New Jersey, Ohio, Virginia, Florida and Washington D.C. The Engineers and the National Association of Homebuilders have also endorsed under proper design conditions (ULI, ASCE, NAHB, 1975).

drainage over conventional storm sewers include: 1) slowing of stormwater ngthening time of concentration and reducing peak discharges; 2) increased ches in some soils); 3) increased storage (as much as 40 acre-feet per mile B, 1975), 4) removal of suspended pollutants (Schueler, 1987; USEPA, 1983) costs than storm sewers. Disadvantages include increased maintenance costs overflow during winter conditions.

Design considerations include the following:

1) A parabolic cross section should be preferred to trapezoidal or triangular shapes since the swale will eventually tend to assume parabolic shape.

2) Swales should tend to follow natural, pre-development drainage paths.

3) Swales should be wide and shallow and well vegetated. They should be as flat as possible without causing unintentional standing water.

4) Swale drainage is most applicable in low density residential areas, commercial sites, office and industrial parks, or planned unit developments. (A constraint to swale drainage is the necessity for a high density of driveways or site entrances/exits which must be crossed with culverts).

5) Erosive velocities should be avoided.

6) Water quality performance can be enhanced in swales by providing check dams or drop structures across swales.

C. Infiltrative Practices

Infiltrative practices include a broad array of measures designed to promote percolation of stormwater runoff into the ground before it reaches a receiving stream. Examples of infiltrative practices include infiltration basins, infiltration trenches, drywells, and porous pavement. Infiltration practices also include measures as simple as routing runoff from rooftops, driveways, parking lots, etc. over pervious surfaces instead of routing this runoff directly to storm sewers.

Advantages of infiltration devices are similar to swales and include: 1) reduction of runoff volume thereby helping to prevent increases in downstream flood peaks due to urbanization and helping to prevent channel erosion due to increased bankfull flow occurrences; 2) reduced sizing requirements for storage and conveyance facilities; 3) groundwater recharge and maintenance of baseflows in receiving streams; and 4) removal and/or decomposition of pollutants in soils. Disadvantages include 1) potentially high maintenance requirements; 2) potential for contamination of shallow groundwater; and 3) high construction costs.

Design considerations are included in the following (ULI, ASCE, NAHB, 1975; ODNR, 1980; MDNR, 1984):

a) Infiltration trenches and porous pavement are limited to relatively small immediate tributary areas (about 5 acres for trenches and 10 acres for porous pavement). Infiltration basins can be effective for areas up to 50 acres in size if combined with detention storage. These size limitations translate to storage and infiltration of about the 2-year, 24-hour event.

b) Soil permeability and depth to seasonally high groundwater and bedrock must be accurately established as a basis for design. It is suggested that four feet of separation be maintained between the bottom of an infiltration device and the groundwater table or bedrock.

c) Infiltrative practices should be installed on relatively flat (less than 5 percent) slopes.

›nsider expected stormwater pollutants and the ability of the infiltration device and/or
; to capture them and prevent groundwater pollution.

ation basin or similar means for capturing sediment before it reaches the infiltration
portant component of any design.

E ·

recent floods has shown that much of urban flooding is caused by stormwater flooding
ık flooding. Stormwater flooding (i.e., inadequate local drainage) is caused by detention
uate overflow structures, rear yards that have no outlet other than storm sewers, and
/ays that have no outlets other than storm sewers. Detention basin overflow structures
ler Safety Considerations in Section XIV.

/ater flooding in the vicinity of low depressional areas not designed as retention or
drainage should be provided. Positive drainage provides for an overland flow path for
perty to prevent flooding when the capacity of the storm sewers is exceeded. These
s should be designed to pass the 100-year flow rate at a stage that is at least one foot
oundation grade in the vicinity of the low area. The overland flow paths should be
plans and drainage easements should be required. If easements are required, it will
ers from placing sandboxes, fences, and other obstructions across these overland flow

ainage plan required under Section 402.0 of the model ordinance specifies that
ps of 100-year flooding be provided. On these maps all of the low areas discussed in
raph, as well as the overland flow paths, would be shown to be inundated. Calculation
low areas does not require detailed routing of flows. Stages can be calculated from
overland flow path and the 100-year flow rate into the low area.

ı streets, under 100-year conditions, should be limited to a depth that would still allow
ency vehicles. The model ordinance recommends that depths be limited to one inch
. However, actual site conditions, such as curb and road crown heights, will dictate
smaller depths are feasible.

small swales are part of the minor drainage system and are designed to keep water
er typical runoff conditions but do not have the capacity to convey extreme flows.
nust be provided wherever feasible to prevent flooding during extreme events. Storm
y designed to pass the 5-year or 10-year flow. Local conditions, such as topography,
eptions of the residents, will dictate the most appropriate design capacity of the minor
or each municipality.

e system is designed to convey the flow in excess of the capacity of the minor drainage
les both the overland flow paths provided for positive drainage and larger swales,
hes that convey flow either offsite or to a detention facility.

VII. RELEASE RATES

Proper consideration of the concept of release rates requires that both a discharge per unit of tributary area and an associated recurrence interval for which that release is valid be specified. The model ordinance recommends release rates for the 100-year and two-year events.

A. 100-year Release Rate

Specification of allowable 100-year discharges from detention facilities varies widely across the country. Many communities continue to rely on the philosophy that post-development peak discharges should not exceed pre-development peak discharges for a property. Although such an approach may be effective for protecting immediately adjacent properties, it likely will lead to increased downstream flood peaks because of the greater volume of stormwater discharge and because of the change in timing of these peaks. Fortunately, most communities in northeastern Illinois have been wise enough to recognize these potential cumulative impacts. Led by the Metropolitan Sanitary District of Greater Chicago's (MWRD) example in the early 1970's, many communities have adopted the peak discharge from the 3-year event for undeveloped conditions as the allowable 100-year peak discharge from a property. Other communities have been concerned, based on historical flood release rates for different streams, that even the MWRD's 3-year event release was not stringent enough to prevent increases in downstream flooding as urbanization progressed. Their ordinances have called for uniform 100-year release rates of 0.15 cfs/acre or less. NIPC's previous model ordinance (1980) recommended a release rate of 0.15 cfs/acre. A comparison of the magnitude of different release rates is presented below.

100-year Undeveloped Peak	1.0 to 1.5 cfs per acre
3-Year Undeveloped Peak	0.20 to .50 cfs per acre
NIPC 1980 Ordinance	0.15 cfs per acre

These can be compared to observed flood of record flow rates for northeastern Illinois streams which range from about 0.02 to 0.15 cfs per acre. The higher flood flow rates (in cfs/acre) occur for small watersheds (i.e. <25 mi^2) while the lower rates occur in large rivers (i.e. >200 mi^2). These differences are attributed to lower areal rainfall amounts in large watersheds, flow attenuation in the channel system, and a greater distribution over time of the runoff from the watershed. NIPC's evaluation of detention effectiveness found that a 100-year release rate of 0.15 cfs per acre was effective in preventing an increase in downstream flood levels over pre-development conditions for a 30 square mile test watershed (Dreher, 1989). For the test watershed NIPC studied, smaller release rates appeared to be unnecessarily restrictive. Higher release rates appeared to not be restrictive enough for watersheds much larger than 30 square miles.

B. 2-Year Release Rate

The Model Stormwater Detention Ordinance recommends the use of what are frequently termed "dual purpose detention basins." The dual purposes are the control of stormwater discharge rates for extreme events to prevent flooding increases, and the control of more frequent runoff events to mitigate channel erosion and water quality impacts. The urbanization of a watershed causes stormwater pollution in two major ways. First, eroded soil and other pollutants washed from urban surfaces, such as metals, fertilizers, pesticides, oils and grease, enter receiving streams causing either acute or chronic damage to aquatic life or habitat (USEPA, 1983). A later section of this guidance discusses measures to deal with stormwater pollutants. Second, the urbanization of a watershed results in increases in the frequency and duration of bankfull flow conditions which can increase bank erosion.

search has suggested that channel morphology is most related to bankfull flow conditions (Leopold, 64; Anderson, 1970). NIPC's study of detention effectiveness showed that the magnitude of the two-ar event, typically representative of bankfull conditions, increased by a factor of three or more as a ult of urbanization. Similarly, both the frequency and duration of exceedence of the pre-urbanization ear event increased dramatically (Dreher, 1989). As a result, streams adjust their capacities to convey increased flows. This can lead to channel and bank erosion and the destruction of aquatic habitat. stly bank stabilization measures are frequently necessary to halt this erosion and corrective measures, ch as riprap, gabions, or concrete lining, can have additional negative habitat impacts.

veral researchers have suggested the use of detention basins to control the frequency and duration bankfull streamflow (Whipple, 1987; Schueler, 1987). The Model Ordinance suggests a release rate 0.04 cfs per acre for the two-year event to accomplish this objective. NIPC's study of detention ectiveness noted that a release rate of 0.02 cfs per acre appeared to be too restrictive for this purpose d that a 0.05 cfs per acre release was not restrictive enough (Dreher, 1989). The Metropolitan ashington Council of Governments (MWCOG) has noted that jurisdictions within their region have opted release rates varying from 0.013 to 0.13 cfs per acre for control of the frequency and duration the 2-year event (Schueler, 1987). In summary, MWCOG recommends that the runoff from a 1 to 1.5 h precipitation event be released over at least 24 hours (0.02 to 0.03 cfs per acre).

ntrol of the 2-year event release rate to 0.04 cfs/acre will require consideration of design features which y not be common in northeastern Illinois. Restricting the two year event will require smaller detention sin outlets as well as prolonged detention times. Outlet size may become a constraint to incorporating tention in small developments. The ordinance recommends a minimum effective outlet orifice of 4 hes. Outlets as small as 2 inches may be possible with the incorporation of special design features, ch as perforated risers. The table below shows the approximate orifice size required to achieve the 2-ar release rate as a function of drainage and 2-year water depth. The table shows that, as expected, smaller the drainage area and the greater the 2-year detention depth, the smaller the required orifice. e table indicates that with a typical 2-year depth of one foot, the smallest drainage area that can be ntrolled with a 4-inch orifice is approximately 8 acres. For smaller drainage areas and/or greater tention depths, special design features may have to be considered. The table below is intended as guideline and to be used for illustrative purposes. Actual orifice sizes will depend on site conditions.

Approximate Orifice Size Versus
Drainage Area and Detention Depth

Drainage Area (acres)	Detention Depth (feet) 1	2	3
1	1.5"	1.1"	1.0"
5	3.3"	2.5"	1.4"
10	4.6"	3.5"	3.1"
20	6.5"	4.9"	4.4"
40	9.2"	7.0"	6.2"

olonged detention times may not impact the operation of wet basins but they can have significant pacts on the maintenance and multiple use potential of dry basins. Portions of dry basins may be wet extended periods of time with the recommended 2-year release restrictions. This wetness may affect

the viability of grass and may make mowing more difficult. The section on Water Quality Considerations discusses several measures, including underdrains and two-level basin designs, to address these problems.

VIII. HYDROLOGIC DESIGN CONSIDERATIONS

Urbanization has a dramatic impact on the precipitation/runoff relationship for a watershed. NIPC's study of detention effectiveness indicated that urbanization increases the volume of runoff for peak annual events by 25 to 30 percent. Urbanization increases the peak flow for flood events even more dramatically. The 100-year event more than doubles and the 2-year event triples as a watershed urbanizes (Dreher, 1989).

Estimation of the hydrologic response of a watershed is a function of rainfall data and a model for converting that rainfall to runoff. Data and methods for accomplishing the estimation of urban hydrology are discussed in the following sections.

A. Precipitation

In Illinois there are three principal sources for rainfall data. The first is actual precipitation gage data, such as the U. S. Weather Bureau precipitation data for gages around Illinois. This data may be used in continuous simulation hydrological models which need a long-term precipitation record. It also can be useful in attempting to model a watershed's hydrologic response to a single storm event. Such raw data however does not have intensity-duration recurrence probabilities associated with it and therefore cannot be used directly to infer risk levels.

The second source of data is the U. S. Weather Bureau's "Technical Paper No. 40, Rainfall Frequency Atlas of the United States" (Hershfield, 1961). This publication, known as TP-40, contains probable rainfall intensity- duration estimates based on long-term U. S. Weather Bureau gages across the country. Estimates are available for rainfall durations from 30 minutes to 24 hours for return periods from 1 to 100 years. The average length of gage record used in developing this information was 48 years. This data is specifically included in the MWRD's detention basin design example and is included in the SCS's TR-55 Manual. These estimates have been widely used throughout northeastern Illinois.

The third source for rainfall data is the Illinois State Water Survey's "Bulletin 70: Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois" (Huff and Angel, 1989). This document provides estimates of rainfall intensity-duration probabilities for durations of 5 minutes to 10 days for return periods from 2 months to 100 years. It was developed using 83 years of data from 63 Illinois raingages. A comparison of rainfall amounts for several predicted return periods for a 24-hour event in northeastern Illinois is presented below.

	100-year	10-year	2-year
TP-40	5.75	4.00	2.90
Bulletin 70 Sectional Average	7.58	4.47	3.04

NIPC's study of detention basin effectiveness found that basins designed using an 8.2 inch, 100-year, 24-hour event came close to overflowing but did not overflow for the 100-year runoff volume based on continuous simulation using 36 year rainfall records from the O'Hare and McHenry gages (Dreher, 1989). The 8.2 inch event was taken from earlier work on rainfall recurrences by Huff (Huff, 1979). Based on the longer rainfall record, the specificity of the ISWS study to Illinois, and NIPC's detention study findings, the use of Bulletin 70 rainfall frequency and intensity-duration estimates is recommended. Bulletin 70 presents mean average sectional intensity-duration values as well as isohyetal frequency distribution data. For example, the average sectional 100-year, 24-hour rainfall value for northeastern Illinois is 7.58 inches whereas the isohyetal values vary from 6.5 inches in Lake and McHenry Counties to 8.5 inches in Will County. The ISWS has indicated that the sectional averages are most appropriate for use in characterizing events of longer recurrence intervals. This is because the sampling error increases with increasing recurrence interval and areal averages can reduce the effect of large, non-representative point values (Huff and Angel, "Personal Communication," 1989). Based on NIPC's study results and the need for conservative design it is recommended that the larger of the sectional average and isohyetal rainfall values be used.

It is important to note that for the design of other components of the drainage system, rainfall intensities and durations other than the 24-hour event are probably more critical. Again, based on the above arguments it is recommended that the larger of the sectional or isohyetal values be used from Bulletin 70 for these types of designs.

Finally, it is important to examine the time distribution of rainfall assumed as part of the design process. Two of the more popular sources for this information are the Soil Conservation Service (SCS) and the Illinois State Water Survey (ISWS). The SCS has defined four types of time distributions of rainfall. Most of the work in northeastern Illinois using SCS hydrologic methods has relied on the Type II distribution as recommended in TR55. The ISWS has conducted three major studies of the time distribution of point and areal rainfall; first in central Illinois (Huff, 1967), then in northeastern Illinois (Huff and Vogel, 1976), and finally all of Illinois (Huff, 1990). All three studies reached similar conclusions, that temporal storm distributions should be defined based on the quartile in which the heaviest portion of the rain falls. The SCS Type II and the four Huff distributions are shown in Figure VIII-1 and tabulated in Table VIII-1. The incremental rainfall amounts are given as percentages of the total rainfall at the percentage of the total storm duration. Each of the Huff distributions have somewhat similar maximum rainfall intensities with the first and fourth having the highest intensities. However the SCS Type II distribution has by far the highest intensity rainfall of the five distributions, containing a 2 increment period around the midpoint of a 24 hour rainfall duration in which about 60 percent of total storm precipitation falls whereas the maximum amount that falls in any two increment period of the Huff distributions is 28%. This can result in some dramatic increases in peak discharges if the SCS Type II distribution is combined with the higher ISWS rainfall quantities.

The ISWS first quartile distribution was found to be representative of 40 percent of the 417 northeastern Illinois storms over 0.5 inches studied in developing the curves in Figure VIII-1 (Huff and Vogel, 1976). However they found that there is a correlation between storm duration and the quartile in which the most intense rainfall occurs (Huff, 1990). The shorter duration storms tend to be first quartile storms and the longer duration storms tend to be third or fourth quartile storms. The ISWS recommends selection of the appropriate time distribution based on storm duration.

In Circular 173, Time Distributions of Heavy Rainstorms in Illinois (Huff, 1990), the ISWS states that storms with durations less than 12 hours mostly exhibit first and second quartile distributions with first quartile distributions being slightly more common for storms of less than six hours and second quartile distributions being slightly more common for storm durations between six and 12 hours. Storms with durations between 12 and 24 hours mostly exhibit third quartile distributions and storms with durations

Figure VIII-1: RAINFALL DISTRIBUTION COMPARISON

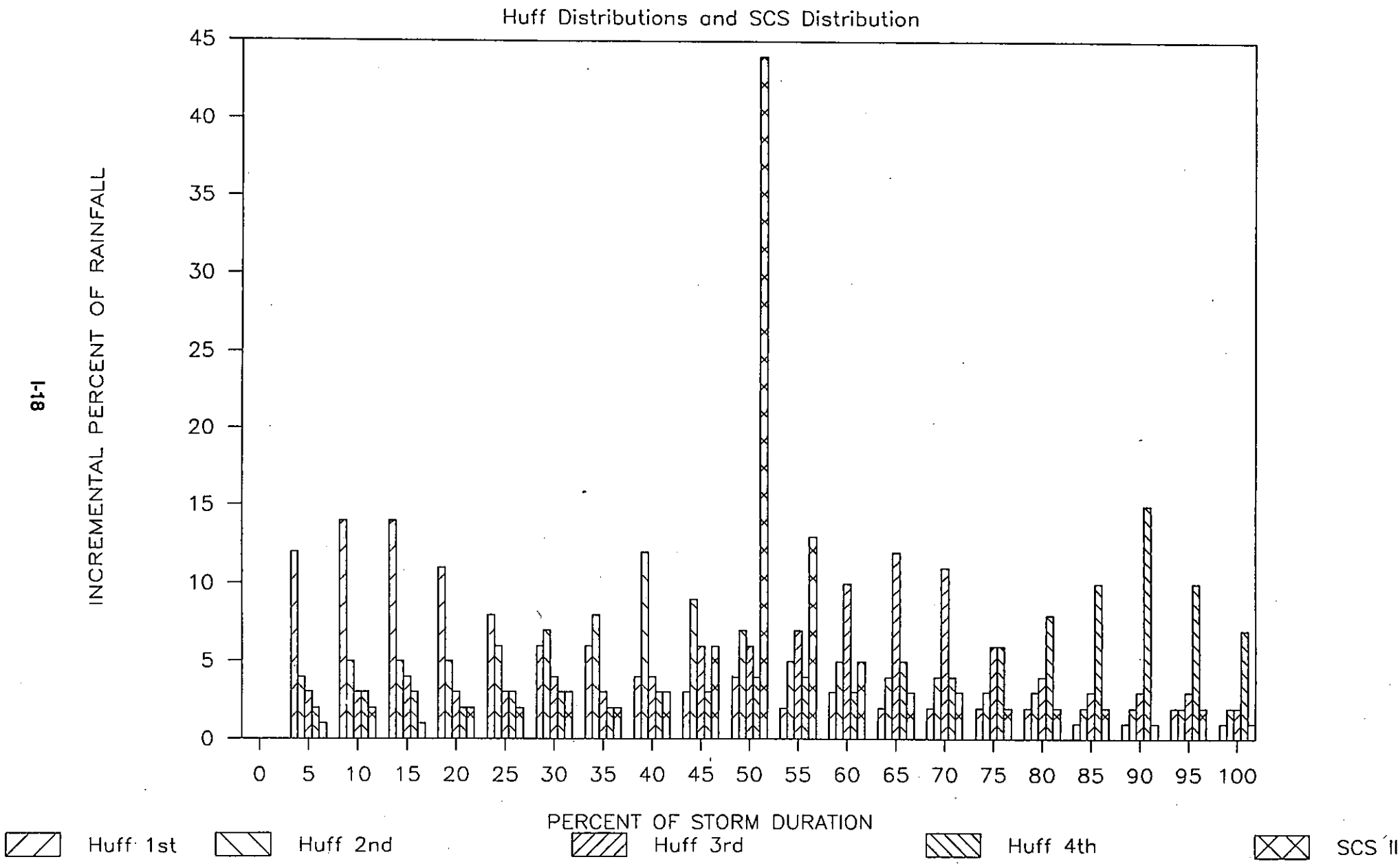


Table VIII-1: RAINFALL DISTRIBUTION COMPARISON

INCREMENTAL PERCENT RAINFALL

F N	HUFF 1ST QUARTILE	HUFF 2ND QUARTILE	HUFF 3RD QUARTILE	HUFF 4TH QUARTILE	SCS TYPE II
0	0	0	0	0	0
5	12	4	3	2	1
.0	14	5	3	3	2
.5	14	5	4	3	1
0	11	5	3	2	2
5	8	6	3	3	2
0	6	7	4	3	3
5	6	8	3	2	2
0	4	12	4	3	3
5	3	9	6	3	6
0	4	7	6	4	44
5	2	5	7	4	13
0	3	5	10	3	5
5	2	4	12	5	3
0	2	4	11	4	3
5	2	3	6	6	2
0	2	3	4	8	2
5	1	2	3	10	2
0	1	2	3	15	1
5	2	2	3	10	2
0	1	2	2	7	1

greater than 24 hours mostly exhibit fourth quartile distributions. For simplicity and because there was only a slight difference in the frequency with which the first and second quartile storms occurred, the model ordinance recommends usage of the first quartile distribution for design storms with durations less than 12 hours. The following table summarizes the ISWS and NIPC recommendations.

Recommended Time Distributions	
Storm Duration	Time Distribution
Less than or equal to 12 hours	First Quartile
Greater than 12 hours and less than or equal to 24 hours	Third Quartile
Greater than 24 hours	Fourth Quartile

The time profile of these distributions, for drainage areas less than 50 square miles, is given in Table 3 of Circular 173. It should be noted that the selection of storm distribution has a small but significant affect on computed detention volumes and can have a dramatic effect on the estimate of peak runoff rates for sizing conveyance systems.

While the Huff distributions are designed to represent typical rainfall patterns, the SCS Type II distribution is not. Rather the Type II distribution is intended as a design tool which contains all rainfall intensities for all durations up to 24 hours and was intended to be used with 24 hour rainfall depths only. However, it is routinely used with shorter duration rainfalls. Although NIPC is not opposed to proper application of the SCS Type II distribution, it is recommended that the appropriate Huff distributions be used for site design purposes as they are more representative of the types of storms that are likely to occur in Illinois.

B. Runoff

Once a source of rainfall data has been selected the next decision will be which runoff model to select. Some of the more popular choices in Illinois are the rational method, USGS regression equations, SCS hydrological methods (TR-20, TR-55), HEC-1, ILLUDAS, SWMM, and HSPF. Each method has particular advantages and disadvantages depending on what the user is attempting to accomplish. The rational method and the USGS regression equations produce an estimate of peak discharge for a watershed. HSPF is a continuous simulation model which develops a continuous runoff trace based on a long-term continuous precipitation input and accounting of water balances. The other methods are event models capable of estimating the hydrograph resulting from individual design precipitation events on a watershed. The modified rational formula is an attempt to simulate a runoff hydrograph using the rational formula and triangular or trapezoidal approximations of true hydrographs. The accuracy of the estimations produced by any of these tools is largely a matter of the appropriateness of its use for the problem at hand and the experience and judgement of the user. Chapter 5: Urban Hydrology of "Urban Stormwater Management", the American Public Works Association's Special Report Number 49 has an extensive discussion of many of the above methods (APWA, 1981).

The model ordinance specifically suggests a runoff method which generates a hydrograph to enable routing of that hydrograph through the major drainage system to estimate floodplains and flood profiles. The generation of a hydrograph also enables the use of reservoir routing for the design of detention facilities. SCS hydrologic methods (TR-20, TR-55), HEC-1, ILLUDAS, SWMM and HSPF can all be used for this purpose. The modified rational formula is specifically excluded, except in estimating runoff peaks

needed in the design of the minor conveyance systems, because of inherent inaccuracies in its estimation of runoff hydrographs.

One of the most critical assumptions needed in running an event model is antecedent moisture conditions. The greater the antecedent moisture conditions the greater the runoff peaks and volumes from a given rainfall event. TR-20 and TR-55 assume that 20 percent of the potential abstraction is available within a watershed at the beginning of rainfall (antecedent moisture condition two). In many versions of the TR-55 software and in HEC-1 the user can modify this assumption. The CN can also be adjusted to allow for varying antecedent moisture conditions when using the SCS methods. ILLUDAS allows the user to choose from four different antecedent moisture conditions. Condition 3, termed "rather wet" is recommended and allows 2 inches of storage capacity in the soil mantle for A soils, 1 inch for B and C type soils, and 0.5 inches for D soils (Terstriep and Stall, 1974). By limiting the amount of available infiltration a conservative detention basin storage volume will be computed.

IX. COMPUTATION OF STORAGE VOLUME

In northeastern Illinois the computation of storage volume needed to prevent overflow of a detention basin for a design risk level is typically accomplished by either the modified rational method or reservoir (Modified Puls) routing. NIPC's study of stormwater detention effectiveness found that basins designed for the runoff from the 100-year rainfall using the modified rational method and TP-40 rainfall data actually overflowed for runoff events in the range of the 10 to 25-year event (Dreher, 1989). A comparison was made between the detention requirements based on TP40 rainfall and the modified rational formula and the detention requirements based on Bulletin 70 rainfall, SCS hydrology, and reservoir routing. The comparison was made for a typical 40 acre site with two different land use assumptions, 1/4 acre lot residential and 85% impervious commercial. The results of the comparison are shown in the table below.

	Detention Storage Requirements	
Storage Calculation Methodology	1/4 Acre Residential	85% Impervious Commercial
SCS Methods/Bulletin 70	3.4 inch	5.3 inch
Mod. Rat./Bulletin 70	1.5 inch	3.9 inch
Mod. Rat./TP40	1.1 inch	2.8 inch

The table shows, in general, the differences in storage requirements that are likely to result from the two methods. For 1/4 acre lot residential areas, the more sophisticated SCS methods based on Bulletin 70 rainfall are likely to result in three times the storage required using the rational formula and TP40 rainfall. As the imperviousness increases, the difference is less. However the SCS methods still results in almost twice the storage at 85% impervious. If Bulletin 70 rainfall is used with the rational formula, the table indicates that detention storage requirements are still less than with SCS methods for this example.

The serious potential for underestimation of necessary detention storage through use of the rational method is the primary reason the model ordinance specifically prohibits its use for detention design. A thorough discussion of the use of reservoir routing can be found in the APWA's "Urban Stormwater Management" Chapter 9: Engineering Design of On-Site Detention Facilities (APWA, 1981) and many other texts and references.

X. DETENTION IN FLOODPLAINS

There are three classes of detention in flood hazard areas: detention in the flood fringe; detention located in the floodway laterally along the stream; and detention created by adding a control across the stream to create storage, often referred to as on-stream detention.

A. Detention in the Flood Fringe

A number of local detention ordinances allow detention to be created for a property by adding storage within the floodplain rather than by constructing a detention basin with a control on stormwater releases. The rationale for such an approach appears to be either that this is equivalent to the detention storage basin approach or that there is a need to allow local flood peaks to pass before upstream flood peaks arrive so that flooding downstream will not be aggravated by the delay of a property's flood peak. In general, without conducting detailed watershed modeling, neither of these rationales appear sound.

Excavation of storage in the floodplain is not equivalent to providing the same amount of storage in a detention basin with a controlled release. In one instance peak discharges from a property are allowed to increase due to urbanization whereas when a basin is built the urbanized property's peak discharges will be controlled to a pre-determined release rate (0.15 cfs per acre in the case of this model ordinance). At some point downstream the increase in peak flows from urbanizing properties will result in increased flood peaks unless storage and discharge control are provided. It would appear that such a policy is not consistent with Templeton vs. Huss in that it does not provide any mitigation of peak discharges from urbanizing property to protect downstream landowners.

The rationale that flood peaks from a property should not be detained so that they can be discharged in advance of the arrival of upstream flood peaks cannot be supported without detailed hydrologic and hydraulic analysis of the entire watershed potentially affected by such a policy. NIPC has evaluated the literature on the subject of randomly sited detention facilities causing increases in flood peaks. All of the studies on this subject were based on detention releases up to ten times greater than allowed in northeastern Illinois. The current allowable releases from detention facilities in northeastern Illinois (typically 0.1 to 0.3 cfs per acre) are so small that the problem of adding to upstream peak discharge is generally insignificant.

For these reasons the model ordinance requires that the peak 100-year discharge from a property be controlled to 0.15 cfs per acre and that if storage to detain flows in excess of this quantity is to be built in the flood fringe that compensatory storage be provided. Excavation of detention storage in the floodplain without control of the property's peak discharge to 0.15 cfs per acre is not allowed. The volume of compensatory storage is based on the total volume of flood fringe storage lost to stormwater detention basin volume including berms and landscaping. Additional provisions of NIPC's and IDWR's Model Floodplain Ordinance are also applicable (IDWR and NIPC, 1989). This includes hydraulic equivalency of compensatory storage and NIPC's recommendations for a safety factor of 1.5 and maintenance of equal flood fringe surface areas. It is also important that the applicant demonstrate the operation of the basin for all streamflow and floodplain backwater conditions.

B. Detention in the Floodway

92 Illinois Administrative Code, Part 708 states that only appropriate uses of the floodway will be allowed as defined by the IDWR. The IDWR has notified NIPC that stormwater detention basins are not an appropriate use of the floodway. The model ordinance therefore does not allow detention in the floodway. There is also a very real engineering question of how detention can be provided in the floodway and still provide gravity release of stormwater during flood events. High floodway stages will undoubtedly seriously

complicate the design of an effective detention basin in these locations. Additional considerations which argue against floodway detention basins include short and long term water quality and habitat impairments due to construction adjacent to a water body.

C. On-stream Detention

The IDWR's rules on appropriate uses make a distinction between placing a detention structure in the floodway and creating an on-stream control and modifying the floodway to provide detention. There are two types of on-stream detention. The first is a regional detention facility which is designed to store runoff from the entire upstream watershed and release it at the prescribed 2- and 100-year rates. While such regional facilities are most appropriately located on-stream or on a major existing drainage swale, locations on streams draining more than one or two square miles is discouraged. First, the costs and potential environmental impacts of enlarging the upstream drainage system to convey the 100-year flow into such a facility will be substantial. Second, the construction of a detention facility on a large stream may result in the impairment of water quality and aquatic habitat. The ordinance calls for mitigation of such adverse impacts and for control of nonpoint source runoff in the upstream watershed.

Another type of on-stream detention is a facility which is designed to control local runoff while passing flow from the upstream watershed undetained. This latter form of detention is discouraged because it provides no regional benefits, may impair water quality, and provides little assurance that effective detention will be provided for the local drainage area for the full range of flood events.

The model ordinance requires that designs of this type must be analyzed using dynamic modeling to ensure that the design meets ordinance release rate requirements and that no upstream or downstream property has its flood stage increased. As explained in the commentary to the model ordinance, there is a concern that because of the shorter times of concentration for an individual property and the large releases allowed by the above approach, increased flood peaks due to urbanization will be passed downstream without mitigation. This situation is very similar to the addition of floodplain storage without any control as in the section on detention in the flood fringe.

XI. DRAINAGE INTO WETLANDS

Historically, wetlands have been viewed as nuisance areas that should be drained, filled, and converted to more useful dry land purposes. Today water quality, flood control, groundwater recharge, and wildlife habitat functions are all attributed to wetlands, and this recognition has led to the protection and enhancement of wetland areas through federal regulations and local stormwater management plans.

The modification of wetlands as part of the development process requires effective local guidelines for protection of natural functions. Urban stormwater runoff contains high levels of pollutants and sediment which may impair wetland water quality, vegetation, and hydrology. In general, the ordinance (Section 709) discourages fill in wetlands as well as the modification of existing wetlands for stormwater detention, unless the wetland is of low quality. Even for low quality wetlands, mitigation measures are recommended to protect wetland functions from the effects of urban stormwater runoff. Soil erosion and sediment control measures should be required for all sites which discharge to wetlands with provisions for an on-going maintenance contract for which the developer is responsible. Standards and Specifications for Soil Erosion and Sediment Control (IEPA, 1987) and Procedures and Standards for Urban Soil Erosion and Sedimentation Control in Illinois also known as the "Green Book" (Northeastern Illinois Soil Erosion and Sedimentation Control Steering Committee, 1988) provide guidance on sediment control designs and specific management practices.

Several researchers have evaluated the use of wetlands in stormwater management (Johnson, 1987; Stockdale, 1986). Reviews of the literature indicate that wetlands generally function best as a polishing device, removing residual nutrients, sediment, and other pollutants from stormwater after it has been routed through best management practices (BMP's). The model ordinance recommends routing runoff through a detention basin and vegetated swales designed for water quality benefits before discharge to the wetland. The primary detention storage volume (i.e., storage in excess of the 2-year volume) can then be provided in the wetland. As an added measure of protection, an unbroken buffer strip of native vegetation at least 25 feet wide should be maintained or restored between construction and development areas and the wetland.

Proposals to use wetlands as detention basins should be critically reviewed to avoid habitat destruction and the need for expensive mitigation in the long-term. Those developers intending to use existing wetlands as part of a stormwater management system must recognize that wetlands vary in quality. A monocultural cattail marsh with a limited biological diversity is better suited for detention than a highly sensitive and rare wetland fen (a spring-fed alkaline bog) which has unique and endangered natural features, meriting a high level of protection. A qualified biologist should be consulted to assess wetland quality, recommend best management practices for wetland protection, and monitor their effectiveness for a 2-5 year period as part of a monitoring and maintenance agreement between the developer and the municipality. An example of a technique used to evaluate several wetland detention projects in northeastern Illinois is a natural areas assessment system developed by staff at the Morton Arboretum (Swink & Wilhelm, 1979). The overall management goal should be to improve species diversity in low quality wetlands used for detention and to protect high quality wetlands from the deleterious effects of stormwater.

Consideration should be given to the creation of wetlands to provide detention functions when their design indicates that they will function properly and safely. For example, a wetland area may be incorporated into a portion of a dual purpose detention basin to provide water quality functions while requiring less maintenance than a traditional dry basin. General features of wetland designs are discussed in detail in Guidelines for Constructing Wetland Stormwater Basins (MDNR, 1987). For example, approximately 75% of the wetland should have normal water depths not exceeding 12 inches. This will promote the establishment of emergent vegetation which is effective in trapping and absorbing pollutants. Influent should be routed through a series of inlets dispersed throughout the shallow vegetated areas of the wetland. The outlet structure should be located in water at least 3 feet deep. Preference should be given to the selection of native emergent plant species that are moderately aggressive and available in nurseries (i.e., bulrush (Scirpus americanus and Scirpus validus), bluejoint grass (Calamagrostis canadensis), water plantain (Alisma subcordatum), cordgrass (Spartina pectinata), and broadleaf arrowhead (Sagittaria latifolia), avoiding cosmopolitan species such as purple loosestrife (Lythrum salicaria), common reed (Phragmites communis), and cattail (Thpha spp.).

XII. FLOWS FROM UPLAND AREAS

The issue of proper management of stormwater flows from upstream areas tributary to developing properties can be very difficult to equitably settle in a manner which insures consistency with the objectives of the model ordinance. The analysis of flows from upstream areas is similar to the analysis of on-stream detention discussed in the previous section. At least eight different approaches are feasible as described below.

Case 1: Upstream Area Undeveloped

A. Assume a developed land cover for the upstream area and build a regional detention facility on the downstream property with 100-year release of 0.15 and 2-year release of 0.04 cfs per acre with storage for the combined areas (sometimes called "opportunity regionalization").

B. Design the downstream property's detention basin independent of the upstream property and route all upstream flows around the downstream detention basin.

C. Design the downstream property's detention basin independent of the upstream property and route all upstream flows into the downstream basin (bypassing runoff from the combined area in excess of the detention storage volume through an overflow structure).

D. Design a regional basin on the downstream property using its independent allowable release rate. After the storage volume is determined, adjust the release rate to also include the peak flow from the upstream property but do not assume a developed condition on the upstream property. Then when the upstream property develops, design a detention basin for it which will work in concert with the downstream basin.

Case 2: Upstream Area Developed But Inadequate or No Detention

A. Build a regional detention facility on the downstream property with 100-year release of 0.15 and 2-year release of 0.04 cfs per acre with storage for the combined areas (Sometimes called "opportunity regionalization").

B. Design the downstream property's detention basin independent of the upstream property and route all upstream flows around the downstream detention basin.

C. Design the downstream property's detention basin independent of the upstream property and route all upstream flows into the downstream basin. Upstream flows are bypassed through an overflow structure. The overflow rate is approximately equal to the upstream runoff rate.

D. Design the downstream property's detention storage using its independent allowable release. After storage volume is determined, adjust allowable release to what would be allowed for the total contributing watershed if detention were provided throughout the watershed. Then route all flows through the basin. Excess upstream flows are bypassed through an overflow structure. The overflow rate is approximately equal to the upstream runoff rate minus 0.15 cfs/acre of upstream area.

The objective of the model detention ordinance is to limit the discharge from the 100-year rainfall to 0.15 cfs per acre from all developing properties in a community. The model ordinance is also designed to provide the community the opportunity to incorporate control of runoff from previously developed areas into detention basins being constructed for the developing areas.

As with on-stream detention basins, design of detention to limit flows from the applicant's property while bypassing the flows from the upstream area can be difficult. Because of this difficulty, routing of upstream flows around applicant's detention basin is encouraged whenever possible when opportunity regionalization is not being pursued.

For Case 1, all of the alternatives are capable of meeting the objective of the ordinance. Alternative A has the advantage of eliminating the need for the upstream detention but requires a means for financing the

additional regional storage and recovering its cost from the upstream property owner(s). Alternative B has the advantage of simplicity but may be difficult and costly to accomplish because of physical constraints, and it does not reduce the number of detention basins in a community. Alternatives C and D each assume the future construction of upstream detention basins. Alternative C probably results in an unnecessarily restrictive release rate in that it limits the release from the combined watersheds to the release for the downstream watershed until overflow of the downstream detention basin occurs. It does preserve the option of routing future upstream flows around the downstream basin and guards against storm patterns which distribute rainfall only to the downstream basin. Because the release rates specified in this ordinance are less than pre-development runoff rates, alternative D results in a release rate greater than 0.15 cfs/acre. When the upstream property is developed and detention provided, the release rate for the downstream detention will be too high. If the release rate of the downstream basin is not reduced to 0.15 cfs/acre of total property after the upstream property is developed, the ordinance objective will not be met.

For Case 2, all of the alternatives may meet the model ordinance objective. Alternative A will also control the flow from previously developed areas. Alternative B will meet the model ordinance objective but will not control the flow from previously developed areas. The advantages and disadvantages of Alternatives A and B are the same as for Case 1. Alternative C and D may meet the model ordinance objective under ideal conditions but will also not control the flow from previously developed areas. Under Alternative D, if the upstream area contributes flow to the detention basin significantly later than the downstream area, the downstream flows will be passed virtually undetained.

In both cases, Alternative C will result in lower than design release rates for all events that do not fill the detention basin. For larger events, the detention basin release rate should be essentially as designed. However depending on the size of the upstream watershed and its baseflow, the detention basin may quickly be filled by upstream flows for nearly all events, rendering the detention storage virtually useless.

The approach recommended in the ordinance follows from the analysis above. Where practicable, provide regional detention to control the flow from the applicant's site and the upstream area. When this opportunity regionalization is not being pursued, upstream flows should be routed around the applicant's detention whenever possible. When it is necessary to route upstream areas through the applicant's detention basin, site conditions will dictate which alternative is best and a combination of Alternatives C and D should be considered. However neither alternative nor a combination may completely achieve the ordinance objective.

Opportunity regionalization is encouraged provided the community has a mechanism to implement it. This requires a means for paying for additional downstream storage and collecting the costs from benefitting properties. This is clearly the favored approach but it does require a commitment on a community's part to have funds available for "opportunity regionalization" so that the downstream property does not have to pay for upstream detention storage without a means for being reimbursed.

XIII. DETENTION DESIGN FOR WATER QUALITY CONSIDERATIONS

The cleanup of wastewater treatment plant flows has significantly improved the quality of streams and lakes in Illinois. However, problems in meeting water quality standards still exist and one of the principal sources of those problems in many urban areas is stormwater pollution. In fact, on December 7, 1988, U.S. EPA proposed stormwater discharge NPDES permit regulations. As proposed, these regulations would require NPDES permits and implementation of best management practices from many storm sewer discharges including residential land development over 5 acres and non-residential development over 1 acre. Also, as communities gain more experience with stormwater detention facilities within their

jurisdictions, many are looking to obtain multiple benefits from these basins to justify their maintenance costs. Stormwater pollution control can be an important facet of a multiple use objective for both new and existing detention facilities.

A. Detention for Water Quality

This section presents recommendations for designing a stormwater detention facility which not only controls flooding, but also optimally removes urban stormwater pollutants. The ability of stormwater detention facilities to remove pollutants from urban runoff is well documented in reports produced through the Nationwide Urban Runoff Project (NURP) (U.S. EPA, 1983). Removal of solids and metals exceeding 90 percent are possible if appropriate considerations are incorporated into the basin design.

Whereas detention basin design for flood control is concerned with relatively infrequent, severe runoff events, design for water quality benefits is concerned with controlling the most frequent events or the largest practicable amount of runoff volume. In a sense, flood control is concerned with the probability of the extreme, whereas detention for water quality is concerned with the probability of the routine.

It is important to note that it is more critical that adequate detention time be provided for events that occur frequently than it is for the 25-, 50-, or 100-year event. The vast majority of water and corresponding pollutants will be delivered by these common smaller events. Ninety percent of all surface stormwater runoff in a typical urban watershed in northeastern Illinois is generated by storms of less than one-year recurrence (Hey, 1983). The suspended solids load carried by these events typically will be in excess of 100 tons per square mile of watershed (Hey and Schaefer, 1983). Current dry basin designs in northeastern Illinois which call only for release rates based on 0.15 cfs/acre or peak runoff from the 3-year event for undeveloped conditions may allow all of these common events to pass through a basin with little detention and carry this sediment and its associated pollutant load directly to receiving streams. Once in the stream, it can cause water quality standards violations and limit the attainment of desirable stream and lake uses. Also, failure to control the frequency and duration of the 2-year event can lead to serious bank erosion and associated water quality problems. Control of the 2-year event, as required in the ordinance, will provide some water quality benefits and should reduce downstream bank erosion. This section describes additional measures which will enhance water quality mitigation.

B. Basic Design Considerations

Detention basins remove suspended pollutants from urban stormwater by settling. The design of detention basins for water quality benefits therefore must focus on attaining a desired pollutant removal by enhancing the ability of a basin to cause pollutants to settle. Typical laboratory solids removals in settling columns range from 70 to 90 percent removal in 6 foot columns in 4 to 6 hours (Hey and Schaefer, 1983; Whipple and Hunter, 1981).

For water quality design purposes, it is important to note that removal of stormwater pollutants by a wet detention basin is accomplished under both dynamic (flow through the basin) and quiescent (no flow leaving the basin) conditions. In a dry basin, removal is accomplished only under dynamic conditions. Wet basin size is determined by providing enough permanent water volume so that the pool is infrequently displaced by runoff events thereby allowing pollutants adequate settling time between storms. The critical design parameter for dry basins is release rate, which must be small enough to achieve a design overflow rate or detention time.

C. Wet Basin Size

A wet detention facility must be large enough to ensure adequate pollutant removal during the long-term combination of dynamic and quiescent hydrologic conditions. A comparison of recommended guidelines

for sizing wet basin permanent pool volumes from around the country follows. All sizes are for 80 percent solids removal with a runoff coefficient of 0.40 (ratio of runoff to rainfall for the mean annual rainfall event).

Jurisdiction	Permanent Pool Volume (Inches of Runoff)
Montgomery County, MD (Schueler, 1987)	0.5
Maryland Water Resources Administration (Schueler, 1987)	2.5 times runoff from mean annual rainfall (0.5" for for northeastern Illinois)
U.S. EPA (U.S. EPA, 1986)	0.4
NIPC Guidebook (45 percent connected impervious) (Schaefer, 1986)	0.4

D. Dry Basin Size

The key water quality consideration for dry basins is providing adequate settling time for routine events which deliver most of the long-term runoff volume and restricting the frequency and duration of pre-development bankfull flow conditions downstream. As discussed in Section VII, Release Rates, a peak release rate of 0.04 cfs per acre for the two-year event seems to be adequate to meet these criteria.

A number of sizing rules have been proposed for determining the volume of storage needed for dry basins to yield water quality benefits. The common approach is to provide detention of the runoff from a relatively frequent rainfall event (1- or 2-year storm) for a period of time sufficient to produce settling of pollutants. Some of the recommendations from other parts of the country follow.

Jurisdiction	Design Storm	Detention Time (Hrs)	Release Rate cfs/acre
Montgomery County, Md. (Schueler, 1987)	0.5 inches of runoff	40	0.013 average
Maryland Water Resources Administration (Schueler, 1987)	Runoff from 1-year, 24-hour (2.6 inches rainfall)	24	0.04 average
Florida	0.5 inches of runoff	24 minimum 72 maximum	0.02 minimum 0.007 maximum
New Jersey (NJDEP, 1986)	Runoff from 1-year event (1.25 inches of rainfall)	Residential 18 Commercial 36	0.02 0.02
NIPC	2-year, 24-hour	24 minimum	0.04 (peak)

The NIPC model ordinance recommends a maximum release rate of 0.04 cfs per acre for the runoff from events less than or equal to the 2-year, 24-hour event. This is equivalent to a detention time, for the 2-year, 24-hour event, greater than 24 hours for a watershed with a SCS curve number (CN) of 75, or greater than 48 hours for a watershed with a CN of 90.

For watersheds larger than 15 acres, this release rate typically can be accomplished directly through the use of an orifice which would not be smaller than 4 inches in diameter. The ordinance prohibits the use of a single orifice smaller than 4 inches. Figure XIII-1 shows several approaches to meeting the 0.04 cfs per acre release rate (Schueler, 1987). Regardless of the outlet control used, it is important that events smaller than the two-year, 24-hour event are detained for at least 24 hours.

E. Wet Basins Versus Dry Basins

Wet and dry detention facilities can function equally well for stormwater quantity control purposes. Each also presents unique opportunities for achieving other multiple use objectives. From a water quality perspective, however, dry basins are much more difficult to design to achieve stormwater quality improvement. The following factors inhibit dry basin water quality performance:

- Turbulent flow resulting in poor settling characteristics
- Dependence solely on dynamic removal
- Resuspension of previously settled pollutants by subsequent runoff
- Lack of biological pollutant removal

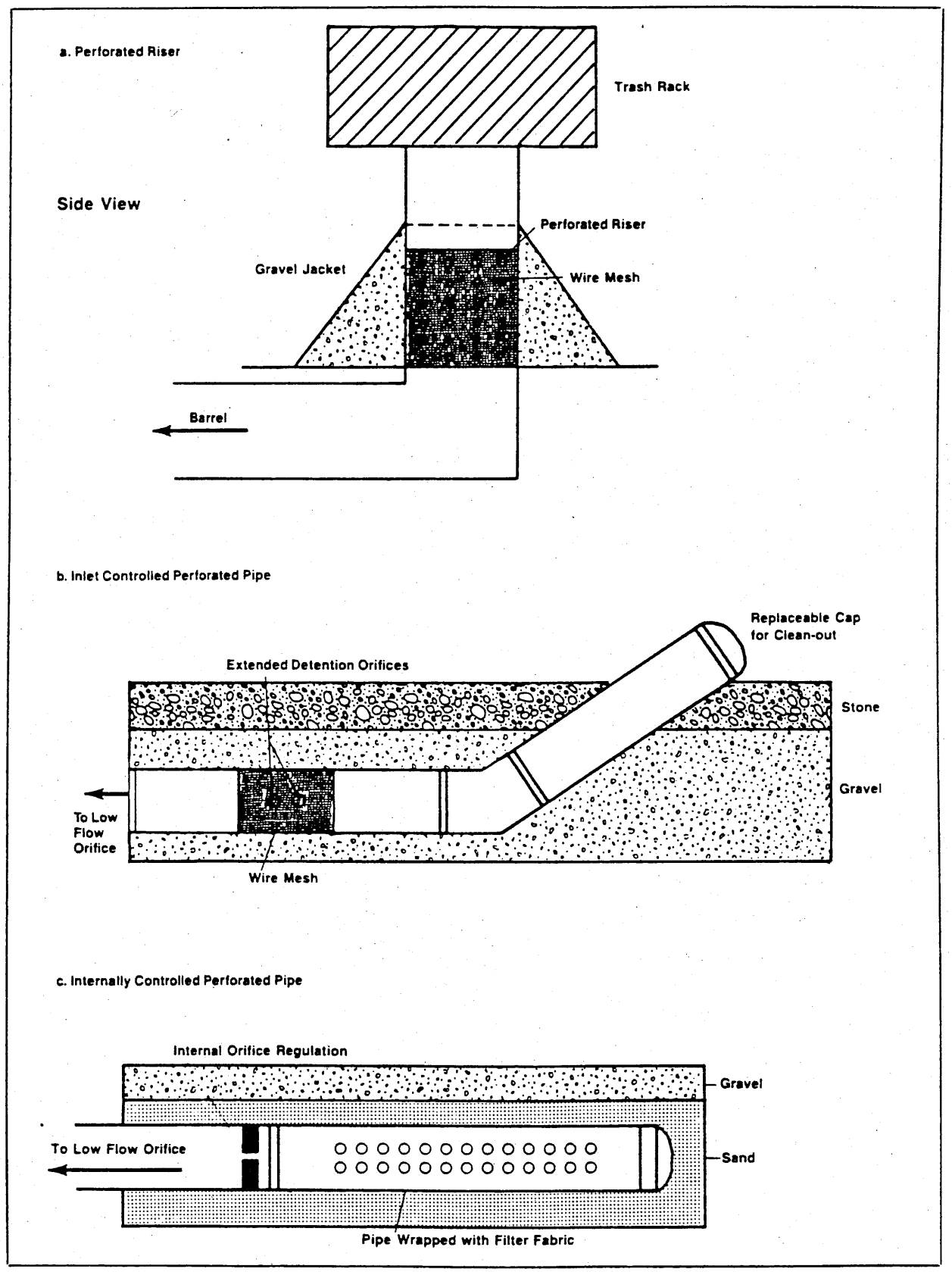
The permanent pool in wet detention facilities acts as a velocity dissipator on incoming runoff thus preserving a more quiescent state within the pond itself and promoting settling. Dry basins will experience more turbulent flow conditions and poorer settling over a longer period of the basin's outflow hydrograph than wet basins. The use of pre-sedimentation basins can help to overcome this problem, particularly if the basin is well vegetated.

The mechanics of flow through a wet basin are such that resident water actually is displaced by new incoming stormwater until the new stormwater "breaks through" to the outlet. There may be no breakthrough for many of the more frequent runoff events with only displaced pool water being discharged. This results in significant "extra" detention time between runoff events. Dry basins do not have this safety factor.

Once pollutants have settled to the bottom of a wet basin, they are essentially immobilized unless pool depths are so shallow as to allow resuspension by influent velocity or wave action. In dry basins, pollutants are exposed to resuspension by incoming flows, as well as to wind induced resuspension if the basin dries. Regular sediment removal from pre-sedimentation basins also may be required for dry basins.

Finally, the biological processes at work in a wet basin are not typically present in a dry basin. The intervals between events sufficient to displace pond water provides an opportunity for plants and bacteria to utilize nutrients and improve stormwater quality (U.S. EPA, 1983). No such opportunity exists except, possibly, at the soil-water interface at the bottom of a dry basin.

Figure XIII-1: METHODS FOR EXTENDING DETENTION TIMES IN DRY PONDS



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F. Other Water Quality Design Considerations

The key detention basin design considerations influencing pollutant removal are, of course, basin size and release rate. However, the following factors also can have a very important impact on stormwater residence time within a basin by preventing short circuiting. Short circuiting refers to flow patterns within a settling basin which result in the actual residence time of water being significantly less than the theoretical detention time obtained by comparing inflow to volume of storage and outflow. The most common factors affecting short circuiting in a detention basin are as follows:

- Inlet/Outlet Orientation
- Basin Length/Width Ratio
- Baffles/Velocity Dissipation

The following additional design considerations are more concerned with preventing the resuspension of settled sediment or the contribution of sediment to the basin from its shoreline.

- Basin Depth
- Shoreline Stabilization

Design considerations for dealing with each of these problems are presented below.

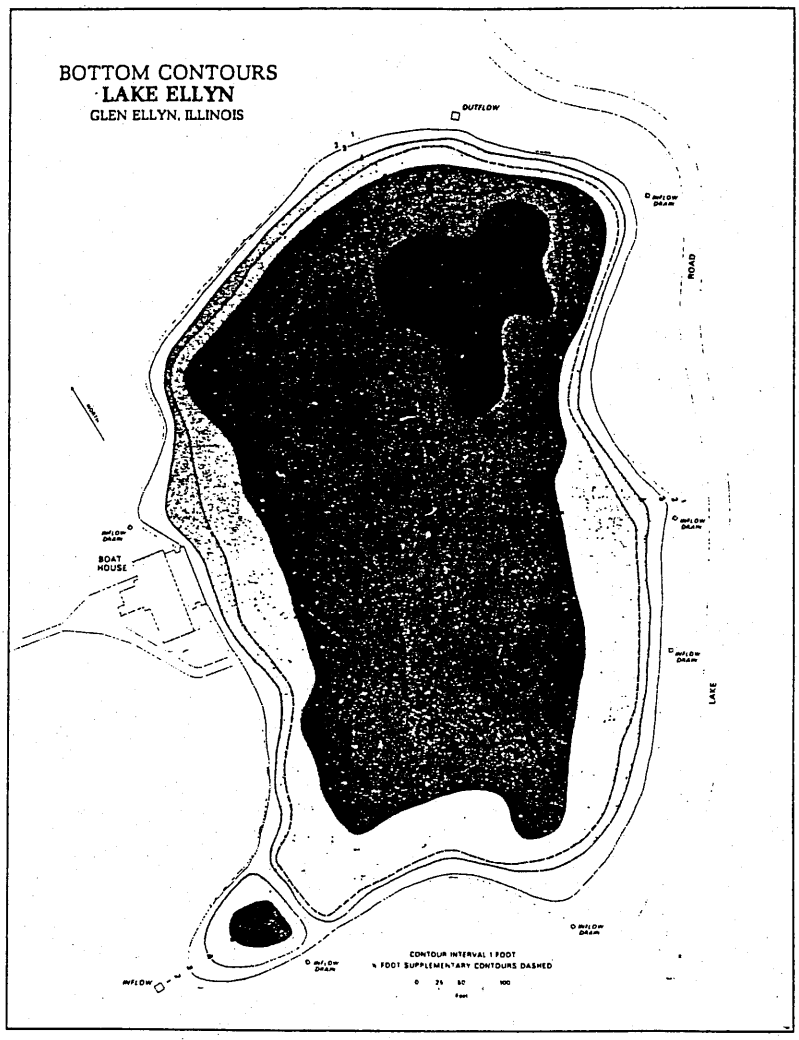
1. Inlet/Outlet Orientation - The spacing between inlets and outlets is one of the most critical factors in preventing short circuiting. Generally speaking, the outlet from a detention basin should be placed at the opposite end of the pond from the major inlets. Basin geometry can be important in achieving this goal. Long narrow ponds with inlet and outlet at opposite ends of the major axis of the basin will provide good settling characteristics. Basins which taper outward from inlet to outlet also can be very effective in slowing influent velocities by increasing cross-sectional flow area (APWA, 1981).

2. Length to Width Ratio - A length to width ratio of approximately 2:1 or 3:1 is recommended for detention facilities. The length to width ratio can be effectively lengthened by using baffles.

3. Velocity Dissipation - High influent velocities can be sufficient to cause short circuiting even in basins meeting the above criteria unless some measures are taken to dissipate them. Several means exist for slowing influent and effluent velocities. Among these are stilling basins, baffles, and energy dissipators.

Stilling basins, as illustrated in Figure XIII-2, can be very effective at reducing influent velocities and localizing sediment deposition for wet basins as well as dry basins. NIPC's Lake Ellyn study found that 20 percent of sediment delivered to a 10 acre urban lake was trapped in a 0.40 acre pre-sedimentation basin formed by erecting an underwater barrier dam across the inlet to which the main influent discharged, as shown in Figure XIII-2 (Hey and Schaefer, 1983). While sediment has accumulated to a depth of 3 feet in the sedimentation basin, main lake sediment depths have averaged much less than a foot with no areas exceeding two feet in depth over a 10 year period.

Figure XIII-2 VELOCITY DISSIPATION BY UNDERWATER BARRIER DAM



4. Other Considerations - Other design considerations to prevent short circuiting include avoidance of paved low flow channels, adequate basin depth, control of influent velocities and prevention of shoreline erosion.

Paved low channels may cause poor settling performance in dry basins since the low flow channel will probably always have storm velocities in excess of 2 feet per second and, therefore, little or no sediment deposition will take place. Low flow channels constructed with pervious materials can prevent erosion of basin bottoms where a constant inflow is anticipated.

Pond depth in wet basins also can be important in preventing wind, density and velocity currents and, consequently, short circuiting. Conventional design practice in water and wastewater sedimentation suggests deep basins when selecting a final basin configuration to provide a design volume. Surface area is minimized to avoid wind induced currents which can hinder settling of solids. Stormwater detention basins, however, are usually much wider than sedimentation tanks. Depths of 3.5 to 4 feet are usually sufficient to prevent sediment resuspension due to wind.

nfluent velocities also can cause sediment resuspension. Prevention of sediment scouring can complished by adjusting basin dimensions to increase cross-sectional area and reduce inflow ties. Stilling basins, baffles, and velocity dissipators also can be used to prevent sediment ng. Depths should be selected to maintain flow velocities less than 10 times the design settling ty of critical pollutants for routine event peak inflows (U.S. EPA, 1975).

line erosion due to local runoff and fluctuating water levels, as well as erosion around inlets and s, due to flow conditions can introduce significant quantities of sediment to detention basins and e water quality performance of otherwise well-designed facilities. A thorough vegetative cover outine sediment removal in dry basins can be vital to preventing resuspension of previously d material. Detention basin banks should be thoroughly mulched during construction. ation or other suitable bank stabilization should be established as rapidly as possible after uction to prevent erosion. One of the most important considerations from a safety, as well as n control standpoint, is shoreline slope (as well as basin bank slope in dry basins). Shoreline s should be very gradual, 5:1 or flatter. Bank slopes for dry basins should not exceed 3:1. At slopes establishment of a vegetative cover will be much easier and more likely to last.

ological Considerations

nal Urban Runoff Program (NURP) studies have indicated that detention basins with a permanent can provide nutrient transformation and/or reduction through biological processes (U.S. EPA, . As with physical design considerations, adequate detention time is a key requirement for ing good pollutant removal. Temperature, light (depth), and oxygen supply are also important, substrate conditions, if rooted aquatic plants are to be encouraged.

mount of shoreline present around a basin will directly impact both the amount and quality of gical activity in a basin. Inherent to an elongated basin configuration is an increase in the line length (as compared with more circular designs). An irregular shoreline, which may include and bays, increases the shoreline length even more, and provides greater aquatic habitat ity.

stablishment of shallow areas around the perimeter of the basin, or a littoral shelf, will allow ization by a more diverse benthic macroinvertebrate (aquatic insect) population. These isms, in turn, will help to support more desirable levels of higher aquatic animals, including fish. In addition, the shoreline areas can provide the spawning areas needed by fish popula- if so desired, as well as a safety buffer in the event that someone accidentally falls into the pond.

stablishment of these shallow areas allows penetration of sunlight to portions of the basin's n, thereby facilitating the growth of submergent and emergent aquatic plants. Limited growth of ergent plants offer several advantages. Suspended particles in the water are intercepted by the and leaves, and subsequently settle out more quickly. Plants growing along the bottom of the act to protect deposited sediment from water turbulence caused by inflowing water and surface s. In addition, stands of submergent plants can break wave momentum and reduce potential line erosion problems. Aquatic plants are also effective in removing certain nutrients and ants from the water column.

ation of aeration devices in retention basins, in an effort to increase dissolved oxygen concentra- in the water, may enhance aquatic habitat and reduce anaerobic reintroduction of pollutants he accumulated sediments. However, aeration systems typically generate some degree of water ence as compressed air bubbles rise through the water column. System selection and aerator ment within the basin should be done so as to minimize disruption of the settling stormwater

particulates. In shallow ponds less than 8 feet in depth, aeration systems may only be needed during winter months when oxygen replenishment from the atmosphere is eliminated.

Vegetation plantings along the shoreline, including grasses, bushes, and trees, can stabilize the water/land interface as well as provide shade and cooler water temperatures for aquatic organisms. Placement of trees along portions of the south and west shores will provide more effective lake shading. The use of vegetation species which produce profuse leaf growth, such as willows, is not always recommended since the falling leaves may become a significant nutrient input to the basin.

H. Summary

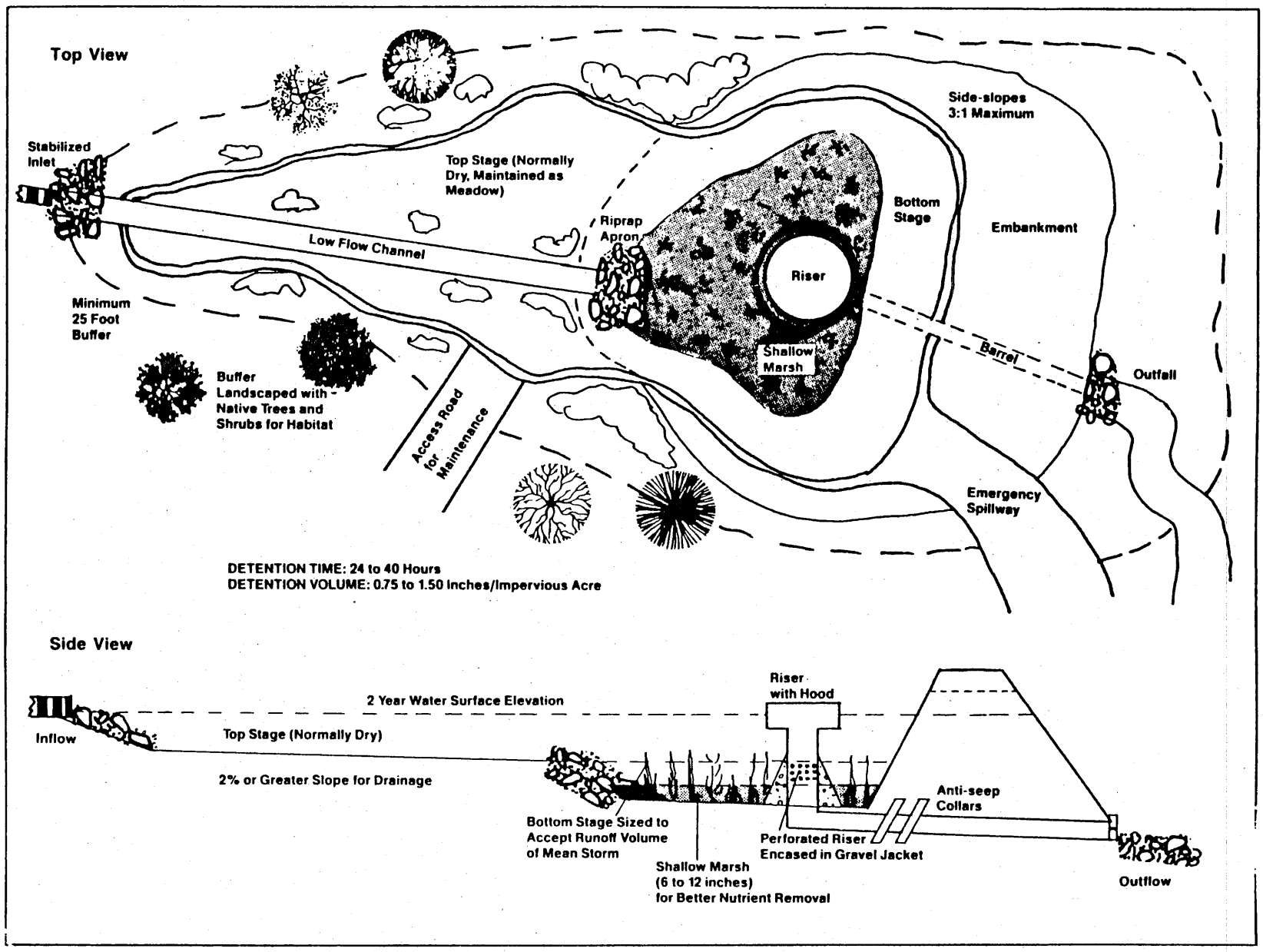
Table XIII-1 and Figures XIII-3 and XIII-4 present summaries of the preceding suggestions for obtaining water quality benefits from detention basins. Important design considerations from a water quality perspective are presented along with specific recommendations relative to each parameter.

In conclusion, detention basins can remove significant amounts of urban stormwater pollutants if design considerations which enhance settling are incorporated. These enhancements often can be made for little or no extra capital or maintenance costs. Basins sizes generally need not be increased beyond that necessary for flood control purposes.

Table XIII-1: DETENTION BASIN DESIGN RECOMMENDATIONS FOR WATER QUALITY BENEFITS

Design Consideration	Water Quality Enhancement Suggestion
1. Basin Size	Wet - Typically, about 0.5 inches of water volume per acre of watershed depending on land cover characteristics and design settling velocity. Storage needed for flood control is then added to this volume. Dry - Release of the runoff from events less than or equal to the two-year, 24-hour storm at a peak rate not to exceed 0.04 cfs per acre.
2. Inlet/Outlet Orientation	Opposite ends of the basin.
3. Basin Shape	Elliptical, rectangular, or triangular with inlet and outlet at opposite longitudinal ends.
4. Length to Width Ratio	2:1 to 3:1 or greater.
5. Velocity Dissipation	Baffles and pre-sedimentation basins located in flow path between inlet and outlet.
6. Outlets	Wet - Surface withdrawal controlled by a weir. Dry - Perforated riser, buried in gravel or underdrain system with no direct release.
7. Depth	Wet - Deep enough to prevent resuspension of settled sediment due to wind or velocity currents. Typically at least 4-5 feet depth.
8. Shorelines	Stabilized with vegetation or rip rap to prevent erosion. Safety ledge should be provided. Slope 5:1 or flatter.
9. Bank Slope	Wet - Safety ledge should be provided. Underwater slope may be important if fish life is desired. Dry - 3:1 or flatter for safety and to encourage establishment of vegetative cover.
10. Maintenance	Provision for maintenance equipment access. Provision of a pre-sedimentation basin to localize sediment deposition. Provision of an alternate bottom outlet in wet basins to allow the pond to be drained for maintenance.

Figure XIII-3 SCHEMATIC OF EXTENDED DETENTION POND DESIGN FEATURES



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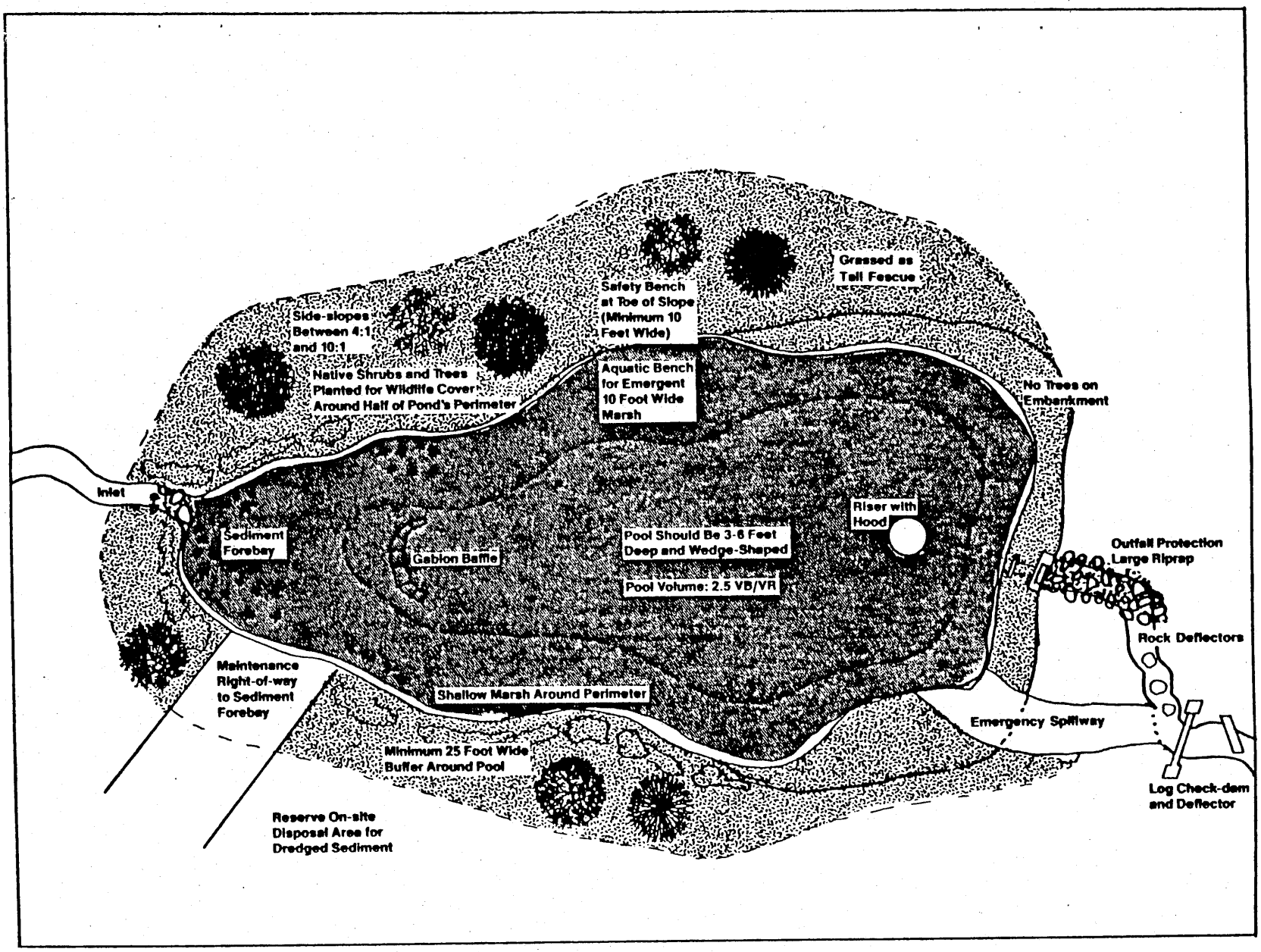

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XIV. SAFETY CONSIDERATIONS

One of the principal objectives of detention basin design should be to eliminate the need to fence the final facility. Fencing increases maintenance difficulty and limits any multiple use and aesthetic value the detention basin may have had. In effect it is frequently an admission that comprehensive design objectives could not be achieved. The key to not fencing detention facilities is the design of specific safety measures to make basins reasonably safe under the full range of stormwater conditions it is likely to encounter.

Specific recommendations have been suggested by a number of organizations. The MWRD has suggested that wet basins have a safety ledge 4 to 6 feet in width and 30 to 36 inches below the permanent pool level to provide footing in the event someone falls into the pond (MWRD, 1972). The MWRD also recommends a ledge 12 to 18 inches above the permanent pool elevation to prevent accidental falls into the basin. NIPC has also recommended safety ledges and flat shoreline (5 horizontal to 1 vertical) and underwater bank slopes (3 to 1)(Schaefer, 1986). The APWA and ASCE have stressed the need to design safe outlet structures (APWA, 1981; ASCE, 1985). They recommend a variety of sloping outlet trash racks which will not trap a person on them during high flows. They also recommend that coarse porous media be used as an alternative to trash racks. Finally, they suggest that hand holds be provided to allow people to pull themselves out of steep areas of the basin or areas where velocities may be high. MWRD has also recommended the installation of 20 foot wide safety ramps at slopes of 6 to 1 in detention basins to allow emergency exit from basins.

Finally, when embankments are used to create a detention facility the subject of dam safety must be addressed. The dam safety section of the Illinois Division of Water Resources should be consulted whenever this approach to creating detention is selected. Two principal areas of concern relating to embankment protection are overflow spillway design and outlet protection.

A. Overflow Spillways

The ASCE recommends that the overflow spillways for stormwater detention basins be designed to safely carry the probable maximum flood without exceeding a recommended freeboard of about three feet in the basin (ASCE, 1985). Such a conservative design will prevent overtopping of the banks of the detention and possible catastrophic bank failure but may not be practical or cost effective in most typical applications. The model ordinance recommends an overflow capacity equivalent to the 100-year peak inflow rate. For this more typical situation, ASCE recommends the following measures to mitigate the effects of bank overtopping.

- Flattening and/or armoring of the downstream embankment face.
- Armoring of the embankment crest.
- Use of a wide embankment crest to prevent excessive overtopping depths and velocities.
- Use of noneroding embankment material.
- Use of off-stream detention facilities.
- Use of a totally excavated pond.

B. Outlet Protection

The ASCE recommends the following measures to prevent embankment failure due to poor outlet design (ASCE, 1985).

- Provide cutoff collars on outlets to prevent piping of water along the outside of the outlet.
- Minimize the number of pipes through the embankment.
- Consider and account for the effect of debris collection on outlet openings.
- Provide a protective exterior encasement for thin-walled conduit through the embankment.
- Design the pipe to operate under little or no internal water pressure.
- Provide for debris collection to protect outlets works openings. Design the pond to minimize debris migration to the outlet.
- Do not depend upon human intervention to operate gates or other controls during a storm runoff event and avoid electrically operated gates. Gates can fail during an emergency. Operators can be late or unavailable due to other responsibilities. Power outages are common during rainfall events.

XV. MAINTENANCE

A principal maintenance activity about which a detention basin designer must be concerned is sediment removal. Design considerations which can facilitate sediment removal are

- Pre-Sedimentation Basins
- Alternate Bottom Outlet for Pond Drainage
- Access for Equipment

The use of pre-sedimentation basins to lower influent velocities and localize sediment deposition was discussed earlier. Cost savings may be realized by sediment removal from a smaller more accessible area although removal will have to occur more frequently than if the entire basin were utilized for settling.

Provision of an outlet at the bottom of a wet detention basin allows for complete drainage of the facility provided adequate bottom slope to the outlet location is provided. Maintenance can be eased by allowing the use of conventional earth moving equipment for sediment removal rather than dredges.

Neither of the first two design considerations will be of much value unless provision for access of maintenance equipment to the pond is provided.

Disposal of dredge spoil may be a concern. Studies indicate that typical urban runoff sediment will not qualify as a hazardous waste (Hey and Schaefer, 1983). However, it may be classified as a special waste and therefore require special handling and disposal under Illinois regulations (IPCB, 1979).

In addition to sediment removal concerns, maintenance of banks, shorelines, and the pool or basin itself are the other principal considerations of which a designer should be aware. Maintenance of the shoreline and banks of a detention facility can be minimized by use of appropriate bank stabilization and gradual slopes, minimizing water level fluctuations, and prompt establishment of a vegetative cover. Gradual bank slopes also facilitate the use of mowing equipment and the establishment of vegetation (DCRPC, 1983, ASCE, 1985).

Maintenance of wet basin pools may also involve mosquito, algae, and odor control. The usual solution for mosquito control is avoiding stagnant areas where mosquitos can successfully breed. Algae can be a problem in any wet detention pond, even those not designed for water quality benefits. Establishment of shoreline vegetation to filter runoff and remove nutrients and the use of biological control measures (sterile grass carp when available) are suggested control measures. Control of sources of nutrients in the upstream watershed also should be considered. Aquatic weed control can be accomplished by providing sufficient depths (i.e. > 3 feet) to prevent adequate light for weed growth, or by harvesting or chemicals. Odor control can be achieved by providing adequate water depth over settled pollutants and through aeration.

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MODEL STORMWATER DRAINAGE AND DETENTION ORDINANCE

ORDINANCE	COMMENTARY
100.0 Authority and Purpose This ordinance is enacted pursuant to the police powers granted to (County, City, Village) by the Illinois Revised Statutes (Chapter ___, Sections _____). The purpose of this ordinance is to diminish threats to public health, safety and welfare caused by runoff of excessive stormwater from new devel-opment and redevelopment. This excessive stormwater could result in the inundation of damageable properties, the erosion and destabilization of downstream channels, and the pollution of valuable stream and lake resources. The cause of increases in stormwater runoff quantity and rate and impairment of quality is the development and improvement of land and as such this ordinance regulates these activities to prevent adverse impacts. This ordinance is adopted to accomplish the following objectives: 100.1 To assure that new development does not increase the drainage or flood hazards to others, or create unstable conditions susceptible to erosion; 100.2 To protect new buildings and major improvements to buildings from flood damage due to increased stormwater runoff; 100.3 To protect human life and health from the hazards of increased flooding on a watershed basis; 100.4 To lessen the burden on the taxpayer for flood control projects, repairs to flood-damaged public facilities and utilities, correction of channel erosion problems, and flood rescue and relief operations caused by increased stormwater runoff quantities from new development; 100.5 To protect, conserve, and promote the orderly development of land and water resources; 100.6 To preserve the natural hydrologic and hydraulic functions of watercourses and floodplains and to protect water quality and aquatic habitats;	**100.0 Authority and Purpose** In order to stand the tests of legality and constitutionality, ordinances should clearly define the purposes for which they are enacted. The purposes described here cover the full range of beneficial water resources uses for which protection of public interests is sought by enactment of this ordinance. County authority to regulate drainage derives from Chapter 34 Sections 414 (subdivision control), 422 (building codes), and 3151 (zoning). Municipal authority derives from Chapter 24, Sections 11-12-5,6, and 12 (subdivision regulations), 11-13-1 (zoning), 11-14-1 (set-back lines), 11-30-2 and 8 (building codes), 11-105-1 (public lands), 11-109-1 (culverts, drains), 11-110-11 (drainage, flood control), and Chapter 85, Section 1711 (on-site detention). Additionally, the Water Quality Act of 1987 and proposed federal regulations 40CFR Parts 122, 123, 124, and 504 will require new construction discharging to the waters of the United States to provide on-site management of stormwater pollutants. Finally, P.A.s 85-905 and 1266 add comprehensive stormwater management authority to northeastern Illinois counties (excluding Cook) which choose to exercise them.

ORDINANCE	COMMENTARY
100.7 To preserve the natural characteristics of stream corridors in order to moderate flood and stormwater impacts, improve water quality, reduce soil erosion, protect aquatic and riparian habitat, provide recreational opportunities, provide aesthetic benefits and enhance community and economic development.	
200.0 Definitions	**200.0 Definitions**
200.1 Adverse Impacts: Any deleterious impact on water resources or wetlands affecting their beneficial uses including recreation, aesthetics,aquatic habitat, quality, and quantity.	Local governments may choose to shorten or expand this list of definitions dependent on information contained in other ordinances. It is important to note that a number of definitions are directly applicable to floodplain ordinances. They are included because of the interaction between stormwater drainage and flood control facilities.
200.2 Applicant: Any person, firm, or governmental agency who executes the necessary forms to procure official approval of a development or permit to carry out construction of a development from the (County, City, Village of _____).	
200.3 Base Flood Elevation: The elevation at all locations delineating the level of flooding resulting from the 100-year frequency flood event.	
200.4 Bypass Flows: Stormwater runoff from upstream properties tributary to a property's drainage system but not under its control.	
200.5 Channel: Any river, stream, creek, brook, branch, natural or artificial depression, ponded area, flowage, slough, ditch, conduit, culvert, gully, ravine, wash, or natural or manmade drainageway, which has a definite bed and bank or shoreline, in or into which surface or groundwater flows, either perennially or intermittently.	200.5 Channel: Channels include on-stream lakes and impoundments.
200.6 Channel Modification: Alteration of a channel by changing the physical dimensions or materials of its bed or banks. Channel modification includes damming, riprapping (or other armoring), widening, deepening, straightening, relocating, lining, and significant removal of bottom or woody rooted vegetation. Channel modification does not include the clearing of debris or removal of trash.	200.6 Channel Modification: NIPC policy expressly opposes unnecessary channel modifications because of the extreme damage they can cause to aquatic habitat and because of the uncertainty that modified systems can provide the same beneficial uses and functions as natural systems.
200.7 Compensatory Storage: An artificially excavated, hydraulicly equivalent volume of storage within the floodplain used to balance the loss of natural flood storage capacity when fill or structures are placed within the floodplain.	

200.8 Conduit: Any channel, pipe, sewer or culvert used for the conveyance or movement of water, whether open or closed.

200.9 Detention Basin: A facility constructed or modified to provide for the temporary storage of stormwater runoff and the controlled release by gravity of this runoff at a prescribed rate during and after a flood or storm.

200.10 Detention Time: The mean residence time of stormwater in a detention basin.

200.11 Development: Any man-made change to real estate, including:

a) Preparation of a plot of subdivision;

b) Construction, reconstruction or placement of a building or any addition to a building;

c) Installation of a manufactured home on a site, preparing a site for a manufactured home, or installing a travel trailer on a site for more than 180 days;

d) Construction of roads, bridges, or similar proj-ects;

e) Redevelopment of a site;

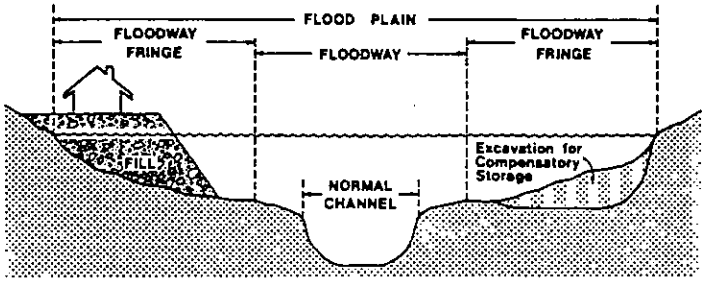
f) Filling, dredging, grading, clearing, excavating, paving, or other non-agricultural alterations of the ground surface;

g) Storage of materials or deposit of solid or liquid waste;

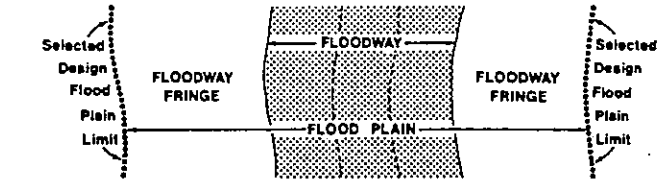
h) Any other activity that might alter the magnitude, frequency, deviation, direction, or velocity of stormwater flows from a property.

200.12 Drainage Plan: A plan, including engineering drawings and supporting calculations, which describes the existing stormwater drainage system and environmental features, as well as the drainage system and en-vironmental features which are proposed after development of a property.

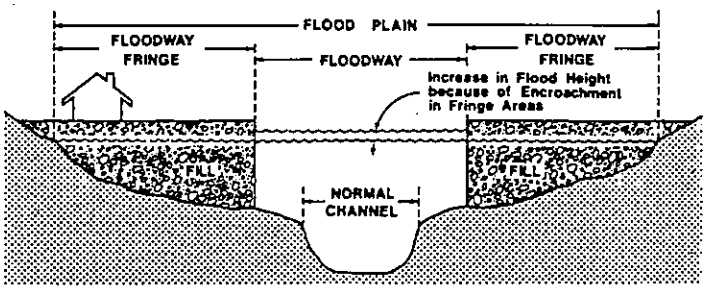
ORDINANCE	COMMENTARY
200.13 Dry Basin: A detention basin designed to drain com-pletely after temporary storage of stormwater flows and to normally be dry over the majority of its bottom area.	
200.14 Erosion: The general process whereby earth is removed by flowing water or wave action.	200.14 Erosion: For the purposes of this ordinance, only erosion by water is considered.
200.15 Excess Stormwater Run-off: The volume and rate of flow of stormwater discharged from an urbanized drainage area which is or will be in excess of that volume and rate which pertained before urbanization.	
200.16 Floodplain: That land adjacent to a body of water with ground surface elevations at or below the base flood or the 100-year frequency flood elevation. The floodplain is also known as the Special Flood Hazard Area (SFHA).	200.16 Floodplain:
200.17 Flood Fringe: That portion of the flood-plain outside of the regulatory floodway.	
200.18 Floodway: The channel and that portion of the flood-plain adjacent to a stream or water-course which is needed to store and convey the anticipated existing and future 100-year frequency flood discharge with no more than a 0.1 foot increase in stage due to any loss of flood convey-ance or storage and no more than a ten percent increase in velocities.	
200.19 Hydrograph: A graph showing for a given location on a stream or conduit, the flow-rate with respect to time.	
200.20 Infiltration: The passage or movement of water into the soil surfaces.	
200.21 Major Drainage System: That portion of a drainage system needed to store and convey flows beyond the capacity of the minor drainage system.	
200.22 Minor Drainage System: That portion of a drainage system designed for the convenience of the public. It consists of street gutters, storm sewers, small open channels, and swales and, where manmade, is usually designed to handle the 10-year runoff event or less.	
200.23 Mitigation: Mitigation includes those measures necessary to minimize the negative effects which stormwater drainage and develop-	



Cross Sectional View of Flood Plain with Compensatory Storage required in Floodway Fringes



Plan View of Flood Plain



Cross Sectional View of Flood Plain no Compensatory Storage required in Floodway Fringes

ment activities might have on the public health, safety and welfare. Examples of mitigation include compensatory storage, soil erosion and sedimentation con-trol, and channel restoration.

200.24 Natural: Conditions resulting from physical, chemical, and biological processes without intervention by man.

200.24 Natural: There are few truly natural stream reaches in northeastern Illinois or the entire state for that matter. Channel modification, treatment plant discharges, and urban runoff all have reduced the naturalness of Illinois streams. NIPC has placed high priority on the protection of natural values that remain on northeastern Illinois streams because of the beneficial uses they provide, including recreation, aquatic habitat, flood control and groundwater recharge.

200.25 One Hundred-Year Event: A rainfall, runoff, or flood event having a one percent chance of occurring in any given year.

200.25 One-hundred Year Event: It is important to note that the term "one-hundred year event" does not mean that only one such event will occur every one hundred years. The more correct way of thinking about such an event is that it will have a one percent chance of occurring in any given year. For example there is an 18 percent chance that two 100-year events will occur within any given 100 year period.

Another important point is that the magnitude of such an event is a statistical estimate whose reliability depends on the size of the sample which is available for analysis and the variability of the data in that sample. In short, factors of safety are strongly encouraged when utilizing these estimates in drainage system design.

Finally, it is important to reiterate that the 100-year rainfall event does not equate to the 100-year runoff event. Antecedent soil moisture, temperature, and streamflow conditions can combine to turn the 25-year rainfall event into the 100-year flood event as in the 1986 flooding in northeastern Illinois.

200.26 Positive Drainage: Provision for overland paths for all areas of a property including depressional areas that may also be drained by storm sewer.

200.27 Peak Flow: The maximum rate of flow of water at a given point in a channel or conduit.

200.28 Property: A parcel of real estate.

ORDINANCE	COMMENTARY
200.29 Regulatory Floodway: The channel, including on-stream lakes, and that portion of the flood plain adjacent to a stream or watercourse as designated by the DWR, which is needed to store and convey the existing and anticipated future 100-year frequency flood dis-charge with no more than a 0.1 foot increase in stage due to the loss of flood conveyance or storage, and no more than a 10% increase in velocities. The regulatory floodways are designated for _____ (stream) on the Flood Boundary and Floodway Map prepared by FEMA (or Department of Housing and Urban Development) and dated _____ and for _____ (stream) on the Regulatory Flood Plain Map prepared by the DWR and dated _____. The regulatory floodways or those parts of unincorporated County that are within the extraterritorial jurisdiction of the (City, Village) that may be annexed into the (City, Village) are designated for _____(stream) on the Flood Boundary and floodway map prepared by the FEMA (or Department of Housing and Urban Development) and dated ____. To locate the regulatory floodway boundary on any site, the regulatory floodway boundary should be scaled off the regulatory floodway map and located on a site plan, using reference marks common to both maps. Where interpretation is needed to determine the exact location of the regulatory floodway boundary, the Division should be contacted for the interpretation.	200.29 Regulatory Floodway: This definition is only applicable to Cook, DuPage, Kane, Lake, McHenry, and Will counties and is the result of Public Act 85-905.
200.30 Retention Basin: A facility designed to completely retain a specified amount of stormwater runoff without release except by means of evaporation, infiltration, emergency bypass or pumping.	
200.31 Sedimentation: The process that deposits soils, debris, and other materials either on other ground surfaces or in bodies of water or stormwater drainage systems.	
200.32 Stormwater Drainage System: All means, natural or man-made, used for conducting stormwater to, through or from a drainage area to the point of final outlet from a property. The stormwater drainage system includes but is not limited to any of the following: conduits and	

ORDINANCE	COMMENTARY
appurtenance features, canals, channels, ditches, streams, culverts, streets, storm sewers, detention basins, swales and pumping stations.	
200.33 Stormwater Runoff: The waters derived from melting snow or rain falling within a tributary drainage basin which are in excess of the infiltration capacity of the soils of that basin, which flow over the surface of the ground or are collected in channels or conduits.	200.33 Stormwater Runoff: The volume and rate of stormwater runoff produced by any rainfall event is a variable dependent on land cover capability to intercept and infiltrate the precipitation. As a result the probability of stormwater runoff volumes and rates are not the same as the probability of rainfall but rather are a function of the probability of antecedent soil moisture conditions and rainfall, as well as temperature (frozen ground) and land cover conditions.
200.34 Storm Sewer: A closed conduit for conveying collected stormwater.	
200.35 Time of Concentration: The elapsed time for stormwater to flow from the most hydraulicly remote point in a drainage basin to a particular point of interest in that watershed.	
200.36 Tributary Watershed: all of the land surface area that contributes runoff to a given point.	
200.37 Two-year Event: A runoff, rainfall, or flood event having a fifty percent chance of occurring in any given year.	
200.38 Wet Basin: A detention basin designed to maintain a permanent pool of water after the temporary storage of stormwater runoff.	
300.0 <u>Applicability</u>	**300.0** <u>Applicability</u>
This ordinance shall apply to all development in the (County, City, Village) of _____.	It is important that all properties within the local government's jurisdiction be treated equitably which suggests the need for uniform applicability of regulations. However, special considerations may be necessary for smaller development sites where very small detention basins would result from the requirements of this ordinance. The necessarily small outlets of these basins could

result in a greater likelihood of operational and maintenance problems.

Communities are encouraged to establish a master drainage plan which provides for regional detention sites and facilities at strategic points in the community's watersheds so that properties not providing on-site detention are still controlled at regional sites. This would require the establishment of a fee-in-lieu of detention system for properties not building on-site detention and a means for collecting and spending these fees, purchasing land for regional basins, constructing regional detention basins and participating in upsizing detention basins to regionalize their function ("opportunity regionalization," see Section 800).

Communities should remain cognizant of their legal responsibilities to ensure that new development will not damage downstream properties. It is likely that even a one-acre commercial site will cause downstream drainage problems if not adequately mitigated. The ordinance therefore recommends that a community review small site exceptions on a case by case basis.

400.0 Drainage Plan Submittal Requirements

Each applicant shall submit the following information, depending on development size, to ensure that the provisions of this ordinance are met. The submittal shall include sufficient information to evaluate the environmental characteristics of the property, the potential adverse impacts of the development on water resources both on-site and downstream, and the effectiveness of the proposed drainage plan in managing stormwater runoff. The applicant shall certify on the drawings that all clearing, grading, drainage, and construction shall be accomplished in strict conformance with the drainage plan. The following information shall be submitted for both existing and proposed property conditions.

Properties smaller than 10 acres shall submit only the Basic Drainage Plan called for in Section 401.0. Properties larger than 10 acres shall comply with the submittal requirements of both the

400.0 Drainage Plan Submittal Requirements

The drainage plan is the essence of the application for a permit to construct. The intent is for the drainage plan to depict existing drainage and environmental (wetlands, watercourses, floodplains, floodways) features on the property and then to define how the applicant intends to modify and/or utilize those features to accommodate the drainage needs for the development. Requirements are divided between small developments whose individual impacts are not likely to be major and larger properties where more detailed analysis of onsite and offsite impacts is warranted.

Properties smaller than one acre should be evaluated for drainage plan submittal re-

Basic Drainage Plan and the Advanced Drainage Plan of Section 402.0.

quirements by the zoning administrator. If it is determined that the impact of the proposed development is insignificant, detailed submittals may be waived.

401.0 Basic Drainage Plan

401.1 Topographic Map: A topographic survey of the property at one-foot contours under existing and proposed conditions, and areas upstream and downstream, necessary to determine off-site impacts of the proposed drainage plan. The map shall be keyed to a consistent datum specified by the (County, City, Village).

401.1 Topographic Map: Local governments should substitute whatever contour interval they would normally require in reviewing plats. However, intervals greater than two feet may lead to the inability to accurately judge drainage plan effectiveness particularly for smaller sites.

401.2 Drainage System: Mapping and descriptions, where relevant, of existing and proposed drainage system features of the property and immediate vicinity including:

a) the banks and centerline of streams and channels;
b) shoreline of lakes, ponds, and detention basins;
c) farm drains and tiles;
d) sub-watershed boundaries within the property;
e) watershed soils classifications;
f) the property's location within the larger watershed;
g) location, size and slope of stormwater conduits and drainage swales;
h) sanitary or combined sewers;
i) depressional storage areas;
j) delineation of upstream and downstream drainage features and watersheds which might be affected by the development;
k) detention facilities;
l) roads and streets and associated stormwater inlets;
m) base flood elevation, and regulatory floodway where identified for the property; and
n) basis of design for the final drainage network components.

401.3 Environmental Features: A depiction of environmental features of the property and immediate vicinity including the following:

401.3 Environmental Features: Consistent with the comprehensive stormwater management intent of this ordinance, a full depiction of existing and proposed environmental features is required as

ORDINANCE	COMMENTARY
a) the limits of wetland areas; b) any designated natural areas; and c) any proposed environmental mitigation features.	part of the drainage plan. Proposed measures to mitigate impacts of development on these features is also required.
402.0 Advanced Drainage Plan	402.0 Advanced Drainage Plan
The same information as required in Section 401.0 is required for properties larger than 10 acres along with the following additional information for the minor drainage system's design runoff event and the 100-year runoff event of critical duration: a) elevations and maps of 100-year flooding; b) cross-section data for open channel flow paths and designated overland flow paths; c) direction of stormflows; d) flow rates and velocities at representative points in the drainage system; and e) a statement by the design engineer of the drainage system's provisions for handling events greater than the 100-year's runoff.	The intent of this section of the drainage plan is to demonstrate that the applicant's design takes into account the extent of flooding on the property for a full range of conditions, that velocities within the drainage system will not be dangerous or erosive, and that flow patterns to any detention facility are identified. The referenced critical duration is the duration of the design event which results in the greatest peak flows at a given point in the drainage system. Local governments should substitute the design event they require for the minor drainage system (storm sewers, etc.) into the ordinance language.
500.0 <u>Minimization of Increases in Runoff Volumes and Rates</u>	500.0 <u>Minimization of Increases in Runoff Volumes and Rates</u>
In the selection of a drainage plan for a development, the applicant shall evaluate and implement, where practicable, site design features which minimize the increase in runoff volumes and rates from the site. The applicant's drainage plan submittal shall include evaluations of site design features which are consisted with the following hierarchy: 1) Minimize impervious surfaces on the property, consistent with the needs of the project; 2) Attenuate flows by use of open vegetated swales and natural depressions and preserve existing natural stream channels; 3) Infiltrate runoff on-site; 4) Provide stormwater retention structures; 5) Provide stormwater detention structures; and 6) Construct storm sewers.	Local governments should carefully evaluate the hierarchy recommended in the model ordinance for applicability to their situations. Some communities may find volume control and swale drainage difficult to implement due to topographical, soil, and building density constraints. However, many communities, particularly those experiencing development in previously rural watersheds, may be able to apply this hierarchy to achieve better control of both stormwater quantity and quality. Land de-velopers may also benefit from the lower costs of drainage systems which rely less on storm sewers and large detention basins. It is important to recognize that certain infiltration practices such as dry wells will require a Class V injection well permit from IEPA. The Illinois Groundwater Protection Act also has resulted in the establishment of setback zones around community wells which need to be observed when siting certain infiltration practices which could be considered potential pollution sources.

ORDINANCE	COMMENTARY
600.0 Water Quality and Multiple Uses	**600.0 Water Quality and Multiple Uses**
The drainage system should be designed to minimize adverse water quality impacts downstream and on the property itself. Detention basins shall incorporate design features to capture stormwater runoff pollutants. Retention and infiltration of stormwater shall be promoted throughout the property's drainage system to reduce the volume of stormwater runoff and to reduce the quantity of runoff pollutants.	Local governments should add language to this section to note that federal National Pollutant Discharge Elimination System (NPDES) permit requirements may apply to construction activities on the property. Final regulations are expected to be available in mid-1990 and would mandate implementation of stormwater quality management practices for land development activities.
The drainage system should incorporate multiple uses where practicable. Uses considered compatible with stormwater management include open space, aesthetics, aquatic habitat, recreation (boating, trails, playing fields), wetlands and water quality mitigation. The applicant should avoid using portions of the property exclusively for stormwater management.	Good drainage system design strives to develop a drainage plan which accomplishes the multiple objectives of recreation, open space, aesthetics, and water quality while safely conveying and storing stormwater from a property.
700.0 Design Criteria, Standards, and Methods	**700.0 Design Criteria, Standards, and Methods**
	Local governments may wish to modify or add language to this section depending on their local conditions or needs. For example, if local governments wish to adopt a design recurrence other than the 10-year event for storm sewer design, it should be substituted wherever the 10-year event requirement appears.
701.0 Release Rates - The drainage system for a property shall be designed to control the peak rate of discharge from the property for the two-year, 24-hour and 100-year, 24-hour events to levels which will not cause an increase in flooding or channel instability downstream when considered in aggregate with other developed properties and downstream drainage capacities. The peak discharge from events less than or equal to the two-year event shall not be greater than 0.04 cfs per acre of property drained. The peak 100-year discharge shall not be greater than 0.15 cfs per acre of property drained.	701.0 Release Rates - In the absence of a detailed watershed-specific planning study, it is felt that these release rates, in combination with the ordinance storage requirements, will be effective in 1) limiting 100-year flooding to existing conditions and 2) controlling flooding to existing conditions for events less than the 100-year event. The recommended release rates are based in part on the results of a study of detention effectiveness in a 30-square mile watershed. The study results indicate that the recommended release rates likely will be effective for larger watersheds, but larger watersheds have not been explicitly evaluated. The recommended 100-year release rate of 0.15 cfs/acre is the same as that recommended in

ORDINANCE	COMMENTARY
	NIPC's previous detention ordinance (dated March 1980) which was based on observed maximum recorded streamflows in northeastern Illinois.
	The two-year release rate criteria is intended to control the magnitude, frequency, and duration of bankfull streamflows downstream of the property. Urbanization without detention control of the two-year event results in dramatic increases (200 percent) in the magnitude of the 2-year event and frequency of bankfull conditions resulting in stream destabilization. This leads to streambed and bank erosion and damages, both economic and environmental.
	The two-year, 24-hour event release rate requirement also will provide additional settling time to remove suspended stormwater pollutants. About 80 percent of the long term runoff volume from a watershed results from events less than or equal to this two-year event. Small events (0.1 to 0.2 inches of runoff) will likely be detained for at least 5 to 10 hours and larger runoffs (1 inch or more) will receive detention times exceeding 24 hours.
	Control of the two-year release rate to 0.04 cfs/acre likely will result in longer detention times than most existing ordinances. As a result, special design features should be considered to avoid maintenance and operational problems.
701.1 Detention Basin Outlet Design: Backwater on the outlet structure from the downstream drainage system shall be evaluated when designing the outlet.	701.1 Detention Basin Outlet Design: If downstream conditions are not considered when determining the capacity of the outlet structure, the detention basin may fill quicker and release a higher peak discharge through the overflow structure than required by the ordinance.
702.0 Detention Storage Requirements - The design maximum storage to be provided in a detention basin shall be based on the runoff from the 100-year, 24-hour event and reservoir (also called modified puls or level pool) routing or equal. Detention storage shall be computed using hydrograph methods as described in this section.	702.0 Detention Storage Requirements - The requirements of this ordinance will result in substantially larger storage volumes than typically required by most existing ordinances. NIPC's study of detention effectiveness indicated that detention basins designed using traditional assumptions of rainfall (i.e. T.P.40) and the simple runoff relationships of the modified rational formula will have too little storage and will likely overflow for events much smaller than the 100-year event.

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	If use of the modified rational formula is to be allowed (which is greatly discouraged), the 100-year event of critical duration should be specified. When the modified rational formula is used, durations of less than 24 hours are often critical.
703.0 Drainage System Design and Evaluation - The following criteria should be used in evaluating and designing the drainage system. The underlying objective is to provide capacity to pass the 10-year peak flow in the minor drainage system and an overload flow path for flows in excess of the design capacity.	703.0 Drainage System Design and Evaluation - The local government should substitute the design event they require for minor drainage systems (storm sewers, swales, etc.).
703.1 Design Methodologies: Major and minor conveyance systems for areas up to 10 acres may be designed using the rational formula. The rational formula may also be used in sizing the minor drainage system for larger sites. Runoff hydrograph methods as described in Section 704.0 must be used for major drainage system design for all systems with greater than 10 acres of drainage area and for the design of all detention basins.	703.1 Design Methodologies: The rational formula is an adequate design tool for small conveyance systems but is not appropriate for larger sites or for the design of detention basins. More sophisticated hydrograph methods are widely available and are relatively easy to apply using personal computers.
703.2 Positive Drainage: Whenever practicable, all areas of the property must be provided an overland flow path that will pass the 100-year flow at a stage at least 1 foot below the lowest foundation grade in the vicinity of the flow path. Overland flow paths designed to handle flows in excess of the minor drainage system capacity shall be provided drainage easements. Street ponding and flow depths shall not exceed curb heights by more than one inch.	703.2 Positive drainage is provided to prevent flooding when the design capacity of the minor conveyance system is exceeded. Positive drainage also makes accurate calculation of peak flows for conveyance system sizing less critical.
704.0 Methods for Generating Runoff Hydrographs - Runoff hydrographs shall be developed incorporating the following assumptions of rainfall amounts and antecedent moisture.	704.0 Methods for Generating Runoff Hydrographs - The following hydrologic design procedures are considered acceptable for generation of hydrographs: Corps of Engineers HEC-1, Soil Conservation Service TR-20 (and TR-55, subject to rainfall distribution modifications), Illinois State Water Survey ILLUDAS, U.S. EPA's SWMM, and continuous simulation (e.g., HSPF). A community may wish to select one of these models as the preferred approach to provide con-

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	sistency in plan submittals and to ease the burden of permit review.
704.1 Rainfall: Unless a continuous simulation approach to drainage system hydrology is used, all design rainfall events shall be based on the Illinois State Water Survey's Bulletin 70. The first quartile point rainfall distribution shall be used for the design and analysis of conveyance systems with critical durations less than or equal to 12 hours. The third quartile point rainfall distribution shall be used for the design and analysis of detention basins and conveyance system with critical durations greater than 12 and less than or equal to 24 hours. The fourth quartile distribution shall be used in the design and analysis of systems with durations greater than 24 hours. The first, third, and fourth quartile distributions described by Huff are presented in Table 37 of Bulletin 70. The SCS Type II distribution may be used as an alternate to the Huff distributions.	704.1 Rainfall: Recent research by the Illinois State Water Survey on rainfall statistics for northeastern Illinois has led to the publication of Bulletin 70. This is the most accurate and up-to-date information available and should be the design standard. NIPC's study of detention effectiveness has indicated that detention designs relying on 100-year rainfall amounts from the U.S. Weather Bureau's Technical Paper No. 40 will overflow for runoff events substantially smaller than the 100-year event. Bulletin 70 reports a 100-year, 24-hour rainfall amount of 7.6 inches as the regional average for northeastern Illinois, but also indicates greater and lesser amounts on regional isohyetal maps. It is recommended that the ordinance specify design rainfall amounts which are the larger of the Bulletin 70 regional average and the local isohyetal amount to provide a conservative design. The Huff rainfall distribution is particularly applicable to northeastern Illinois storms but is also an integral part of ILLUDAS. It is important to note that TR-55 assumes SCS Type II rainfall distribution.
704.2 Antecedent Moisture: Computations of runoff hydrographs which do not rely on a continuous accounting of antecedent moisture conditions shall assume a conservative wet antecedent moisture condition as a minimum.	704.2 Antecedent Moisture: It is important that local governments stipulate what design assumptions they will allow concerning antecedent moisture conditions and the ability of pervious areas to abstract rainfall. The ordinance should specify minimum antecedent moisture conditions for approved models. (Eg., SCS TR-20 and TR-55 - antecedent moisture condition two; ILLUDAS - ILLUDAS number 3, "rather wet").
705.0 Wet Detention Basin Design - Wet detention basins shall be designed to remove stormwater pollutants, to be safe, to be aesthetically pleasing, and as much as feasible to be available for recreational use.	
705.1 Wet Basin Depths: Wet basins shall be at least three feet deep, excluding nearshore banks	705.1 Wet Detention Basin Depths: Wet basins need to be deep enough to discourage aquatic

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ıdations were developed
ıt of Conservation.

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fluctuating water levels.
ımended that aquatic
d around the perimeter
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enhance aesthetics by
atable debris.

olume: The pool volume
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ormwater pollutants.

Orientation: Maximizing
s and outlets will prevent
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luctive to the removal of
Short-circuiting can also
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706.1 Dry Basin Drainage: Dry basins shall be designed so that eighty percent of their bottom area shall have standing water no longer than seventy-two hours for any runoff event less than the 100-year event. Underdrains directed to the outlet control shall be used if necessary to accomplish this requirement.	706.1 Dry Basin Drainage: It is very important that dry basins not have standing water unintentionally as a result of poor drainage because of aesthetic and maintenance considerations. The maximum inundation time of 72 hours was chosen to ensure the viability of grass based on recommendations received from NIPC's Stormwater Management Technical Advisory Committee. Two-level designs for dry basins should be considered. The lower wetter portion may be managed as a wetland and should be maintained over time to remove accumulated sediment.
706.2 Velocity Dissipation: Velocity dissipation measures shall be incorporated into dry basin designs to minimize erosion at inlets and outlets and to minimize the resuspension of pollutants.	
706.3 Inlet and Outlet Orientation: To the extent feasible, the distance between detention inlets and outlets shall be maximized. If possible, they should be at opposite ends of the basin.	706.3 Inlet and Outlet Orientation: Maximizing the distance between inlets and outlets will prevent the short-circuiting of flows through a basin. short-circuiting is counter productive to the removal of stormwater pollutants. Short-circuiting can also be avoided by the use of baffles or berms in the basin bottom.
707.0 Minimum Detention Outlet Size - Where a single pipe outlet or orifice plate is to be used to control discharge, it shall have a minimum diameter of 4 inches. If this minimum orifice size permits release rates greater than those specified in this section, and regional detention is not a practical alternative, alternative outlet designs shall be utilized which incorporate self cleaning flow restrictors.	707.0 Minimum Detention Outlet Size - Use of single orifices smaller than 4 inches may result in operating difficulties due to obstructions. If design release rates call for outlets smaller than this, self cleaning flow restrictors such as perforated risers should be utilized. This situation likely will occur for small sites, particularly those less than 5 acres in drainage area.

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708.0 Detention in Floodplains -The placement of detention basins within the floodplain is strongly discouraged because of questions about their reliable operation during flood events. However, the stormwater detention requirements of this ordinance may be fulfilled by providing detention storage within flood fringe areas on the project site provided the following provisions are met.	708.0 Detention in Floodplains -Detention in floodplains requires additional design criteria if the environmental and flood storage and conveyance functions of the floodplain are to be preserved.
708.1 Detention in Flood Fringe Areas: The placement of a detention basin in a flood fringe area shall require compensatory storage for 1.5 times the volume below the base flood elevation occupied by the detention basin including any berms. The release from the detention storage provided shall still be controlled consistent with the requirements of this section. The applicant shall demonstrate its operation for all streamflow and floodplain backwater conditions. Excavations for compensatory storage along watercourses shall be opposite or adjacent to the area occupied by detention. All floodplain storage lost below the ten-year flood elevation shall be replaced below the ten-year flood elevation. All floodplain storage lost above the existing ten-year flood elevation shall be replaced above the proposed ten-year flood elevation. All compensatory storage excavations shall be constructed to drain freely and openly to the watercourse.	708.1 Detention in Flood Fringe Areas: Detention in flood fringe areas can present great design difficulties in preventing streamflows from backing up into the basin and in being able to discharge a property's runoff during flood stages on the stream. Allowing detention in the flood fringe requires careful review of final design and a community may find it better to not allow it at all. It is important to note that merely adding additional flood fringe storage equivalent to the stormwater detention volume needed for the property is not acceptable unless the rate at which it enters the flood fringe is also controlled consistent with this section.
708.2 Detention in Floodways: Detention basins shall be placed in the floodway only in accordance with 708.3.	708.2 Detention in Floodways: Detention basins are not an appropriate use for floodway construction as defined by 92 Illinois Administrative Code, Part 708. NIPC policy also recommends against location of detention facilities in the floodway because of serious questions about their ability to meet this ordinance's requirements over the full range of flood stages which will occur in such a location. For example if the outlet of a basin is submerged during a flood event, release from the basin will be controlled by the backwater condition. If the flood stage is high enough no discharge may occur from the basin until overflow from the basin spillway occurs, at a rate considerably higher than that specified by this ordinance. NIPC also has serious concerns about the impact of placing basins in the floodway in light of the fact that current floodway boundaries are likely under-

estimated by steady state modeling techniques which may not adequately consider the effects of lost storage. Placement of any structure in the floodway, even if existing cross-sectional area and storage are maintained, may cause unexpected problems.

Finally, it is very difficult to successfully prevent short term environmental impacts associated with any construction in the floodway. For this reason NIPC recommends against any avoidable construction in floodway areas.

708.3 On-stream Detention: On-stream detention basins are discouraged but allowable if they provide regional public benefits and if they meet the other provisions of this ordinance with respect to water quality and control of the two-year and 100-year, 24-hour events from the property. Further criteria are presented in Section 800.0 of this ordinance. If on-stream detention is used for watersheds larger than one square mile, it is recommended that the applicant use dynamic modeling to demonstrate that the design will not increase stage for any properties upstream or downstream of the property. Also, impoundment of the stream as part of on-stream detention:

a. shall not prevent the migration of indigenous fish species, which require access to upstream areas as part of their life cycle, such as for spawning,

b. shall not cause or contribute to the degradation of water quality or stream aquatic habitat,

c. shall include a design calling for gradual bank slopes, appropriate bank stabilization measures, and a pre-sedimentation basin,

d. shall not involve any stream channelization or the filling of wetlands,

e. shall require the implementation of an effective nonpoint source management program throughout the upstream watershed,

f. shall not occur downstream of a wastewater discharge, and

708.3 On-stream Detention: NIPC policy discourages the modification of streams to construct on-stream detention basins unless they are designed to provide regional public benefits and their adverse environmental impacts are mitigated. On-stream detention basins may have a very difficult time meeting the release rate requirements of this section unless they are in the headwaters of a stream. This is because the time of concentration of an individual property is dramatically less than the time of concentration for an entire upstream watershed. As a result peak discharges from an individual property will pass through on-stream facilities relatively undetained well before upstream flood peaks arrive. This can result in downstream flood peaks being larger than if off-stream detention were applied.

The environmental criteria are provided in an effort to mitigate the impacts of on-stream detention on beneficial stream uses. The interruption of free-flowing stream reaches, by weirs and dams designed to produce on-stream detention, affects stream water quality in several ways. First, sediment and pollutant deposition is encouraged behind the dam, leading to a potential in-stream water quality problem for larger watersheds. Second, channel modification is frequently a part of on-stream detention projects and this results in direct destruction of stream habitat. Third, the change from a free-flowing reach to a reservoir can adversely impact existing fish life and habitat. Fourth, the slowing of in-stream flow velocities can reduce reaeration and the ability of the stream to assimilate organic pollutant loads.

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comply with 92 Illinois Administrative ɜ Parts 702 and 708 and the floodplain ıance of (County, City, Village of _____).	The recommendation that dynamic modeling be performed for watersheds larger than one square mile is based on the concern that on-stream detention perform as effectively as off-stream detention as discussed above. The one-square mile cutoff was selected because watersheds larger than this will fall under IDWR permitting requirements and so the need to furnish additional data on potential impacts will be anticipated by developers. Dynamic modeling, incorporating continuous simulation hydrologic modeling, can assess a full range of storm types, temporal and spatial distributions and antecedent moisture conditions. Gradually varied, unsteady flow hydraulics are needed to accurately assess the complex interactions of storage and conveyance which on-stream structures frequently present.
'ainage into Wetlands - Wetlands shall :ted from damaging modifications and :hanges in runoff quality and quantity ıd with land developments. In addition ıer requirements of this ordinance, the requirements shall be met for all de- ıts whose drainage flows into wetlands:	709.0 Drainage into Wetlands - Wetlands provide valuable habitat, water quality, and hydrologic functions which may be adversely affected by development activities. Adverse impacts can result from direct modifications, the introduction of urban runoff pollutants, as well as changes in runoff rates. Changes in hydrology, in particular, can affect the delicate balance which exists in sensitive wetlands and result in loss of habitat diversity. For these reasons, wetlands should be protected from urban runoff changes by the measures specified in this ordinance and moderate to high quality wetlands should not be modified to accommodate stormwater detention.
ıtention in Wetlands: Existing wetlands be modified for the purposes of storm- ɜntion unless it is demonstrated that the etland is low in quality and the proposed ıons will maintain or improve its habitat ' to perform beneficial functions. Existing ınal storage in wetlands shall be main- ıd the volume of detention storage ıo meet the requirements of this section ı addition to this existing storage.	709.1 Detention in Wetlands: Low quality wetlands, with adequate protection and mitigation, can be beneficially utilized for detention. Low quality wetlands are those which have been substantially disturbed. This disturbance is usually reflected in a low diversity of habitat and the presence of only insensitive plant species (e.g., a monoculture of cattails). Certain modifications of low quality wetlands, such as the limited exavation of open water areas, may actually enhance their value.

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709.2 Sediment Control: The existing wetland shall be protected during construction by appropriate soil erosion and sediment control measures and shall not be filled.	709.2 Sediment Control: This provision is consistent with "Greenbook" recommendations for controlling soil erosion from disturbed sites.
709.3 Alteration of Drainage Patterns: Site drainage patterns shall not be altered to substantially decrease or increase the existing area tributary to the wetland.	
709.4 Detention/Sedimentation: All runoff from the development shall be routed through a preliminary detention/sedimentation basin designed to capture the two-year, 24-hour event and hold it for at least 24 hours, before being discharged to the wetland. This basin shall be constructed before property grading begins. In addition, the drainage hierarchy defined in section 500.0 should be followed to minimize runoff volumes and rates being discharged to the wetland.	
709.5 Vegetated Buffer Strip: A buffer strip of at least 25 feet in width, preferably vegetated with native plant species, shall be maintained or restored around the periphery of the wetland.	
710.0 Street, Parking Lot, and Culvert Drainage	
710.1 Streets: If streets are to be used as part of the minor or major drainage system, ponding depths shall not exceed curb heights by more than one inch and shall not remain flooded for more than eight (8) hours for any event less than or equal to the 100-year event.	710.1 Streets: Local governments should substitute whatever depth and duration of ponding their citizens are willing to tolerate. Since there are a variety of curb types in use with varying heights it is important that each local government tailor this section to its design standards. It is also very important that local governments take into consideration curb cuts leading to garages below grade. Where street storage of runoff is considered, below grade parking should be prohibited.
710.2 Parking Lots: The maximum stormwater ponding depth in any parking area shall not exceed six (6) inches for more than four (4) hours.	710.2 Parking Lots: The use of parking lots to provide stormwater detention will be limited by the storage volume and detention time requirements of this ordinance. In addition, parking lot detention will provide little or no water quality benefits and is therefore discouraged as a primary source of detention. However, parking lot storage may be useful in providing supplementary storage for a

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	traditional detention basin. In such an application, the parking lot may be located at a higher elevation than the detention basin bottom and would only store water for more extreme events (e.g., greater than 5 or 10-year recurrence interval).
710.3 Culvert Road and Driveway Crossings: Sizing of culvert crossings shall consider entrance and exit losses as well as tailwater conditions on the culvert.	710.3 Culvert Road and Driveway Crossings: Use of mannings equation to size culverts does not account for the significant entrance and exit head losses. Federal Highway Administration culvert nomographs or more sophisticated backwater models are recommended, as appropriate.
711.0 Infiltration Practices - To effectively reduce runoff volumes, infiltration practices including basins, trenches, and porous pavement should be located on soils in hydrologic soil groups "A" or "B" as designated by the U.S. Soil Conservation Service. Infiltration basins and trenches designed to recharge groundwater shall not be located within seventy-five feet of a water supply well or a building foundation. A sediment settling basin shall be provided to remove coarse sediment from stormwater flows before they reach infiltration basins or trenches. Stormwater shall not be allowed to stand more than seventy-two hours over eighty percent of a dry basin's bottom area for the maximum design event to be ex-filtrated. The bottom of infiltration facilities shall be a minimum of four feet above seasonally high groundwater and bedrock.	711.0 Infiltration Practices - There is considerable potential for the use of infiltration practices in northeastern Illinois but their application must be carefully analyzed before they are implemented. Soil acceptability and the potential for groundwater contamination must be carefully assessed. Infiltration practices are also very sensitive to maintenance concerns, especially clogging by sediment. As a result pre-sedimentation basins to remove the bulk of any sediment load are recommended. Local governments should refer to publications from the state of Maryland and the Metropolitan Washington Council of Governments listed in this document's references for further information. Local governments also need to be aware of IEPA Class V injection well permit requirements and setback zones from community wells established by the Illinois Groundwater Protection Act.
712.0 Safety Considerations - The drainage system components, especially all detention basins, shall be designed to protect the safety of any children or adults coming in contact with the system during runoff events.	712.0 Safety Considerations - Safety of stormwater drainage system components is always a principal design criteria. The local government should avoid the use of fencing around detention basins by designing safe facilities. However, certain extreme cases may require the use of fences to protect the public.
712.1 Side Slopes: The side slopes of all detention basins at one-hundred year capacity shall be as level as practicable to prevent accidental falls into the basin and for stability and ease of maintenance. Side slopes of detention basins and	712.1 Side Slopes: The Metropolitan Washington Council of Governments generally recommends side slopes no greater than 3:1. The Illinois Department of Transportation Standards and Specifications for Highway Construction call for

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open channels shall not be steeper than three to one (horizontal to vertical).	maximum embankment slopes of 3 to 1 for safe mowing.
712.2 Safety Ledge: All wet detention basins shall have a level safety ledge at least (four) feet in width (2.5 to three) feet below the normal water depth.	712.2 Safety Ledge: The recommended requirements for safety ledge design are based on a review of a number of sources whose design criteria vary. A community may wish to revise these requirements based on its local experience.
712.3 Velocity: Velocities throughout the surface drainage system shall be controlled to safe levels taking into consideration rates and depths of flow.	712.3 Velocity: One common rule of thumb for safe velocities calls for the product of velocity (feet/second) times depth (feet) not to exceed 4 for human safety.
712.4 Overflow Structures: All stormwater detention basins shall be provided with an overflow structure capable of safely passing excess flows at a stage at least 1 foot below the lowest foundation grade in the vicinity of the detention basin. The design flow rate of the overflow structure shall be equivalent to the 100-year inflow rate.	712.4 Overflow Structures: Recent NIPC inspections of stormwater detention basins revealed that few had a stable and clearly defined overflow spillway to safely pass flows exceeding the 100-year design event, or to pass flows if an outlet becomes obstructed. This is a very important design consideration as the invert for the spillway will control the depth of storage and potential flood stages on properties tributary to the detention basin. Spillway velocity and rate considerations should be addressed in the drainage plan. The probable maximum storm has been recommended as a design event by ASCE, but may be excessively conservative for most applications. More conservative overflow designs may be necessary for large detention basins if their size makes them subject to IDWR's Dam Safety Rules.
713.0 Maintenance Considerations - The stormwater drainage system shall be designed to minimize and facilitate maintenance. Turfed sideslopes shall be designed to allow lawnmowing equipment to easily negotiate them. Wet basins shall be provided with alternate outflows which can be used to completely drain the pool for sediment removal. (Pumping may be considered if drainage by gravity is not feasible.) Pre-sedimentation basins shall be included, where feasible, for localizing sediment deposition and removal. Access for heavy equipment shall be provided.	713.0 Maintenance Considerations - Local governments should tailor this section to meet their maintenance concerns. The ability to completely drain wet basins for sediment removal is an important maintenance option, as is the ability for heavy equipment to access a basin.

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800.0 Accommodating Flows From Upstream Tributary Areas Stormwater runoff from areas tributary to the property shall be considered in the design of the property's drainage system. Whenever practicable, flows from upstream areas that are not to be detained should be routed around the basin being provided for the site being developed.	**800.0 Accommodating Flows From Upstream Tributary Areas** The model ordinance is designed to provide flexibility in managing tributary area flows while retaining the degree of control needed to protect downstream property owners. It is strongly recommended that local governments look for opportunities to participate with applicants to build regional detention facilities in advance of upstream property development. The costs for the local government share could be paid by the downstream property and then recaptured when upstream properties develop; or the local government could use special assessments on the upstream properties to pay the costs immediately. Finally, costs could be paid from any fee in lieu of detention programs for the areas in question. Where bypassing of flows from upstream areas is the selected approach, it is recommended that these flows be routed around the detention basin for the same reason that online storage is discouraged. (I.e., the peak flows from the individual site may pass virtually undetained before the upstream peaks arrive).
801.0 Upstream Areas Not Meeting Ordinance Requirements - When there are areas not meeting the storage and release rates of this ordinance, tributary to the applicant's property, regionalized detention on the applicant's property shall be explored by the applicant. The following steps shall be followed. a. The applicant shall compute the storage volume needed for his property using the release rates of Section 600.0, the applicant's property area, and the procedures described in Section 700.0. b. Areas tributary to the applicant's property, not meeting the storage and release rate requirements of this ordinance, shall be identified. c. Using the areas determined in 801.b. above plus the applicant's property area, total	

storage needed for the combined properties shall be computed.

Allowable release rates shall be computed using the combined property areas. Storage shall be computed as described in Section 700.0. If tributary areas are not developed, a reasonable fully developed land cover, based on local zoning, shall be assumed for the purposes of computing storage.

Once the necessary combined storage is computed the (County, City, Village) may choose to pay for oversizing the applicant's detention basin to accommodate the regional flows. The applicant's responsibility will be limited to the storage for his property as computed in "a" above. If regional storage is selected by the (County, City, Village), then the design produced in "c" above shall be implemented. If regional storage is rejected by the (County, City, Village), the applicant shall bypass all tributary area flows around the applicant's basin whenever practicable. If the applicant must route upstream flows through his basin and the upstream areas exceed one-square mile in size, the applicant must meet the provisions of Section 708.30 for on-stream basins.

802.0 Upstream Areas Meeting Ordinance Requirements - When there are areas which meet the storage and release rate requirements of this ordinance, tributary to the applicant's property, the upstream flows shall be bypassed around the applicant's detention basin, or be routed through the applicant's detention basin if this is the only practicable alternative. Storage needed for the applicant's property shall still be computed as described in Section 801.0, a. However, if the (County, City, Village) decides to route tributary area flows through an applicant's basin, the final design stormwater releases shall be based on the combined total of the applicant's property plus tributary areas. It must be shown that at no time will the runoff rate from the applicant's property exceed the allowable release rate for his/her property alone.

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00.0 Early Completion of Detention Facilities	**900.0 Early Completion of Detention Facilities**
Vhere detention, retention, or depressional storage reas are to be used as part of the drainage ystem for a property, they shall be constructed s the first element of the initial earthwork program. ny eroded sediment captured in these facilities hall be removed by the applicant before project ompletion in order to maintian the design volume f the facilities.	Completion of detention facilities first on a property provides a vital element of a runoff management and soil erosion and sediment control strategy for a property. It also places the burden for cleanup of soil eroded from a construction site on the applicant before the drainage system can receive a final permit. These recommendations are consistent with the Northeastern Illinois Soil Erosion and Sediment Control Steering Committee's Green Book.
000.0 Fee in Lieu of Detention	**1000.0 Fee in Lieu of Detention**
ll single-family residential developments under acres in size and all other development under acre in size shall pay a fee of $_____ for each cre-foot of detention which would be required nder this ordinance rather than installing detention acilities on the property, unless specifically directed o do otherwise by the (insert appropriate local fficial's title). The (County, City, Village of _____) also shall have the option for larger roperties of requiring a fee of $_____ for each cre-foot of detention needed in lieu of the pplicant building a basin on-site provided the roperty will discharge stormwater to the (County's, ity's, Village's) storm sewer system. n instances where regional benefits and economies f scale can be achieved, it will be permissible for djacent properties to utilize a common regional letention basin. Applicants shall have the option f paying a fee of $_____ for each-acre foot of letention required so that the (County, City, Village f _____) can build regional facilities or they an jointly build the necessary facilities themselves.	The intent of this ordinance is to minimize the number of small detention basins which may have greater maintenance and operational problems. At the same time, there may be a need for small, onsite basins in situations where in-fill development occurs, potentially resulting in local drainage problems on adjacent properties. This situation always should be evaluated by the local government. Local governments should not implement this section of the ordinance unless they have a completed master drainage plan for their watersheds, an administrative mechanism for collecting fees, and financial reserves to participate in the purchase of land and construction of regional detention basins. Obviously, a local government must be certain that properties which pay a fee will have their stormwater runoff adequately managed. The responsibility for this management will fall either to the local governments directly or to joint efforts between downstream developers and the local government. Failure to expeditiously invest fees could lead to the municipality being charged with not meeting the "reasonable use" rules of Illinois drainage law. The model ordinance might recommend a higher minimum lot size if it were not for the distinct possibility that the U.S. Environmental Protection Agency will soon be requiring NPDES permits and the implementation of best management practices from all land development activities over 5 acres (1 acre for non-residential development). It would

appear that if a local government builds a regional facility which accepts flows from such activities the NPDES permit responsibility and some of the best management practice implementation responsibility will fall to the local government.

Each unit of local government should determine an equitable basis for assessing an adequate fee in lieu of detention. Typical methods include fees based on percent impervious area on the property, fees based on acre feet of detention required, and fees based on the actual cost to construct facilities.

1100.0 Maintenance Responsibility

Maintenance of stormwater drainage facilities located on private property shall be the responsibility of the owner of that property. Before a (insert appropriate permit) is obtained from the (County, City, Village of _____) the applicant shall execute a maintenance agreement with the (County, City, Village of _____) guaranteeing that the applicant and all future owners of the property will maintain its stormwater drainage system. The maintenance agreement shall also specifically authorize representatives of the (County, City, Village) to enter onto the property for the purpose of inspections and maintenance of the drainage system. Such agreement shall be recorded with the Recorder of Deeds of(_____ County). The maintenance agreement shall include a schedule for regular maintenance of each aspect of the property's stormwater drainage system and shall provide for access to the system for inspection by authorized personnel of the (County, City, Village of _____). The maintenance agreement shall also stipulate that if the (appropriate authorized personnel of the County, City, Village of _____) notify the property owner in writing of maintenance problems which require correction, the property owner shall make such corrections within 30 (thirty) calendar days of such notification. If the corrections are not made within this time period the (County, City, Village) may have the necessary work completed and assess the cost to the property owner.

The (County, City, Village of _____) has the option of requiring a bond to be filed by the

1100.0 Maintenance Responsibility

It is critical that if maintenance contracts are used by a local government that the maintenance organization have the ability to assess and collect fees. Local governments may also wish to investigate the requirement that covenants be added to property recordings to reflect maintenance responsibilities.

Some local governments, particularly at the county level, may wish to undertake all maintenance activities themselves. In this instance impact fees or some other means of regularly collecting the cost of such activities needs to be investigated.

Property owners may include individuals, corporations, or homeowners associations.

Local governments also should require maintenance easement from property owners in the event they must enter property to correct deficiencies.

property owner for maintenance of the stormwater drainage system.

1200.0 Administration

1201.0 Inspections

1201.10 Inspections During Construction: General site grading shall not begin until the (appropriate official of the County, City, Village) has certified in writing to the applicant that any necessary detention facilities are in place and operational. The (appropriate official of the County, City, Village) or his representative will also conduct periodic inspections of the work in progress to be certain that the drainage system is being built as designed. If any violations of the provisions or requirements of this ordinance are noted during such inspections, the (_____) shall notify the property owner in writing of the items needing correction. The property owner shall have ten (10) calendar days to make such corrections unless given a specific extension of time in writing by the (_____).
Failure to complete such corrections within the specified time period shall constitute a violation of this ordinance.

1201.20 Final Inspection: Upon notification by the applicant that the drainage system is completed, the (appropriate official of the County, City, Village) or his representative shall conduct a final inspection. If the drainage system is found to contain deficiencies which require correction the (_____) or his
representative shall notify the property owner of the necessary corrections. The property owner shall correct such deficiencies within ten (10) calendar days unless given a specific extension of time in writing by the (_____). Failure to make necessary corrections within the specified time period shall constitute a violation of this ordinance. Upon finding that the drainage system meets the provisions and requirements of this ordinance the (_____) shall issue in writing a notice of drainage system completion to the property owner.

ORDINANCE	COMMENTARY
1201.30 Routine Inspections: All privately owned drainage systems shall be inspected by representatives of the (County, City, Village) not less often than once per year. A written report shall be filed of the results of any inspection and a copy sent to the property owner detailing any problems which need correction.	
1202.0 Enforcement - The administration and enforcement of this ordinance shall be the responsibility of the (_____) Department of the (County, City, Village of _____)or his representatives.	
1203.0 Appeals - All appeals to the Director of (_____) Department's decisions regarding the interpretation of this ordinance shall be heard by the (_____) Board of the (County, City, Village of _____).	
1300.0 Severability	
If any section, clause, provision or portion of this ordinance is judged unconstitutional or invalid by a court of competent jurisdiction, the remainder of this ordinance shall remain in force and not be affected by such judgement.	
1400.0 Penalties	
Any person convicted of violating any of the provisions or requirements of this ordinance shall be guilty of a misdemeanor and shall be subject to a fine of not more than One Thousand Dollars ($1,000.00) or be imprisoned for not more than (_____). Each day the violation continues shall be considered a separate offense.	

ORDINANCE	COMMENTARY

1500.0 Effective Date

This ordinance shall be in full force and effect from and after its passage and approval and publication, as required by law.

Passed by the _____ of the _____, Illinois, this _____ day of _____, 19___.

_____
Clerk

APPROVED by me this _____ day of _____, 19___.

_____
Mayor/Village President

ATTESTED and FILED in my office this _____ day of _____, 19__.

_____
Clerk