20.22.04. Permanency of Grade.

Land alteration shall be accomplished in such a way that the grades left at the time that the work is completed will be permanent and stable. Vegetative materials may be buried in the ground only if placement will clearly not interfere with the stability of all areas and cause settlement or erosion.

Sec. 10-524 Storm Sewer Tap-ons.

20.23.01. Tap-On Permit Required.

No person or persons shall connect to a public storm sewer without first submitting plans and obtaining a permit to do so from the City. Such plans and application shall show in detail the manner in which the proposed connection is to be made, the exact location, and other pertinent details as may be necessary to insure a proper connection.

20.23.02. Applicability.

The requirements of this Section apply to both residential and non-residential buildings and structures.

Sec. 10-525 Minimum Standards for Land Alteration to Control Erosion and Sediment.

Conformance with Minimum Standards. Land alterations shall be accomplished in accordance with standards found in the Stormwater Drainage and Sediment Control Ordinance of the City of Greenwood.

DIVISION IX.

DEFINITIONS.

For applicable definitions, refer to Article 22 of the Greenwood Zoning Ordinance No. 82-1 and Greenwood Municipal Code, as amended.

Sec. 10-526 through Sec. 10-532 Reserved for future use.

ARTICLE 21 STORMWATER DRAINAGE & SEDIMENT CONTROL ORDINANCE

Sec. 10-533 Policies and Procedures.

21.01.01. Purpose.

This ordinance establishes minimum standards for the planning and design of drainage systems and stormwater management facilities within the jurisdiction of the City of Greenwood. The purpose of this Ordinance is to control stormwater drainage facilities, grading, excavation, clearing, and other alterations of the land in order to limit the dangers of personal injury or property damage that may be caused by stormwater runoff and to comply with the standards set forth in 327 IAC 15-13. Also, these provisions are needed to secure the eligibility for flood insurance under Public Law 1016 and thereby promote the public health, safety, and general welfare of the citizens of Greenwood. This Ordinance regulates:

(Ord. No. 02-12, §2, 4-1-02)
(Ord. No. 02-07, §1, 3-18-02)
(Ord. No. 04-55, §1, 1-17-05)

1. Stormwater drainage improvements related to development of lands located within the jurisdiction of the City of Greenwood;
2. Drainage control systems installed during new construction and grading of lots and other parcels of land;
3. Erosion and sediment control systems installed during new construction and grading of lots and other parcels of land;
4. The design, construction, and maintenance of stormwater drainage facilities and systems; and
5. Existing stormwater drainage systems where the inclusion of improvements is feasible.

It is recognized that smaller streams and drainage channels serving the City of Greenwood and its extra-territorial planning jurisdiction may not have sufficient capacity to receive and convey stormwater runoff, as land changes from agricultural or open use to a more urbanized use. It is further recognized that deposits of sediment from developments during and after construction can reduce capacities of storm sewers and drainage systems and result in damages to receiving water bodies. Therefore, it shall be the policy of the City of Greenwood that the storage and controlled release of storm water runoff shall be required of all new development, any redevelopment and other new construction in the City of Greenwood's jurisdiction. The release rate of stormwater from developed lands shall not exceed the release rate from the land area in its present land use, as further defined in Section 10-535, Hydrology and Hydraulics.

Because topography and the availability and adequacy of outlets for stormwater run-off vary with almost every site, the requirements for stormwater drainage tend to be an individual matter for any project. It is recommended that each proposed project be discussed with staff from the City Engineer's Office at the earliest practical time in the planning stage.

21.01.02. Conflicting Ordinances.

The provisions of this Ordinance shall be deemed as additional requirements to minimum standards required by other City, State or Federal regulations. In the case of conflicting requirements, the most restrictive shall apply.

21.01.03. Compliance with Other Ordinances.

In addition to the requirements of this ordinance, compliance with the requirements set forth in other applicable ordinances for submission and approval of preliminary and final subdivision plats, improvement plans, building permits, zoning approvals, and similar matters, and compliance with applicable State of Indiana statutes and regulations shall be required.

The following approvals, if applicable, must be obtained before City approval on the Detailed Design Drainage Plan will be granted:

1. Permit for Construction in a Floodway, Chapter 318, Acts of 1945, as amended from the State of Indiana, Department of Natural Resources. This permit is required if the drainage area for the affected stream is one square mile or greater and is required for any construction in a floodway and any works for flood control.
2. Section 404 Permit, Section 404 of the Clean Water Act, 33 CFR Part 330 from the U.S. Army Corps of Engineers. This permit is required for projects that may involve the discharge of dredged or fill material into waters of the United States.

3. Section 401 Water Quality Certification from the State of Indiana, Department of Environmental Management. This permit is required for any project that has a Section 404 Permit from the Corps of Engineers.
4. Rule 5 Compliance, NPDES General Permit, 327 IAC 15. For any construction activity on a site of one acre or more, proof of compliance with these requirements must be provided. A Notice of Intent letter and fee must be submitted to the Indiana Department of Environmental Management and an Erosion Control Plan must be submitted to the Johnson County Soil and Water Conservation District office.

21.01.04. Definitions.

Definitions pertinent to the drainage ordinance shall be found in Article 22 of the Greenwood City Code.

21.01.05. Stormwater Control Policy.

It is recognized that the streams and drainage channels serving the drainage needs of the City of Greenwood and its extra-territorial planning jurisdiction may not have sufficient capacity to receive and convey stormwater runoff resulting from continued development. To address this condition, the storage and controlled release rate of excess stormwater runoff shall be required for any development, redevelopment and new construction located within the City of Greenwood and its extra-territorial planning jurisdiction. All drainage in the developed area must be confined and maintained on site through perimeter structures including swales and inlets, and shall be channeled through the stormwater storage area.

No improvement location permit will be issued by the City for construction or extension of any proposed or existing building until the required drainage plans have been approved in writing by the City, except for the following exemptions:

1. Construction or extension of a single family dwelling house or an accessory use building thereto;
2. Construction or extension of a duplex dwelling house or an accessory use building thereto;
3. Extension or replacement of any existing building that does not increase the existing rate of runoff.

The above exceptions, 1 - 3, however, shall not be applicable to a project if located in a previously designated Impact Drainage Area as established per Sec. 10-533 (F) of this Ordinance.

The City may waive the requirement of controlled runoff for certain subdivisions, only when formal application has been made, in accordance with Sec. 10-534, 21.02.11 of this Ordinance, and the Board of Public Works and Safety finds that the criteria listed in the Ordinance have been satisfied.

The release rate of storm water from development, redevelopment, and new construction may not exceed a 2-year pre-developed rainfall event rate for a 10-year post-developed storm, or a 10-year pre-developed rainfall event rate for a 100-year post-developed storm ("peak flows").

The developer must submit to the City Engineering Department detailed computations of runoff before and after development, redevelopment, or new construction that demonstrates that runoff will not be increased. Hydrograph techniques and computer modeling methods used to determine stormwater runoff shall be proven and accepted methods, and will be subject to approval of the City Engineering Department.

These computations must show that the peak runoff rate after development for the 100-year return period storm of critical duration must not exceed the 10-year return period pre-development peak runoff rate. These computations must show that the peak runoff rate after development for the 10-year return period storm of critical duration must not exceed the 2-year return period pre-development peak runoff rate. The critical duration storm is that storm duration that requires the greatest stormwater storage. The top of the embankment must provide a two-foot freeboard above the elevation of the 100-year routed pool level. Also, the emergency spillway must be designed so that it becomes operational at or above the elevation of the routed 100-year storm. The 100-year storm must be routed through the pond with the primary spillway inoperative.

Acceptable methods of computing the quantities of runoff will be described in Section 10-535, Hydrology and Hydraulics.

21.01.06. Determination of Impact Drainage Areas.

The Board of Public Works and Safety is authorized, but is not required, to classify certain geographical areas as Impact Drainage Areas and to enact and promulgate regulations that are generally applied. In determining impact drainage areas, the Board of Public Works and Safety shall consider such factors as topography, soil type, and capacity of existing regulated drains and distance from adequate drainage facility. The following areas shall be designated as Impact Drainage Areas, unless good reason for not including them is presented to the Board of Public Works and Safety:

1. A Floodway Fringe as designated on the Federal Emergency Management Agency's Floodway Maps;
2. Land within 75 feet of the top of each bank of any regulated drain; and
3. In situations where there is not available land to provide an adequate outlet, taking into consideration the capacity and depth of the outlet, the location may be designated as an impact drainage area by resolution of the Board of Public Works and Safety. Special requirements for development within any impact drainage area shall be included in the resolution.

21.01.07. Board of Public Works and Safety Authority.

The Board of Public Works and Safety has the authority to review and act on all drainage plans for Primary Plats, Secondary Plats and Site Development Plans. The Board of Public Works and Safety may choose to delegate that responsibility.

Sec. 10-534 Local Review Process.

21.02.01. When to Submit.

Applicants must submit drainage plans for review and approval prior to the initiation of any land alteration on the site. Local drainage review as part of the land alteration process shall typically be accomplished as a two-step process, in conjunction with the platting of land. A general drainage plan, including submittal of drainage calculations, and information for the entire parent tract shall be required with submittal of a primary plat. A detailed design drainage plan shall be submitted with the secondary plat. In addition to the information required by the platting process, other information shall be required, as noted in this section.

In the case where the site has already been platted, but development plan approval has not been granted, the drainage review process shall be completed in conjunction with the initial site development plan application. In addition to the information required by the development review process, other information shall be required, as noted in this section.

21.02.02. Pre-Submittal Meeting.

The Board of Public Works and Safety or the City Engineering Department can require a pre-submittal meeting.

21.02.03. General (Preliminary) Drainage Plan.

The applicant shall file in required form and numbers the application form, filing fee, and copies of the General Drainage Plan, in compliance with the applicable filing requirements set forth by the plan commission for the associated subdivision plat or development plan. All submittals are subject to cursory review. Incomplete submittals will not be accepted for review. The general drainage plan submission shall include the following information:

1. Site Features. The plan shall be drawn to scale, preferably 1" = 50', or a sufficient scale to accurately depict all features that affect stormwater design, and an arrow indicating north shall appear on each page. Sheet size shall not exceed 24" by 36". Show existing contours with intervals of not more than two feet where the slope is greater than 4% and not more than one foot where the slope is less than or equal to 4%. Off-site watershed boundary maps can be submitted at an appropriate contour interval sufficient to depict drainage areas and slopes. A benchmark, which is easily accessible and re-locatable, shall be shown. The benchmark may be assumed at the discretion of the City Engineering Department if the area contains less than 3 acres, but otherwise shall be determined by use of NAVD 88 datum (vertical).
2. Location and Vicinity Map. A map that identifies the location and vicinity of the proposed land alteration shall be included in the stormwater plan, and shall reference a nearby major road intersection.
3. Existing Stormwater Facilities. Show the locations of all existing stormwater facilities. Dimensions on the plans shall locate storm drains, manholes and other structures in relation to surrounding physical features. Show the direction of flow, elevation of inverts, gradient, materials and size of existing storm drains.
4. Topographic Map. A topographic map shall be provided covering the land to be developed and any adjoining land whose topography may affect the layout or drainage of the development. The contour intervals shall be one foot when slopes are less than 4% and two feet when the slope is greater than 4%.

   Drainage areas shall be delineated showing all existing on-site and off-site drainage areas and flow paths to stormwater facilities, and the limits of the 100-year floodplain for all areas with contributing drainage watersheds of one acre or greater and shall also include 100-year base flood elevation ("BFE") with notation as to the source of the BFE.

5. Proposed Stormwater Facilities. The complete proposed system should be shown in plan view, including swales, storm sewers, and stormwater ponds. Supplemental data and calculations supporting the design of all drainage facilities shall also be submitted. It is the intent of the Board that the drainage system design be verified early in the permitting process.

6. Technical Information Report. A completed Technical Information Report is required as part of the drainage plan application. All reports submitted under this section to the City Engineering Department must be prepared by a qualified professional licensed in the State of Indiana, and engaged in storm drainage design. The Technical Information Report shall contain the following information:
   a. Existing site conditions, with specific problem areas identified during site inspections;
   b. Known neighborhood concerns;
   c. Written commitments related to stormwater management;
   d. Downstream conditions/restrictions (with a justification for the level of downstream analyses performed);
   e. Design calculations are required as part of the stormwater plan and shall, at a minimum, include:
      i. Estimation of Stormwater Runoff - hydrographs/peak runoff rates for all design storms;
      ii. Drainage area calculations;
      iii. Weighted curve number or runoff coefficient computations;
      iv. Time of concentration computations indicating overland flow time, and flow time in the swale, gutter, pipe or channel;
      v. Capacity of the pond in acre-feet by pool elevation (stage-storage relationship);
      vi. Design of the pond's outfall control structure, with stage-discharge relationship and pond outfall velocity in feet per second;
      vii. Computations of the routings of the design hydrographs through the proposed stormwater pond, indicating the maximum routed pond discharge rate, and the maximum routed 100-year, 10-year and 2-year pool elevation;
      viii. Design of the emergency spillway, including the routing of the 100-year storm through the pond with the primary spillway inoperative, and showing the maximum pool elevation and flow through the emergency spillway; and
      ix. Information regarding the computer models used, including printouts and an identification of the pertinent output data.
7. Additional Information. The City Engineering Department shall be empowered to require additional information to evaluate and determine the adequacy of the proposed stormwater facility.
8. Certification Required. All drainage plans submitted to the City Engineering Department, as described under this section, must be prepared and certified by a qualified professional licensed in the State of Indiana, and engaged in storm drainage design.

21.02.04. Detailed Design (Final) Drainage Plan.

The detailed drainage plan shall be incorporated into the secondary plat, as part of the construction drawings, or with a final site development plan. That submittal should be a finalized version of the earlier Preliminary Drainage Plan. All final development and construction plans shall be submitted under the seal and signature of a qualified professional licensed to practice in the State of Indiana. All sheets shall be 24" x 36" size drawn to scale at a minimum 1"=50' and a maximum 1"=10' with the exception of the maps on Sheet One, unless otherwise approved by the City Engineering Department. The drainage component of the final construction plans shall be incorporated into the following sheets. Plans submitted for review shall observe the following format:

1. All sheets shall contain the following information:
   a. The proposed name by which the project shall be legally and commonly known;
   b. Date of survey, scale, and north arrow; All lots or outlots intended for sale or lease shall be designated with boundary lines and numbered or labeled for identification purposes;
   c. Private parks, common areas, or excluded parcels shall be designated as such and clearly labeled on the plans;
   d. Such other information as may be deemed necessary for proper review of the secondary plat or site development plan by the administrator, City Engineering Department, or commission; and
   e. All necessary reference points tying the subject property to the appropriate section corners.
   f. Each sheet shall be sealed and signed by the professional preparing the drawings.
   g. All sheets shall be tied to state plane coordinates for horizontal and vertical controls.
2. Sheet One (Title Sheet).
   The following information shall be submitted as part of Sheet One:
   a. Full legal description with sufficient reference to section corners and boundary map of the subject project, including appropriate benchmark references;
   b. Name of the Project;
   c. Name and address of the owner, developer, and person who prepared the plans;
   d. Total acreage within the project and the number of residential dwelling units or the gross square footage of non-residential buildings whichever is applicable;
   e. Existing zoning of the subject land and all adjacent lands;
   f. Boundary lines of adjacent tracts of land, showing owners of record;
   g. A key or vicinity map at a scale of one inch equals four hundred feet or less, showing the boundaries of the proposed project and covering the general area within which it is to be located;
   h. A statement of the proposed uses, stating the type and size of residential and non-residential buildings, and the type of business, commercial or industry, so as to reveal the effect of the project on traffic, fire hazards, or congestion of population;
   i. Proposed covenants, restrictions, by-laws, or articles of incorporation affecting property owners and/or homeowners associations; and
   j. Statement of proposed starting and completion dates for the project, including any proposed phasing and sequencing;
3. Sheet Two (Existing Site Conditions).
   The following information shall be submitted as part of Sheet Two:
   a. Location, widths, and type of construction of all existing streets, street names, alleys, or other public ways and easements, street classifications as per the Thoroughfare Plan, railroad and utility rights-of-way or easements, parks, wooded areas, cemeteries, watercourses, drainage ditches, designated wetlands, low areas subject to flooding, permanent buildings, bridges, and the locations of all existing stormwater facilities. Storm drains, manholes and other structures shall be located by dimensions on the plans, in relation to surrounding physical features. Show the direction of flow, elevation of inverts, gradient, materials and size of existing storm drains. Other data may be added which is considered pertinent by the commission or the administrator for the subject land. Existing site conditions shall include all land within 300 feet of the proposed project;
   b. Existing water mains, fire hydrants, storm sewers, sanitary sewers, culverts, bridges, and other utility structures or facilities within, adjacent to, or serving the subject land, including pipe sizes, grades, and exact locations, as can best be obtained from public or private records;

c. Existing contours based in U.S.G.S. datum with intervals of not more than five feet where the slope is greater than 10% and not more than two feet where the slope is less than 10%. Off-site watershed boundary maps can be submitted at an appropriate contour interval sufficient to depict drainage areas and slopes. A benchmark, which is easily accessible and re-locatable, shall be shown. The benchmark shall be determined by use of NAVD 88 datum (vertical), and elevations shall be based on sea level datum; and

d. The water elevation at the date of the survey of lakes, streams, or designated wetlands within the project or affecting it, as well as the approximate high and low water elevation of such lakes, streams, or designated wetlands. The plan shall also show the contour line of the regulatory flood (100-year flood) elevation and the contour line for the floodway fringe boundary. All elevations shall be based on sea level datum;

4. Sheet Three (Proposed Site Conditions).

The following information shall be submitted as part of Sheet Three:

a. Location, widths, grades and type of construction of all existing and proposed streets, street names, alleys, or other public ways and easements, railroad and utility rights-of-way or easements, parks, wooded areas, cemeteries, watercourses, drainage ditches, designated wetlands, low areas subject to flooding, permanent buildings, bridges, and other data considered pertinent by the commission or the administrator for the subject land, and within 300 feet of the proposed project;

b. Existing and proposed water mains, fire hydrants, storm sewers, sanitary sewers, culverts, bridges, and other utility structures or facilities within, adjacent to, or serving the subject land, including pipe sizes, grades, and exact locations, as can best be obtained from public or private records;

c. Building setback lines, showing dimensions;

d. Full description and details, including engineering calculations, for provision of storm water drainage plans and facilities, including basin mapping. The standard for drainage detention storage is that the peak run-off rate of a 100-year post-development event cannot exceed the peak run-off rate for a 10-year pre-development event; and that the peak runoff rate of a 10-year post-development event cannot exceed the peak run-off rate for a 2-year pre-development event;

e. Internal and perimeter sidewalk system/pedestrian circulation plan;

f. Proposed contours for proposed ponds with intervals of not more than five feet where the slope is greater than 10% and not more than two feet where the slope is less than 10%. The plan shall also show the contour line for the floodway fringe boundary. Spot elevations will be satisfactory for other proposed improvements, unless otherwise directed by the City Engineering Department; and

g. The location and detail plans for all trash dumpsters.

5. Sheet Four (Erosion Control Plan).

The following information shall be submitted as part of Sheet Four:

a. Location, widths, and type of construction of all existing and proposed streets, street names, alleys, or other public ways and easements, railroad and utility rights-of-way or easements, parks, wooded areas, cemeteries, watercourses, drainage ditches, designated wetlands, low areas subject to flooding, permanent buildings, bridges, and other data considered pertinent by the commission or the administrator for the subject land, and within 300 feet of the proposed project;

b. Proposed contours with intervals of not more than five feet where the slope is greater than 10% and not more than two feet where the slope is less than 10%;

c. Details of terrain and area drainage, including the identity and location of watercourses, intermittent and perennial streams, receiving waters, and springs, and the total acreage of land that will be disturbed;
d. The direction of drainage flow and the approximate grade of all existing or proposed streets;
e. Detailed plans and locations of all surface and subsurface drainage devices, walls, dams, sediment basins, storage reservoirs, and other protective devices to be constructed with, or as part of, the proposed project, together with a map showing drainage area, the complete drainage network, including outfall lines and natural drainage ways which may be affected by the proposed development, and the estimated runoff of the area served by the drains;
f. A description of the methods to be employed in disposing of soil and other material that is removed from the grading site, including the location of the disposal site;
g. Measures for soil erosion and sediment control which must meet or exceed the methods and standards adopted by the Indiana Department of Natural Resources and/or set forth in the Indiana Handbook For Erosion Control in Developing Areas and which must comply with the design principles, performance standards, and requirements set forth in this chapter and the Indiana Department of Environmental Management Municipal Separate Storm Water Sewer System Conveyances storm water run-off requirements;
h. A schedule of the sequence of installation of planned erosion and sediment control measures as related to the progress of the project, including the total area of soil surface that is to be disturbed during each stage, the anticipated starting and completion dates, and a schedule for the maintenance of such measures;
i. Include the following notes on the sheet:
   i. "All erosion control practices shall be in accordance with the IDNR "Indiana Handbook For Erosion Control In Developing Areas" dated October 1992 and the SCS "Field Office Technical Guide."
   ii. "The City Engineering Department has the right to require additional erosion control measures in the field as conditions warrant."
j. Copies of the letter of intent and response from the Johnson County Soil and Water Conservation District office for Rule 5 compliance, when required; and
k. Any other information reasonably required by the commission or administrator to properly evaluate the plan.

6. Sheet Five (Landscape Plan).

A landscape plan shall conform to the following requirements:

a. It is recommended that the landscape plan be prepared by a landscape architect, nurseryman, or other professional experienced in landscape design and the installation and care of plant materials. The name and address of the plan preparer shall be included on the plan;
b. All plans shall show the entire lot to scale;
c. Show the location and dimensions of all existing and proposed structures, parking lots and drives, roadways and right-of-way, sidewalks, bicycle paths, ground signs, refuse disposal areas, bicycle parking areas, freestanding electrical equipment, recreation facilities, utility lines and easements, freestanding structural features, and other landscape improvements, such as earth berms, walls, fences, screens, sculptures, fountains, street furniture, lights and courts or paved areas;
d. The location, quantity, size, and name, both botanical and common name of all proposed planting materials;
e. The location, size and common name of existing trees and individual shrubs, areas of dense trees or shrubs, and other natural features, indicating which are to be preserved and which are to be removed;

f. The approximate location and generic identification of existing structures and plant materials within the yard of adjoining properties;
g. Existing and proposed grading of the site, including proposed berming, indicating contours at no more than two-foot intervals;
h. Specification of the type and boundaries of all proposed vegetative ground cover;
i. Design of fences and other significant accessory structures;
j. The location of barriers to be placed at or beyond the drip line of any trees to be preserved, and the type of material to be used for the barrier;
k. Planting and installation details as necessary to ensure conformance with all required standards;
l. Details indicating specific grading measures or other protective devices where trees are to be preserved in areas of cut and fill; and
m. A tabulation clearly displaying the relevant statistical information necessary for the Plan Commission to evaluate compliance with the provisions of this ordinance.

7. Sheet Six (Plat-like dedication sheet, if necessary).
The following information shall be submitted as part of Sheet Five if a plat-like dedication document for easements and rights-of-way is deemed necessary by the Plan Commission or its authorized designee:
a. Parcels of land proposed to be dedicated or reserved for public use, or reserved for common use of all property owners within the project, with the proposed conditions and maintenance requirements, if any, shall be designated as such and clearly labeled on the plans;
b. Radii, internal angles, points of curvature; tangent bearings and lengths of all arcs, chord, and chord bearings; and
c. Accurate location of all survey monuments erected, corners and other points established in the field in their proper places.

8. Sheet Seven (Storm Plan and Profile).
For all pipe intended to be dedicated to the City of Greenwood, a storm drain plan and profile shall be submitted. Sections of pipe that will not be dedicated to the public, shall at a minimum show pipe sizes and invert elevations, material and slope unless a plan/profile is requested by the City Engineering Department. The plan shall be shown on the upper portion of the drawing. The plan, generally, shall be drawn on a scale that is clear and legible and not greater than 1"=50'. The plan shall show appropriate right-of-way and easement limits. The profile shall be shown under the plan and shall extend a sufficient distance downstream of the outlet to allow any pertinent information to be listed. For each pipe, the length, size, slope, material and class shall be annotated on the profile sheet near the dimension line. Detail title and/or number references shall be called out on the profile plan.

The storm drain and inlet profile shall generally be drawn on a scale of 1"=50' horizontal and 1"=5' vertical. Where a storm drain is located inside the limits of an existing or proposed pavement or shoulder, the centerline grade of the road shall be shown. Where a storm drain is located outside pavement or shoulder, the existing ground over the storm drain with proposed grading shall be shown. If the storm drain is to be constructed on fill, the profile of the undisturbed earth, at the storm drain location shall be shown. All utility locations at intersections with the storm drain shall be shown.

The Storm and Profile Plan shall contain the following information:
a. Size of pipe or channel cross-section;
b. Pipe or channel invert's slope in percent;

c. Material and roughness coefficient; and
d. Flowing velocities in feet per second.

9. Standard Detail Sheets.
Standard detail sheets as adopted by the Greenwood Board of Public Works and Safety, shall be included as part of the submittal.

10. Technical Information Report.
A completed Technical Information Report is required as part of the drainage plan application. All reports submitted under this section to the City Engineering Department must be prepared by a qualified professional licensed in the State of Indiana, and engaged in storm drainage design. The Technical Information Report shall contain the following information:

a. A written narrative describing the existing and the proposed drainage system and the results of the design, including a summarization of calculations and design recommendations for the collection system and the stormwater pond (including primary and emergency spillways);
b. Existing site conditions, with specific problem areas identified during site inspections;
c. Known neighborhood concerns;
d. Written commitments related to stormwater management;
e. Downstream conditions/restrictions (with a justification for the level of downstream analyses performed); and
f. Design calculations are required as part of the stormwater plan and shall, at a minimum, include:
    i. Estimation of Stormwater Runoff. hydrographs/peak runoff rates for all design storms;
    ii. Drainage area calculations with appropriate drainage basin maps;
    iii. Weighted curve number or runoff coefficient computations;
    iv. Time of concentration computations indicating overland flow time, and flow time in the swale, gutter, pipe or channel;
    v. Inlet grate and gutter flow computations;
    vi. Closed conduit and open channel design computations with appropriate drainage basin maps;
    vii. Size of pipe or channel cross-section;
    viii. Pipe or channel slopes in percent;
    ix. Pipe/channel material and roughness coefficient;
    x. Design velocities, for channels, pipes, and pond outfalls, in feet per second;
    xi. Design calculations for culvert pipes;
    xii. Design capacity of channels and pipes in cubic feet per second, capacity of the pond in acre-feet by pool elevation (stage-storage relationship);
    xiii. Hydraulic grade line computations for storm sewer design;
    xiv. Design of the pond's outfall control structure, with stage-discharge relationship;
    xv. Computations of the routings of the design hydrographs through the proposed stormwater pond, indicating the maximum routed pond discharge rates and the maximum routed 2-year, 10-year, and 100-year pool elevation.
    xvi. Design of the emergency spillway, including the routing of the 100-year storm through the pond with the primary spillway inoperative, and showing the maximum pool elevation and flow through the emergency spillway;
    xvii. Information regarding the computer models used, including printouts and an identification of the pertinent output data;

xviii. Summary of planned erosion control measures to be utilized.

g. A written narrative is required with the submittal stating that the drainage plans are in compliance with the provisions of the Greenwood Stormwater Drainage and Sediment Control Ordinance.

11. Required Information.
The City Engineering Department shall be empowered to require additional information to evaluate and determine the adequacy of the proposed stormwater facility, which may include, but is not limited to, written documentation of the following, when applicable:
a. Utility encroachment approvals;
b. Johnson County Drainage Board approval;
c. Other local, state, and federal approvals, including other City boards, commissions, or departments;
d. Inspection and testing agreements with the Board of Public Works and Safety;
e. Outside reviews as required by the City; and
f. Easements and rights-of-ways not on a plat-like document shall be submitted in the form prescribed by the Board of Public Works and Safety and include both a full legal description and a drawing exhibit.

The City Engineering Department shall also be empowered to waive information requirements when he/she determines that it is not necessary for evaluating or determining the adequacy of the proposed stormwater facility.

12. Certification Required.

All drainage plans submitted to the City Engineering Department, as described under this section, must be prepared by a qualified professional licensed in the State of Indiana, and engaged in storm drainage design.

21.02.05. Deviations from Approved Plans.

Deviations from approved plans and specifications shall not be made after the Board of Public Works and Safety grants formal drainage plan approval. Written application for deviation(s) from approved plans shall be filed in duplicate with the City Engineering Department and approved by the Board of Public Works and Safety, prior to implementation of the revision or change(s). Copies of the revisions or changes, if approved, shall be attached to the original plans and specifications.

Examples of deviations from the approved drainage plan shall include, but are not limited to, the following:

1. Pipe size changes;
2. Pipe grade changes (because of their affect on the hydraulic capacity of the stormwater facility);
3. Significant changes in horizontal alignment;
4. Construction materials and installation which are not in conformance with the requirements of this ordinance;

5. Changes in grade of the site that will effect the stormwater direction, velocity, and amount of concentration or may expose structures or streets to a greater risk of flooding than under approved plans;
6. Changes to drainage swales or ditches within right-of-ways, or on easements dedicated to the City; and
7. Addition of storm pipes or ditches;
8. Other changes deemed substantial by the City Engineering Department. If an applicant does not agree with the decision of the City Engineering Department, as it relates to this section, the applicant may request review and action by the Board of Public Works and Safety.

21.02.06. Responsibilities for Maintenance.

Responsibilities for maintenance are listed on the associated plat and/or plan.

21.02.07. Performance and Maintenance Guarantees.

The City of Greenwood may require financial guarantees such as performance bonds, or irrevocable letters of credit to be submitted. These performance bonds, irrevocable letters of credit, or other accepted financial guarantees may be part of the financial guarantee package required by the Board of Public Works and Safety for subdivisions, development plans, etc.

1. Performance Guarantees.
   Submission of Performance Guarantees. Performance guarantees shall be in a form approved by the City Attorney, and shall be based upon the bond estimate form and unit prices, as approved by the Board of Public Works and Safety for the cost to complete proposed site improvements.
   a. Performance guarantees shall be required to cover total installed cost for storm drainpipe, culvert, manhole, and box inlet installation, etc.
   b. Performance guarantees shall be required to cover total cost for site filling and grading, including but not limited to construction of open drainage swales and stormwater storage detention/ retention facilities.
   c. A separate performance guarantee shall be required for the installation of erosion and sediment control measures and regrading of minor drainage collector swales. Erosion and sediment control performance guarantees shall be in a form approved by the City Attorney, and shall be based upon the bond estimate form and unit prices, as approved by the Board of Public Works and Safety, for the cost to complete proposed sediment and erosion control installation, including, but not limited to:
      i. Re-establishment of erosion and sediment control devices;
      ii. Re-grading of the site;
      iii. Seeding of the entire disturbed area; and
      iv. Cleaning of the storm drain system.
2. Release of Performance Guarantees. The contractor or owner will schedule the final inspection with the Office of the City Engineering Department. After successful completion of the final inspection, the performance guarantees will be released in conformance with Board of Public Works and Safety policies and procedures, after the City Engineering Department approves the Maintenance Guarantees and "Record" drawings prepared under the supervision of and certified by a qualified professional licensed in the State of Indiana.

3. Maintenance Guarantees.
   1. Submission of Maintenance Guarantees. Prior to the release of the stormwater facility, and erosion and sediment control performance guarantees, a maintenance guarantee shall be submitted.
      a. This guarantee shall be in the amount not to exceed 20% of 110% of the performance bond amount.
      b. Guarantees shall not be accepted from December 1 through March 1 of any given year.
      c. Maintenance guarantees shall be in a form approved by the City Attorney.
      d. Maintenance guarantees may be required for storm systems that are to remain privately owned and maintained at the discretion of the Board of Public Works and Safety.
   2. Release of Maintenance Guarantees.
      a. Maintenance guarantees shall cover a period of 3 years from the date of acceptance by the City.
      b. Guarantees shall not expire From December 1 through March 1 of any given year unless the Board of Public Works and Safety specifically determines otherwise.

21.02.08. Record Drawings.

As part of the final acceptance process, record drawings of the drainage facilities must be submitted to the City Engineering Department, as set forth herein, for all platted subdivisions and site development plans for both public and private improvements. A qualified professional licensed to practice in the State of Indiana shall certify record drawings. Record drawings shall provide at a minimum the following information:

1. Building pad elevations;
2. Calculated percentage slope in swales, pipes and from building pads;
3. Elevation shots along the flow line of the rear yard swales at its intersection with the property lines, and also at the midpoint of the swale on each lot. In no case shall the distance between elevation shots along the rear yard swale exceed 50';
4. Flow line elevations of the highpoint along sideyard swales;
5. Pipe size and pipe material;
6. Lengths of all pipe structures;
7. Data regarding the stormwater storage basin, including top of bank elevation, invert elevations of primary and emergency spillways, size and pipe material of primary spillway, emergency spillway shape and dimensions, and width of top of embankment;
8. Structure inverts, pipe inverts, top-of-castings;
9. Horizontal alignment of storm drain pipes, culverts, streets and storm drain structures, to a minimum accuracy of ± 2 feet;
10. The horizontal location and/or bank cross-sections for all wet-bottom or dry-bottom storage facilities or other information sufficient to verify that the constructed stormwater storage facility provides the required minimum runoff storage volume;
11. Certified statement on plans stating the completed storm drainage system substantially complies with construction plans as approved by the Board; and
12. Other information which may be requested by the City Engineering Department.

Final record drawings shall not be accepted until the Board of Public Works and Safety accepts the improvements. Record drawings shall be initially submitted as paper copies, while final record drawings shall be submitted as original Mylar copies, and in an electronic format compatible with the City of Greenwood's database.

21.02.09. Land Alteration Permit.

A Land Alteration Permit to begin site development shall not be granted by the Planning Department office until the detailed design drainage plan has been approved by the City Engineering Department, in addition to the execution of required performance guarantees, inspection agreements, and other required documents.

21.02.10. Driveways and Swales.

Driveways should be constructed over swales or ditches within public right-of-way or easements only when the City Engineering Department has permitted appropriate sized culverts or other approved structures.

21.02.11. Waivers from these Regulations.

The Board of Public Works and Safety may grant waivers from these regulations, based on evidence submitted by the developer that the natural surface drainage is adequate, and that a constructed storm water system is not necessary, in which case easements for such natural surface drainage would be provided instead of construction of a storm drainage system. Waivers may be based on "Show no Impact" or a hydraulic study of peak flows.

1. Waiver Guidelines.
   The Board of Public Works and Safety shall not approve waivers unless it agrees with the evidence presented to it by the applicant in each specific case, that:
   a. The granting of the waiver will not be detrimental to the public safety, health, or welfare, or injurious to other property;
   b. The conditions upon which the request for a waiver is based are unique to the property for which a waiver is sought and are not applicable generally to other property;
   c. Because of the particular physical surroundings, shape, or topographical conditions of the specific property involved, a particular hardship to the owner would result, as distinguished from a mere inconvenience, if the strict letter of these regulations are carried out. Financial hardship does not constitute grounds for a waiver;
   d. The waiver is exclusive to the Drainage Ordinance, and shall not in any manner vary the provisions of the Zoning Ordinance, Subdivision Ordinance, Comprehensive Plan or Thoroughfare Plan of the City of Greenwood; and
   e. Where the waiver impacts on design and construction of public facilities, all appropriate public agencies will be given reasonable time to comment in writing to the Board of Public Works and Safety.
2. Conditions of Waivers.
   In order to request a waiver, the petitioner shall submit the proper application form at the time when the drainage plan is filed for consideration with the Plan Commission Office, as part of the application for the subdivision plat or development plan. The contents of the form shall state fully the grounds for the application and all of the facts relied upon by the petitioner.
3. Jurisdiction.
   It is not within the jurisdiction of the Plan Commission to grant waivers to these drainage regulations. Likewise, it is not within the jurisdiction of the Board of Public Works and safety to grant waivers to the subdivision ordinance.

Sec. 10-535 Hydrology and Hydraulics

21.03.01. Determination of Runoff Quantities.

It is the intent of this Ordinance that all runoff generated on the project site be subject to the controlled release rate provisions of this Ordinance. Runoff from adjoining property that flows through the project site must also be addressed. Runoff values for developed conditions should be calculated under the assumption that the tributary drainage area is in its ultimate, fully developed condition.

As described elsewhere in the Ordinance, there are instances where a direct discharge is allowed rather than a controlled release. Where a direct release is allowed, only a peak discharge value may be required. When a controlled release is required, a hydrograph procedure is required, since a volume of runoff must be routed through a stormwater pond. An adequate downstream receiving facility shall be identified on the plans. There shall be no increase in erosion potential on the adjoining properties. All proposed outfalls shall have an adequate receiving facility identified on the plans. There shall be no increase in erosion and sedimentation on adjoining properties. All pipe systems shall accommodate the 10-year storm event with the hydraulic gradeline in the crown of the pipe. In addition, an overflow route for the detention structure shall be provided for the flows resulting from storms with a return period greater than the 10-year. In situations where an overflow route to the detention structure cannot be created, the pipes shall be designed with the 100-year hydraulic gradeline runoff below the top of casting or provide an easement encompassing the 100-year inundated areas. This section describes the recommended procedures for calculating stormwater runoff.

1. Rational Method.

   The Rational Method may be used to calculate peak runoff where:

   a. The total drainage area is 5 acres or less, and
   b. No on-site storage will occur.

   The Rational Method calculates peak discharge only (as opposed to developing a runoff hydrograph for a drainage area). It makes a basic assumption that the design storm has constant rainfall intensity for a time period equaling the project area time of concentration.

   i. The rational method is based on the equation,

   Q = C i A

   Where Q = is the peak runoff rate, cubic feet per second (cfs)

   C = the runoff coefficient (Table _1_)

   i = the rainfall intensity (in/hr)

   A = area of the drainage basin in acres.

   The rainfall intensity is chosen corresponding to the time-of-concentration. The time-of-concentration shall be calculated as described in ii., below.

The following steps summarize the procedure:

- Determine the watershed area;
- Estimate from Table _1_ the runoff coefficient C or the composite area runoff coefficient;
- Calculate the time-of-concentration (per subsection ii.);
- Determine the rainfall intensity (per subsection _iv_).

ii. Time-of-Concentration (Tc)

The time-of-concentration shall be determined using the Time of Concentration or Travel Time Worksheet in Technical Release 55 (TR-55). This method addresses the time-of concentration in three parts. Sheet flow, shallow concentrated flow and channel flow. See Tim of Concentration Worksheet _1_, Manning's roughness coefficients for sheet flow (Table _2_), and the graph for determining the average velocity for shallow concentrated flow (Figure _1_). A minimum time-of-concentration of 5 minutes shall be used for all calculations. In addition, only a 5 minute time-of-concentration may be assumed for calculations. All other times-of-concentration must be supported with calculations.

iii. Curve Number

The curve number shall be calculated using the TR-55 methodology. The composite curve number shall be calculated and documented using Worksheet _2_ and Tables _3_ and _4_ (from TR-55) as appropriate for the project site. The Worksheet and Tables are provided for reference at the end of this Chapter.

iv. Rainfall

Intensities – Rational Method

The rainfall intensities for use in the rational method can be determined using the following equation:

$\mathbf{i = a / (t + b)^N}$ where:

i = intensity, in / hr

t = time (min)

a,b, and ^{N} are values from Table _5_

These variables were determined from the Indianapolis Intensity-Duration-Frequency (IDF) curves (Figure 2). Table _6_ provides intensities for specific durations and return periods.

Tables are provided at the end of this Chapter for use in selecting appropriate values of C (for various land use categories) and I (for the Greenwood area). The Rational Method should be applied using standard engineering procedures as provided in numerous reference books.

2. Hydrograph Procedures.
Determination of runoff for projects that require a stormwater pond must be developed by use of a hydrograph procedure. Hydrographs should be developed by a procedure based on that outlined in Chapter 4 of the USDA Soil Conservation Service (SCS) National Engineering Handbook (NEH-4) or FHWA publication Hydraulic Engineering Circular #19, "Hydrology."

Rainfall Depths – Hydrograph Methods

Rainfall depths for various storm durations and return periods are given in Table _7_ (the Intensity Duration Depth [IDD])

Rainfall Distribution – Hydrograph Methods

All hydrographs shall be generated using the appropriate Huff, 50% rainfall distribution. The Huff Distributions were derived from historical rainfall data in the Midwest. The first quartile is applicable to storm durations up to 6 hours, the second quartile is applicable to storm duration of 6 up to 12 hours, third quartile for durations between 12 and 24 hours and the fourth quartile for storm durations of 24 hours and greater.

A table of the Huff quartile ordinates is given in Table _8_ at the end of this Chapter.
(See also Figure 3, "Second Quartile Huff Rainfall Distribution", and Table 13.).

This procedure makes use of the hydrologic soil group, cover type, land use, hydrologic condition, and antecedent runoff condition. Information regarding soil types in Johnson County and the selection of appropriate runoff curve numbers is provided in Tables 3 and 4 and Figure 4, "Soil and Water Features".

21.03.02. Amount of Runoff to be Accommodated.

Various parts of a drainage facility must accommodate runoff water as follows:

1. Street Drainage.
The street drainage system, such as inlets, catch basins, street gutters, swales, sewers and small channels which collect storm water must accommodate peak runoff from a 10-year return period storm.

a. The allowable spread of water on Collector and Arterial Streets is limited to maintaining two clear 10-foot moving lanes of traffic. One lane is to be maintained on Local Streets.
b. Open channels carrying peak flows greater than 30 cubic feet per second shall be capable of accommodating peak runoff for a 50-year return period storm within the drainage easement.
c. Culverts under roadways designated as thoroughfares, arterials or that provide the only means of ingress and egress to developments shall accommodate the 100-year flow to the culvert without overtopping the roadway. Culverts under collector roadways (those roadways connected to designated thoroughfares and arterials) shall accommodate the 50-year flow to the culvert without overtopping the roadway. All other roadway culverts shall accommodate the 25-year flow to the culvert without overtopping the roadway. Driveway culverts shall accommodate the 10-year flow to the culvert without overtopping the driveway. In no case shall a new culvert be designed to carry less than the existing capacity of the channel.
d. The gutter spread should be determined using the 10-year storm event. The gutter spread shall be computed using the following equation.

$$Q = (0.56 / n)(S_x^{1.67})(S_L^{0.5})(T^{2.67})$$

Where Q = is the peak flow through the gutter on each side of the inlet

n = the Manning's roughness coefficient (Table 9)

S_x = the cross slope of the pavement from the crown to the gutter (ft/ft)

S_L = the longitudinal grade/slope of the street (ft/ft)

T = the width of water extending into the roadway from the vertical gutter face (ft)

Once the peak gutter flow is determined, the maximum drainage area can be calculated using the rational method and the basin characteristics. For a basin consisting only of the roadway itself, the maximum area can be calculated by using a fixed width of the roadway from the crown to the curb and determining the total length required to achieve the maximum flow.

2. Overall Drainage System.
The overall drainage system shall be designed in accordance with Indiana Department of Natural Resources standards. Storm sewers shall be designed for a 10-year storm. Swales shall be designed to accommodate the 10-year storm runoff within the banks. Ditches shall accommodate the 100-year runoff within the banks or a designated easement.

a. Pre-developed runoff rates. Pre-developed runoff rates shall be based on the existing land use at the time the new development is being planned.
b. General Drainage System Design Standards. The drainage system shall be constructed and installed in accordance with plans and specifications approved by the Board of Public Works and Safety. All streets shall have a storm drainage system consisting of curbs, gutters and storm sewers, unless a waiver is granted to the applicant.

c. Storm Sewer Design Standards. All public storm sewers shall conform to the design standards and other requirements contained in this ordinance, and per the standard detail sheets as approved by the Board of Public Works and Safety.

i. Manning Equation. The hydraulic capacity of storm sewers shall be determined using Manning's Equations:

$v = (1.486/n) R2/3 S½$, where

v = mean velocity of flow in feet per second,
R = the hydraulic radius in feet,
S = the slope of the energy grade line in feet per foot,
n = roughness coefficient,

The hydraulic radius, R, is defined as the cross sectional area of flow divided by the wetted flow surface or wetted perimeter. Typical "n" values are listed in Table 10. Roughness coefficient (n) values for other sewer materials can be found in standard hydraulics texts and references.

ii. Velocity. The minimum pipe flow should not be less than 2 ½ feet per second. The maximum pipe velocity is to be 15 feet per second. However, outlet velocities in excess of 5 feet per second will necessitate energy dissipation measures, as approved by the City Engineering Department.

iii. Minimum Pipe Size. The minimum pipe size of all storm sewers shall be 12" diameter. An orifice plate, weir, or other devices, subject to approval of the City Engineering Department shall control the rate of release for stormwater storage, where the pond's primary spillway pipe will not limit the required rate of release.

iv. Grade. Storm sewer grade shall be such that, in general, a minimum of 2 feet of cover is maintained over the top of the pipe. Pipe cover less than the minimum may be used only upon approval of the City Engineering Department. Uniform slopes shall be maintained between inlets, manholes, and inlets to manholes. Final grade shall be set with full consideration of the capacity required, sedimentation problems, and other design parameters. Minimum and maximum allowable slopes shall be those capable of producing velocities of 2 ½ and 5 feet per second, respectively, when the storm sewer is flowing full.

v. Alignment. Storm sewers shall be straight between manholes, insofar as possible. Where long radius curves are necessary to conform to street layout, the minimum radius of curvature shall be no less than 100 feet for sewers 42" and larger in diameter. Deflection of pipe sections shall not exceed the maximum deflection recommended by the pipe manufacturer. The deflection shall be uniform and finished installation shall follow a smooth curve.

vi. Manholes. Manholes shall be installed to provide access to continuous underground storm sewers for the purpose of inspection and maintenance. Manholes shall be provided at the following locations:

a. Where two or more storm sewers converge;
b. At the point of beginning or at the end of a curve, and at the point of reverse curvature (PC, PT, PRC);
c. Where pipe size changes;

d. Where an abrupt change in alignment occurs;
e. Where a change in grade occurs; and
f. At suitable intervals in straight sections of the storm sewer. The maximum distance between storm sewer manholes shall be 300' for pipe 12" through 42", and 500' for pipes larger than 42";

vii. Inlets. Inlets or drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels or culverts. Inlet design and spacing shall be in accordance with INDOT's Road Design Manual or other appropriate design procedure, but in no case may be spaced more than 500 feet apart. Inlets shall be sized and each individual inlet shown on plans. The inlet grate opening provided must be adequate to pass the design 10-year flow with 50% of the sag inlet areas clogged. An overload channel from sag inlets to the overflow channel or basin shall be provided at sag inlets, so that the maximum depth of water that might be ponded in the street sag shall not exceed 6 inches.

viii. Protection of Embankment. Erosion protection shall be provided for the primary outlet and emergency spillway so that the stormwater facility embankment will be adequately protected. The location of the emergency spillway shall be in undisturbed material, unless otherwise approved by the City Engineering Department.

ix. Outlet Conduit. The minimum allowable size for the primary outlet conduit, from the stormwater facility, shall be 12 inches. If further restriction of the outlet conduit is required, the restriction shall be made to the inlet end of the conduit.

x. Outlet Velocity. In those instances where the discharge velocity from the primary outlet or emergency spillway is excessive in the opinion of the City Engineering Department, energy dissipation may be required. In general, outlet velocities in excess of 5 feet per second in earth/grassed channels are considered excessive.

xi. No submerged pipes shall be allowed in any storm detention/retention facility for either the inflow or outflow pipes.

21.03.03. Regional vs. Individual Site Drainage.

All drainage in developed area must be confined and maintained on site through perimeter structures including swales and inlets, and shall be channeled through the stormwater storage area. However, regional stormwater storage may be allowed for a development. In the case of approval of a regional stormwater storage system plan, individual lots shall not create separate lot stormwater storage, but shall follow the regional stormwater storage plan.

21.03.04. Open Channel Design Standards.

1. Manning Equation.
   Open channel design shall be based on the Manning Equation. See Sec. 10-535 (B)2.c.(i) for an explanation of Manning equation. Open channels (swales and ditches) shall be designed using Manning's equation and using Table _11_. The swales should be designed to convey the 10-year storm event within the banks. The 100-year storm event should remain within the easement of the ditch.

2. Minimum Size.
The required channel cross-section and grade are determined by the design capacity, the material in which the channel is to be constructed, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches or streams. The channel grade shall be such that the velocity in the channel is high enough to prevent siltation but low enough to prevent erosion. Velocities less than 1.5 feet per second should be avoided because siltation will take place and ultimately reduce the channel cross-section. The maximum permissible velocities in vegetal-lined channels are shown in Table 12. Developments through which the channel is to be constructed must be considered in design of the channel section.

3. Side Slopes.
Side slopes for grass-lined channels shall be no steeper than 3 to 1. Side slopes for rock riprap-lined channels shall be no steeper than 1 ½ to 1. Channels with vertical walls may be constructed, with approval of the City Engineering Department.

4. Drainage of Vegetated Waterways.
Vegetated waterways that have less than 1 ½ % slope, are subject to low flows of long duration or where wet conditions prevail shall be drained with an underdrain or low flow structure. Lines may be outletted through a drop structure at the end of the waterway, or through a standard tile outlet.

5. Open Channel Design Standards.
For Drainage Swales, longitudinal slopes shall be grass-lined and the minimum standard longitudinal slope shall be 1.30%. If the longitudinal slope of the drainage swale is less than 1.30% but at least 1.00%, a 6" solid perforated underdrain is required which shall outlet into a storm structure or daylight. If the longitudinal slope of the drainage swale is less than 1.00%, a paved concrete swale as approved by the engineering department shall be required and the minimum slope of the paved concrete swale shall be 0.50% (The minimum longitudinal slope shall be 0.50%).

6. Alternative swale/ditch treatments.
Alternative open channel treatments shall be subject to approval of the City Engineering Department. All channels shall be lined with material capable of withstanding the shear stress from the proposed design velocity. Channels that convey runoff with velocity greater than 5 fps will be required to have invert treatment. A table of channel linings and maximum velocities is provided at the end of this Chapter as Table 12.

7. Channel Stability.
All swales shall be blanketed (not seeded), so erosion control extends completely to the top of the bank.

8. Effect of Channel Improvements.
The effect of channel improvements on existing culverts, bridges, buried cables, pipelines and inlet structures for surface and subsurface drainage on the channel being improved and laterals thereto shall be evaluated to determine the need for modification or replacement. Culverts and bridges which are modified or added as part of channel improvement projects shall meet reasonable standards for the type of structure, and shall have a minimum capacity equal to the design discharge or governmental agency design requirements, whichever is greater.

9. Disposition of Spoil.
Spoil material resulting from clearing, grubbing and channel excavation shall not stay on the site unless it is to be used as part of the approved grading plan. In no case shall spoil be deposited in the floodway. Excavated materials, when stored temporarily on-site, must be handled in accordance with the Rule 5 Erosion Control Plan and the erosion control measures included in the construction plans.

10. Flood Modeling. On lands that adjoin a ditch, stream, or river that has a watershed of 25-acres or greater, upstream from the subject parcel, the base flood elevation (BFE) shall be provided for the entire stream reach through the affected property. If available the BFE shall be determined from a Flood Insurance Rate Study (FIS) or DNR approved study. If no published BFE is available for the watershed the submitting engineer must determine the BFE. The US Army Corps of Engineers HEC-2 or HEC-RAS programs shall be acceptable methods. Any other methods must be approved by the City Engineering Department.

21.03.05. Construction and Materials.

1. Construction.
Specifications shall be in keeping with the current standards on file with the Johnson County Soil and Water Conservation District, and shall describe the requirements for proper installation of the project to achieve its intended purpose.

2. Street Drainage.
Street drainage shall be divided to drain on both sides of the street, and shall comply with the City's approved standard details, as adopted by the Greenwood Board of Public Works and Safety.

3. Materials.
Storm Sewers. Pipes shall comply with the City's approved standard detail. End treatments shall be slopewalls or reinforced concrete end sections. Storm sewers within public right-of-way or to be accepted by the City shall be reinforced concrete pipe, unless otherwise approved by the City Engineering Department.

Open Channels. Materials acceptable for use as channel lining are grass, revetment rip-rap, concrete, hand-laid rip-rap, pre-cast cement concrete rip-rap, grouted rip-rap, and gabions. Lining materials shall receive specific approval of the City Engineering Department. Materials shall comply with the latest edition of INDOT's Standard Specifications.

(Ord. No. 02-07, §1, 3-18-02)
(Ord. No. 04-55, §10 & 11, 1-17-05)

4. Special Hydraulic Structures.
   Special hydraulic structures, including junction chambers, drop manholes, inverted siphons, stilling basins, energy dissipation structures, etc. shall be used only if they match one of the City's approved standard details or if approved by the City Engineering Department.

21.03.06. Stormwater Storage.

The following shall govern the design of any improvement with respect to the temporary storage of stormwater runoff.

1. Acceptable Storage Methods.
   Increased stormwater runoff resulting from a proposed development should be detained on-site by the provision of appropriate stormwater storage ponds. Storage of stormwater shall not be allowed to occur within any swales.

2. Design Storm.
   Design of stormwater storage facilities shall be based on a return period of once in 100 years. The storage volume and outflow rate shall be sufficient to handle storm-water runoff from a critical duration storm, as defined in this Ordinance.

3. Allowable Release Rate ("Peak Flows").
   The allowable release rate of stormwater originating from a proposed development shall not exceed a 2-year pre-developed rainfall event rate for a 10-year post-developed storm, and a 10-year pre-developed outlet rate for a 100-year post-developed storm, and as described by the determination of storage volumes through hydrograph methods (See Sec. 10-535 (F) 5.) In any case the system must assure adequate positive outfall to a recognized water way or drainage facility.

   In the event that the natural downstream channel of the storm sewer system is inadequate to accommodate the release rate provided above, then at the discretion of the City Engineering Department, one of the following alternative solutions must be selected:

   a. The allowable release rate shall be reduced to that rate permitted by the capacity of the receiving downstream channel or storm sewer system, and additional storage volume determined by the Board shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways; or

   b. The developer must correct the downstream restriction.

   If more than one stormwater basin is involved in the development of the area upstream of the limiting restriction, the allowable release rate from any one basin shall be in direct proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.

4. Drainage System Overflow Design.

   Drainage systems shall have adequate capacity to convey the stormwater runoff from all upstream tributary areas through the development under consideration for a storm of 100-year design return period calculated on the basis of the upstream land in its present state of development.

   The Board of Public Works and Safety or the City Engineering Department may approve, upon review of evidence submitted by the developer, an allowance, equivalent to the reduction of flow rate provided, for upstream storage when such upstream storage and release rate have previously been approved by the Board and evidence of its construction can be shown.

5. Determination of Storage Volume.

   Hydrograph Method. For developments requiring that stormwater storage be provided, the hydrograph methods shall be used to determine the required volume of stormwater storage.

21.03.07. General Stormwater Basin Design Requirements.

Basins shall be constructed to detain temporarily the stormwater runoff that exceeds the maximum peak flow rate authorized by this Ordinance. The volume of storage provided in these basins shall be sufficient to control excess runoff from the 100-year storm.

1. Detention ponds collecting watersheds greater than 5 acres and facilities not designed using the rational method shall be designed by hydrograph routing techniques. The 0.5, 1, 2, 3, 6, 12, and 24-hour duration storms shall be routed to determine the peak release rates, maximum pond elevation and required peak volumes for the 2-year, 10-year, and 100-year storm events. The peak elevations shall be shown on the grading plan. Fully developed conditions of the watershed shall be used.
2. Runoff for upstream off-site development will flow through the site, but will not be stored. The 100-year run-off under existing upstream conditions shall be determined, and this shall be used in sizing the emergency spillway for the pond.
3. The 100-year runoff for the fully developed watershed routing shall determine the maximum 100-year pool elevation, the maximum routed 100-year peak discharge, and the maximum 100-year pond storage requirement for the design storm. The maximum fully-developed routed 100-year peak discharge shall be equal to or less than the 10-year frequency peak discharge from the watershed under pre-developed conditions.
4. The 10-year peak run-off for the fully developed watershed must be routed through the stormwater pond and have a routed peak discharge rate not to exceed the pre-developed 2-year peak discharge rate.
5. The lip of the emergency spillway shall be established at or above the routed 100-year pool elevation. The pond embankment shall have a minimum freeboard of two feet between the maximum routed 100-year pool elevation and the top of the facility embankment.
6. The emergency spillway shall be designed by routing the 100-year peak run-off through the pond assuming that the primary spillway is not operating. This peak storm run-off should be routed through the basin with the maximum pool level below the top of the embankment.

7. All stormwater storage facilities shall be separated by a minimum of 50 feet from any primary building or structure to be occupied. A 20' wide easement around the perimeter of the pond, measured from top of bank shall be required. Off-site or other access easements may be required by the City, based on the location of primary and emergency pond spillways, and their proximity to adjacent property.
8. Outlet control structures shall be designed to operate as simply as possible and shall require little or no maintenance and/or attention for proper operation. They shall limit discharges into existing or planned downstream channels or conduits so as not to exceed the predetermined maximum authorized peak flow rate. This facility shall be designed to allow easy access from the embankment to remove trash and debris from the outlet structure.
9. Emergency access easements (easement) shall be provided for all stormwater conveyances and facilities to be maintained by the City of Greenwood. In addition, easements shall be provided for all conveyances, including ponds, carrying runoff from off-site drainage basins and for any pond serving greater than 5 acres. Regulated Drains (proposed and existing) may have additional easement requirements to ensure the provisions of this Chapter and the Stormwater Drainage and Sediment Control Ordinance are met. The City Engineering Department shall be contacted to determine any special requirements prior to design. All stormwater conveyances must be centered within the required drainage easement. Easements for all drainage conveyances, retention/detention facilities, floodways and floodway fringes, and BMP's must be exclusively Drainage Easements and can not be shared with utilities or used as vehicular access easements.

   Stormwater BMP's used for the water quality requirements must maintain easements as well. Stormwater ponds shall maintain the same easement as required for a detention facility. Off-line manufactured BMP's structures should maintain an easement that includes the connecting manholes and the weir structure. All easements should be clearly included on the plans. On a case-by-case basis the City Engineering Department may determine additional easement requirements. The City Engineering Department may require such additional easement requirements as are necessary to ensure that the provisions of this Chapter and the Stormwater Drainage and Sediment Control Ordinance are met.
10. Emergency overflow facilities such as a weir or spillway shall be provided for the release of exceptional storm runoffs or in emergency conditions should the primary spillway become totally or partially inoperative. The overflow facility shall be of such design that its operation is automatic and does not require manual attention. All stormwater storage facilities shall be provided with an emergency spillway.
11. Sod or other vegetative cover acceptable to the City Engineering Department shall be provided throughout the entire basin area. Grass should be cut regularly at approximately monthly intervals during the growing season or as required.
12. Debris and trash removal and other necessary maintenance shall be performed regularly by the designated body (e.g., developer or homeowner's association) to assure continued operation in conformance to design.
13. A report shall be submitted to the Office of the City Engineering Department describing the proposed development, the current land-use conditions, the method of hydraulic and hydrologic analysis used (including any assumptions or special conditions), the results of the analysis, and the recommended drainage control facilities. Hydraulic and hydrologic calculations, including input and output files, shall be included as appendices to the report.

(Ord. No. 02-07, §1, 3-18-02)
(Ord. No. 04-55, §13, 1-17-05)

14. Drainage easement. All stormwater storage facilities should be located in a drainage/utility easement so that the City can access the facility under emergency conditions.

21.03.08. Dry-Bottom Basin Design Requirements.

Dry-bottom stormwater storage basins shall only be permitted if approved by the Board of Public Works and Safety as a waiver, under the conditions of this ordinance. Stormwater storage facilities, which are designed to have dry bottoms, must be designed to include underdrains that shall connect to a storm structure or daylighted to drain the bottom of the stormwater storage facility, so that the facility can be maintained. Also, the bottom of the facility shall be designed to have a longitudinal slope of 1.3% and traverse grade to the outlet, so that the facility will empty, leaving no ponded water.

21.03.09. Wet-Bottom Basin Design Requirements.

Where part of a stormwater basin will contain a permanent pool of water, all the items required for stormwater storage shall apply except that the system of drains with a positive gravity outlet required to maintain a dry-bottom basin will not be required. A controlled positive outlet will be required to maintain the design water level in the wet-bottom basin and provide required temporary storage above the design water level (permanent pool). However, the following additional conditions shall apply:

1. Stormwater basins designed with permanent pools shall have a water area of at least one-half acre surface area, and a minimum surface width of 50 feet. The pond shall have a minimum water depth of 10 feet, except for the side slopes;
2. Stormwater basins shall be designed in compliance with the City of Greenwood's Standard Detail;
3. In the case of valley storage, natural slopes may be considered to be stable;
4. A safety ledge shall be provided per the City's standard detail must be installed in all ponds;
5. There shall be a minimum easement width around the pond of 20 feet <u>from top of bank</u>, with an additional easement area adjacent to the pond large enough to serve as a staging area for maintenance equipment such as dredges and dump trucks and as a boat launch area; and
6. Periodic maintenance by the developer/owner is required in ponds to control weed and larval growth. The pond shall also be designed to provide for the easy removal of sediment that will accumulate during periods of pond operation. A means of maintaining the designed water level of the pond during prolonged periods of dry weather is also required.

21.03.10. Roof Top Storage.

Stormwater storage requirements shall not be met by temporary storage on flat roofs.

21.03.11. Paved Parking Lot Storage.

Paved parking lots may be designed to provide temporary storage of stormwater on all or a portion of their surfaces, up to a maximum depth of 6 inches. Outlets will be designed to empty the stored waters slowly. The developer must identify the area for storage, subject to approval by the City Engineering Department. Parking lot detention facilities may not accept runoff from off-site drainage basins and must have an appropriate emergency overflow route.

(Ord. No. 02-07, §1, 3-18-02) 1089.65 [Rev. 01-05]
(Ord. No. 04-55, §13-16, 1-17-05)

21.03.12. Underground Detention Requirements.

Underground detention facilities may not accept runoff from off-site drainage basins and must include emergency overflow facilities, including a flow path. Appropriate details of each pond design must be included on the plans. The appropriate normal pool elevation, 2-year, 10-year, and 100-year water surface elevations must also be indicated on the grading plan.

21.03.13. Facility Financial Responsibilities.

The construction cost of the stormwater control systems and facilities as required by this Ordinance shall be accepted as part of the cost of land development, and the developer shall be responsible for all costs.

21.03.14. Facility Maintenance Responsibilities.

Maintenance of stormwater facilities during construction and thereafter shall be the responsibility of the land developer/property owner. Assignment of responsibility for maintenance of drainage facilities serving more than one lot shall be part of appropriate covenants to property deeds. The City shall not be responsible for maintenance of drainage facilities unless the Board of Public Works and Safety formally agrees to accept responsibility for maintenance.

21.03.15. Joint Development of Control Systems.

Stormwater control systems may be planned and constructed jointly by two or more developers as long as compliance with this Ordinance is maintained.

21.03.16. Installation of Erosion Control Systems.

Runoff and erosion control systems shall be installed as soon as possible during the course of site development. Perimeter and entrance/exit erosion facilities are required prior to the start of any site work. Basins should be designed to collect sediment and debris in specific locations so that removal costs are kept to a minimum.

21.03.17. Stormwater Storage Facilities in Floodway and Floodway Fringe Areas.

No storage facilities shall be permitted in the floodway or floodway fringe.

21.03.18. Off-Site Drainage Provisions.

When the allowable runoff is released in an area that is susceptible to flooding, the developer may be required to construct appropriate storm drains through such area to avert increased flood hazard, caused by the concentration of allowable runoff at one point, instead of the natural overland distribution. The requirement of off-site drains shall be at the discretion of the City Engineering Department.

21.03.19. Standard Details.

Standard detail sheets are adopted by the Greenwood Board of Public Works and Safety, which has the authority to enforce these regulations.

(Ord. No. 02-07, §1, 3-18-02)
(Ord. No. 04-55, §17-24, 1-17-05)

21.03.20 Water Quality.

Unless determined by the City Engineering Department that a project is exempt, the following criteria shall be addressed for stormwater management at all sites: The plan sheets shall specify stormwater best management practices (BMPs) (stormwater quality treatment systems) to be implemented, operated and maintained to meet water quality requirements. Because water quality requirements vary depending on the uses of the water bodies in the watershed, a framework methodology is provided here.

1. Treatment Objective.
   The City of Greenwood has adopted a policy that the control of stormwater runoff quality will be based on the management of total suspended solids (TSS). Control of sediment is required for construction site run off within the City.

   For new and existing development areas that disturb one (1) or more acre of land, or disturbances of less than one (1) acre of land that are part of a larger common plan of development, whether for sale or lease, (if the larger common plan will ultimately disturb one (1) or more acres of land), or for new and existing development that disturb more than 0.5 acres, structural BMPs shall be designed to comply with this manual. It is presumed that a BMP complies with this standard if it is:

   - sized to capture the prescribed water quality volume (WQ_v) or water quality treatment rate,
   - constructed properly, and
   - maintained regularly.

   The following requirements shall be fulfilled:

   (a) All stormwater runoff generated from land development and land use conversion activities shall not discharge untreated stormwater runoff directly into a jurisdictional wetland or local water body without adequate treatment. Where such discharges are proposed, the impact of the proposal on the wetland shall be assessed using a method acceptable to the City Engineering Department. In no case shall the impact by any less than allowed by the Army Corp of Engineers (ACOE) or IDEM.

   (b) Infiltration practices shall not be allowed where stormwater is generated from highly contaminated source areas as recognized by the EPA, IDEM or the City Engineering Department; where stormwater is carried in a conveyance system that also carries contaminated, non-stormwater discharges; where stormwater is being managed in a designated groundwater recharge area; and under certain geologic conditions (e.g. karst) that prohibit the proper pretreatment of stormwater.

   (c) Land Development projects shall comply with the water quality performance-based criteria in accordance with the following:

A BMP shall be located, designed, and maintained to achieve the target pollutant removal efficiencies to effectively reduce the pollutant load to the required level.

(d) Stormwater discharges to critical areas with sensitive resources (I.e., cold water fisheries, shellfish beds, swimming beaches, recharge areas, water supply reservoirs) may be subject to additional criteria, or may need to utilize or restrict certain stormwater management practices at the discretion of the City Engineering Department.

(e) Industrial sites which are listed under the Standard Industrial Code are required to prepare and implement a stormwater pollution prevention plan, and shall file a notice of intent (NOI) under the provisions of the National Pollutant Discharge Elimination System (NPDES) general permit. The stormwater pollution prevention plan requirement applies to both existing and new industrial sites.

(f) Stormwater discharges from land uses or activities with higher potential pollutant loadings may require the use of specific structural BMPs and pollution prevention practices at the discretion of the City Engineering Department.

(g) Prior to design, applicants are required to consult with the City Engineering Department to determine if they are subject to additional stormwater design requirements.

(h) Discharges will not be allowed directly into sinkholes or fractured bedrock, without treatment that results in discharge meeting Indiana ground water quality standards as referenced in 327 IAC 2-11.

(i) Any stormwater practice that is a Class V injection well must ensure that the discharge from such practices meets Indiana ground water quality standards as referenced in 327 IAC 2-11.

2. Plan Requirements.

Pursuant to the Ordinance all Stormwater Management Plans must include the following:

(a) Location, dimensions, detailed specification, and construction details of all post construction stormwater quality treatment BMPs.

(b) A description of those measures (BMPs) that will be installed to treat stormwater discharges that will occur after construction activities are completed.

(c) A sequence describing when each post construction stormwater quality treatment BMP will be installed.

(d) Stormwater quality treatment BMPs that will remove or minimize pollutants from stormwater run-off.

(e) Stormwater quality treatment BMPs that will be implemented to prevent or minimize adverse impacts to stream and riparian habitat.

(f) An Operation and Maintenance manual.

3. Operations and Maintenance Manual

Each BMP on a site must have an operations and maintenance (O&M) manual. The O&M Manual must be submitted with the Stormwater Management Plan. The approved O&M manual must be signed by and provided to the BMP owner and the City Engineering Department. The O&M manual shall include the following:

(a) BMP owner name and contact person, address, and contact information, i.e. business phone, fax e-mail, pager, cell phone, etc., as appropriate;

(b) Site drawings clearly indicating the location of the BMP and including plan and cross-sectional details, showing the BMP and applicable features. Dimensions, easements (as previously defined), outlet works, forebays, signage, connecting structures, weirs, invert elevations, etc. shall be clearly indicated on the plans and details;

(c) Guidance on both owner-required periodic inspections and inspections to be performed by the City Engineering Department;

(d) Guidance on routine maintenance, including mowing, litter removal, woody growth removal, etc.;

(e) Guidance on remedial maintenance, such as inlet replacement, outlet work, etc.;

(f) Guidance on sediment removal, both narrative and graphical, describing when sediment removal shall occur in order to insure that the BMP remains effective as a water quality and/or quantity control device;

(g) A statement that the City Engineering Department has the right to enter the property to inspect the BMP;

(h) A tabular schedule showing inspections and maintenance requirements;

(i) Identification of the property/BMP owner as the party responsible for maintenance, including cost; and

(j) A text or graphic narrative of the easement around the BMP.

Completed inspection forms must be maintained by the BMP owner and produced upon request by the City Engineering Department. The City Engineering Department must be notified of any changes in BMP ownership, major repairs, or BMP failure in writing within 30 days of the change. The letter should be addressed to:

City of Greenwood
Engineering Department
225 S. Emerson Avenue, Suite A
Greenwood, IN 46143

In the event that the City Engineering Department finds that a BMP is in need of maintenance or repair, the City Engineering Department will notify the BMP owner of the necessary maintenance or repairs and give the landowner 60-calendar days for completing the maintenance or repairs. If the maintenance or repairs are not completed within the 60-calendar days, the City Engineering Department shall perform the repairs or maintenance and bill the landowner for the actual costs for the work and if not paid shall become a lien on the property.

4. Water Quality Volume / Rate Calculations

In order to protect and maintain water quality, a portion of the stormwater runoff created by the development project must be treated. BMPs may be designed to treat on a volumetric basis or flow rate basis. The runoff volume to be treated or the peak flow rate to be treated by a BMP shall be determined by the following methods.

(a) Water Quality Volume

The volume of stormwater runoff to be captured, stored, and treated is called the Water Quality Volume ("WQv").

The formula for determining WQv is:

$$\mathbf{WQv = \frac{(P)\,(Rv)\,(A)}{12}}$$

where:

WQv = water quality volume (acre-feet)
P = rainfall depth (inches); the volume of rainfall for 90% of the storm events which produce runoff in the watershed annually (e.g., 1.0 inches)
A = project area (acres)
Rv = volumetric runoff coefficient; [0.05 + 0.009(I)], where I is the percent impervious cover on the site as defined by the area that does not have permanent vegetative or permeable cover.

(b) Water Quality Treatment Rates

The peak water quality treatment rate shall be determined using hydrograph generation methods. The hydrograph shall use the Huff 1st Quartile, 50% distribution with a 0.5 inch rainfall and a one-hour storm duration. The peak rate of this hydrograph shall be used as the minimum water quality treatment rate.

Documentation for all proposed manufactured BMPs shall be provided clearly demonstrating the BMP will remove 80% of the particles listed below at this peak flow rate.

Runoff Particle Distribution

Particle Size (μm)	% of TSS
250	20
125	40
75	40

5. Pretreatment

Several practices that are not capable of providing water quality treatment can nonetheless function in a pretreatment role or as a supplemental practice. These practices can often be incorporated into the Stormwater Management Plan design as pretreatment devices, to treat a small portion of a site, or in retrofit or redevelopment applications. Some of these practices, including dry ponds and underground storage vaults, can be used to meet water quantity goals such as channel protection and flood control requirements. In addition, some of these practices may be helpful to reduce the total volume of runoff from a site or to disconnect impervious surfaces. Some practices ***not*** currently deemed effective for stand-alone water quality treatment include:

- Catch basin inserts
- Dry Ponds
- Underground vaults (designed for flood control)
- Oil/grit separators
- Filter strips
- Grass channels (includes ditches designed primarily for conveyance as well as modified practices that can achieve some pollutant removal)
- Deep sump catch basins
- On-line storage in the storm drain network
- Porous pavement

The City Engineering Department shall determine, in its discretion, whether a practice is effective for pretreatment.

6. Primary Treatment

   Effective storm water management is often achieved from a management systems approach. A combination of BMPs can be used to meet the water quality treatment requirements.

7. Specific Practices

   The principles and practices provided by the State in Rule 13 (327 IAC 15-13) and in Rule 5 (327 IAC 15-5) are to be followed in the development of all water quality treatment options. Rule 14 (327 IAC 15-13) and Rule 5 (327 IAC 15-5) do not give specific requirements for use of various practices leaving that to the localities. The designer and operator shall rely on the EPA's Stormwater Phase II Menu of Best Management Practices (BMPs) as well as the Indiana BMP manual (as it is developed and updated), currently under development by the State of Indiana, for detailed design, construction and maintenance criteria for water quality treatment. Stormwater quality treatment systems will be approved on a case-by-case basis by the City Engineering Department. As the City Engineering Department develops a more specific and comprehensive menu of stormwater treatment BMPs that information will be included in updated versions of the Stormwater Drainage and Sediment Control Ordinance.

8. Regional Stormwater Management Plans

   Applicants are directed to communicate with the City Engineering Department prior to submitting an application for stormwater management plan approval to determine if a Regional Stormwater Management Plan has been developed for the applicable watershed. If such a plan is in existence, the applicant must provide stormwater management water quality treatment on-site in accordance with the provisions of the regional plan, and other management provisions as specified by the City Engineering Department.

21.03.21. Soil Erosion and Sedimentation Control.

The purpose of this section is to control soil erosion, sediment damages, and related environmental damage by requiring adequate provisions for surface water detention/retention and drainage and for the protection of exposed soil surfaces in order to promote the safety, public health, convenience, and general welfare of the citizens of the City of Greenwood.

The volume and rate of any stormwater discharges allowed under this Ordinance must be managed to prevent the physical degradation of receiving waters, such as by streambank scour and erosion. The following requirements are necessary for soil erosion and sedimentation control:

1. All persons who cause, in whole or in part, any earth change to occur shall provide erosion and sedimentation control so as to adequately prevent soils from being eroded and discharged or deposited onto adjacent properties or into a stormwater drainage system, a public street or right of way, wetland, creek, stream, water body, or floodplain.

2. All development shall be in accordance with all applicable federal, state and local ordinances, rules and regulations.

3. During any earth change, which exposes soil to an increased risk of erosion or sediment track-out, the property owner and other persons causing or participating in the earth change shall do the following:

   (a) Comply with the stormwater management standards of this Ordinance.

   (b) Obtain and comply with the terms of a soil erosion and sedimentation control permit if required by law.

   (c) Prevent damage to any public utilities or services within the limits of grading and within any routes of travel or areas of work of construction equipment.

   (d) Prevent damage to or impairment of any water body on or near the location of the earth change or affected thereby.

   (e) Prevent damage to adjacent or nearby land.

   (f) Apply for all required approvals or permits prior to the commencement of work.

   (g) Proceed with the proposed work only in accordance with the approved plans and in compliance with this Ordinance.

   (h) Maintain all required soil erosion and sedimentation control measures, including but not limited to, measures required for compliance with the terms of this manual.

   (i) Promptly remove all soil, sediment, debris, or other materials applied, dumped, tracked, or otherwise deposited on any lands, public streets, sidewalks, or other public ways or facilities, including catch basins, storm sewers, ditches, drainage swales, or water bodies. Removal of all such soil, sediment, debris or other materials within twenty-four (24) hours shall be considered to comply with this requirement, unless such materials present an immediate hazard to public health and safety.

   (j) Refrain from grading lands at locations near or adjoining lands, public streets, sidewalks, alleys, or other public or private property without providing adequate support or other measures so as to protect such other lands, streets, sidewalks or other property from settling, crackling or sustaining other damage.

   (k) Request and obtain inspection of soil erosion and sedimentation control facilities, by the City Engineering Department or its designee. Qualified personnel provided by the owner or operator shall inspect construction sites for which the City Engineering Department or its

designee will not perform inspections. The qualified person shall inspect all disturbed areas which are not finally stabilized, storage areas of possible polluting agents such as paints, solvents, fuels, fertilizers and pesticides that are exposed to precipitation, structural control measures and locations of vehicle entrance and exit at least once every seven (7) calendar days and, for sites which disturb greater than five (5) acres, within 24 hours of the end of a storm that is 0.5 inches or greater. Inspections will continue until all disturbed areas are stabilized, structural controls are removed or converted to stormwater management facilities, and stored materials are removed from exposure. Corrective action will be taken for all noted deficiencies. Such actions will be initiated within 24 hours of inspection notification.

(l) Follow the minimum design standards of this manual to protect properties and receiving waterways downstream of any land development project from erosion and damage due to increases in volume, velocity and frequency of peak flow rate or stormwater runoff.

4. Land alterations, including regrading, which strip the land of vegetations, shall be accomplished in a manner, which minimizes erosion or the addition of sediments to natural and mandmade drainageways. This will reduce the impact on adjacent properties and water quality of receiving waters. Whenever feasible, natural vegetation shall be retained, protected and supplemented.

5. Cut and fill operations shall be kept to a minimum to endure conformity with existing topography to reduce the potential erosion. Applicants shall follow the procedures and comply with the requirements of Rule 5 (327 IAC 15-5), regarding sediment and erosion control during construction.

6. Sediment controls shall be installed whenever runoff from disturbed portions of the parcel will leave the parcel. Sediment controls may include vegetative buffer strips, filter barriers, sediment basins, debris basins or silt traps. Vegetative buffer strips shall only be used where runoff is dispersed and exits the parcel as sheet flow. Filter barriers shall not be used in areas of concentrated flow. Synthetic filter fences are more effective than straw bales and shall be used in series. Straw bales shall also be anchored with stakes and grounded to reduce unfiltered underflow by burying the lower 3 inches of each bale.

7. Any flow from a disturbed parcel shall pass through a vegetative filter barrier or sediment basin before entering a storm drain inlet. Existing inlets or those being constructed in a disturbed area shall have all flow diverted away from them, be plugged or protected by a filter. Downstream development parcels shall be protected from increases in volume, velocity, and sediment load or peak flow rates.

8. The duration of time, which an area remains exposed, shall be kept to a practical minimum and the area stabilized as quickly as possible. Temporary vegetation or mulch shall be used to protect exposed areas during development. For areas subject to daily disturbance, a weighted cover of impermeable material may be used, if approved by the City Engineering Department.

9. Stockpiles shall be located outside of drainage ways and the 100-year floodplain. It may be necessary to divert drainage around a stockpile that must be located in a drainage way.

(Ord. No. 02-07, §1, 3-18-02)
(Ord. No. 04-55, §26, 1-17-05)

10. Soil stabilization shall be maintained in an effective condition throughout construction until permanent vegetation stabilization is achieved.

11. Permanent vegetation or structural erosion control devices shall be installed as soon as practical after as-built topographic conditions are finalized.

12. Permanent stabilization requires permanent structures, pavement or vegetation sufficiently mature to withstand annual climate cycle or permanent mulch.

(a) Plan Requirements.

If the owner or operator is required to prepare an erosion and sedimentation control plan (ESCP) under Rule 5 (327 IAC 15-5) and/or Rule 6 (327 IAC 15-6) and/or Rule 13 (327 IAC 15-13), all applicable state and federal permits or notices for land disturbing activities shall be obtained or filed prior to commencement of land disturbing activities. All applicable state or federal standards shall be adhered to when conducting land-disturbing activities. For land disturbances within the MS4 area that are greater than or equal to one (1) acre, or disturbances of less than one (1) acre of land that are part of a larger common plan will ultimately disturb one (1) or more acres of land, copies of all applications, letters of intent submittals, plans and other erosion and sediment control related information shall be submitted to the City Engineering Department. The construction project site owner shall also submit a copy of the application directly to the IDEM. (Johnson County Soil and Water Conservation District)

If an ESCP is prepared, it shall be prepared under the supervision of, and certified by a registered professional and shall include at a minimum the requirements as specified in Rule 5 (327 IAC 15-5).

(b) General Criteria for Erosion and Sediment Control Practices.

i. Perimeter Control and Sediment Trapping – Perimeter control and other sediment trapping measures shall be installed as specified on the approved plan, including: construction access drives, straw bale dams and fabric fencing, temporary sediment traps. Sediment basins, and diversions. Also storm drain system inlet shall be protected from sedimentation.

ii. Vegetative Control – Disturbed areas, which are at finish grade, shall be permanently seeded within seven (7) days. At the discretion of the City Engineering Department, barren areas to be rough graded and left undisturbed for more than thirty (30) days shall be established with temporary vegetation; and dormant seeding will be required during seasonal periods (October through February) for those barren areas to be left undisturbed for one-hundred and twenty (120) days or longer.

iii. Slope Protection – Slope protection shall be provided by use of temporary and permanent diversion dikes, vegetative cover, and slope drains. Concentrated stormwater flows shall not be allowed to flow down cut or fill slopes without proper slope stabilization.

iv. Protection of Outlet Channel – Concentrated stormwater runoff leaving a development site shall be outlet to an open channel, storm sewer pipe inlet or culvert, which is capable of receiving this discharge. Runoff velocities shall be controlled during all storm events, up to the 100-year return interval storm, so that the peak runoff velocity during and after the completion of the land alteration approximates existing conditions.

v. Waste, Debris, and Pollution Elimination – Appropriate measures shall be taken to minimize or eliminate wastes and unused building materials and all pollutants from being carried from the site by runoff. Proper storage, handling and use of all potentially polluting substances shall be employed.

vi. Roadways – Public and private roadways shall be kept clear of accumulated sediment. Bulk clearing of accumulated sediment shall not include flushing the area with water.

(c) Specific Practices

The principles and practices provided by the State in Rule 5 (327 IAC 15-5) are to be followed in the development of all ESCPs. Rule 5 (327 15-5) does not give specific requirements for use of various practices leaving that to the localities. The designer and operation shall rely on the Indiana Handbook for Erosion Control in Developing Areas (HECDA) or an approved equivalent for detailed design, construction and maintenance criteria for all erosion control practices. The manual may be obtained from:

Urban Conservation Program
Division of Soil Conversation
Indiana Department of Natural Resources
402 West Washington Street, Room W-265
Indianapolis, IN 46204-2748
Tel: (317) 232-4180

21.03.22. Other Requirements.

1. Sump Pumps.
Sump pumps shall adhere to the requirements set forth in Section 10-524 of the Greenwood Municipal Code. In no case shall a sump pump be used for more than one function; sump pumps shall be used only for the discharge of stormwater. Sump pumps shall be discharged onto a grass surface in the side or rear yard, no closer to the street than the building setback line. (Ord. No. 03-41, § 6, 10-20-03)

2. Downspouts and Roof Drains.
All downspouts or roof drains shall be discharged, no closer to the street than the building setback line. In no case shall a downspout or roof drain be connected to the sanitary sewer.

3. Footing Drains and Drainage Tiles.
   Footing drains and drainage tiles shall be connected to designated storm drainage channels. In no case shall a footing drain or drainage tile be connected to the sanitary sewer.

4. Basement and Garage Floor Drains.
   Basement and garage floor drains shall be connected to the sanitary sewers.

5. Outlet Points.
   A sump pump discharge pipe which outlets onto the surface of the ground shall have its point of discharge outside the boundaries of any drainage or utility easement or street right-of-way. Discharge pipes directed toward or into an open drainage swale or ditch shall provide sufficient separation distance so as to provide sufficient area for reasonable absorption of water into the soil without creating erosion control problems.

6. Open Street Drains Prohibited.
   No person or persons shall connect or construct a sump pump or floor drain from the basement or crawl space of any building or structure so as to spill the discharge water onto a public street. Such discharges must drain directly into a storm sewer (or appurtenant structure) in compliance with Sec. 10-524, or drain directly into a drainage ditch or swale. (Ord. No. 03-41, § 6, 10-20-03)

7. Facility Maintenance and Inspection Responsibilities
   a. It shall be the responsibility of the developer/owners to maintain all detention/retention facilities, BMPs and drainage easements on their property. If there are more than one lot or holding served by the facility this shall be documented on the property deeds and recorded on the plat unless responsibility is formally accepted by a public body. This shall be determined prior to final drainage plan approval. In addition, the developer/owners shall be responsible for getting an annual inspection of each BMP.

   b. Failure of the developer/owner to maintain such easements or facilities as approved in the original plan shall constitute a violation of the Greenwood Stormwater Drainage and Sediment Control Ordinance and subject the developer/owner to the penalty provided in Section 10-538, *21.06.05 Penalties for Water Quality Stormwater Drainage and Sediment Control Ordinance Violations.*

   c. Annually, thirty (30) days prior to the anniversary date of the acceptance of the improvements, to thirty (30) days after said anniversary date, the developer/owner shall contact the City Engineering Department to schedule an inspection of each BMP and detention/retention facility maintained by the developer/owner. An inspection fee shall be charged the developer/owner by the City Engineering Department for each BMP and detention/retention inspected. Payment shall be made to the Clerk-Treasurer of the City of Greenwood. The fee shall be set at the same amount, and subject to the same agreement terms, as the fee set by the Board of Public Works and Safety for inspection and testing of sanitary sewer lines pursuant to Greenwood Municipal Code Section 9-134.

d. Failure of the developer/owner to have each BMP and detention/retention facility inspected annually or failure to schedule the inspection shall be a violation of the Greenwood Stormwater Drainage and Sediment Control Ordinance and subject the developer/owner to the penalty provided in Section 10-538, *21.06.05 Penalties for Water Quality Stormwater Drainage and Sediment Control Ordinance Violations.*

e. If the annual inspection finds a BMP or detention/retention facility to be deficient the developer/owner shall be given 60 calendar days to correct the deficiency. However, if in the judgment of the City Engineering Department such deficiency poses a threat to the public health, safety, or welfare, the City has the right and authority to repair the deficiency at developer/owner's expense with or without prior notice to developer/owner. After 60 days if the deficiency has not been corrected, or there has not been a good faith effort made on making corrections, it shall be a violation of the Greenwood Stormwater Drainage and Sediment Control Ordinance and subject the developer/owner to the provisions of Section 10-538, *21.06.04 Enforcement of Water Quality Requirements.*

Sec. 10-536 Illicit Connections and Illegal Dumping.

21.04.01 Illicit Connections.

No person shall:

1. Cause or allow an illicit discharge to the storm drain system or any component thereof, or onto driveways, sidewalks, parking lots, sinkholes, creek banks, or other areas that may drain to the storm drain system;

2. Connect, or allow to be connected any sanitary sewer system to the storm drain system, including any sanitary sewer or septic system connected as of the date the Rule 13 Regulations amendments to the Greenwood Stormwater Drainage and Sediment Control Ordinance are adopted;

3. Connect, or allow to be connected, any stormwater system to a sanitary sewer.

21.04.02 Illegal Dumping.

No person shall:

1. Dump, deposit, release, leak, pump, pour, emit, empty, discharge, inject, bury, or dispose of any oil, anti-freeze, herbicide, pesticide, fungicide, animal or human excrement or any other solid, liquid, or hazardous waste to any part of the storm drain system or on any public or private premises in the City.

2. Dispose of any leaves, brush, sticks, dirt, landscape debris, or other yard waste to any part of the storm drain system. This includes the blowing of grass, leaves, or other yard waste by mower or any other means into any part of the storm drain system.

21.04.03 Illicit Connections and Illegal Dumping Violations.

Any person found in violation of the activities prohibited by this Section shall be subject to the fine set forth in Section 10-538, *21.06.05 Penalties for WaterQuality Stormwater Drainage and Sediment Control Ordinance Violations*, for each violation, and further shall be responsible for the cost of cleanup or correction of the prohibited action. If the responsible person has not taken corrective active within fifteen (15) calendar days after notification of a violation then the City or a designated third party may take whatever action is necessary to cleanup or correct the prohibited act with the cost to be taken as a lien against the property from which the violation originated.

Sec. 10-537 Reporting.

21.05.01 Reporting Requirements.

The City Engineering Department or an appointed representative shall report in the month of July of each year to the Greenwood Board of Public Works and Safety an account of the status of the Greenwood Stormwater Drainage and Sediment Control Ordinance. The report shall contain no less than the following:

1. The number of drainage reviews completed;

2. The number of Stormwater Management Plan Approvals granted;

3. The number of water quality Best Management Practices approved and installed in the City;

4. The number of Erosion and Sediment Control plans reviewed by the City Engineering Department or its representative;

5. A statement as to the effectiveness of the Stormwater Drainage and Sediment Control Ordinance to address ongoing drainage issues and concerns within the City of Greenwood; and

6. A statement as to the adequacy of the established fees to affectively cover expenses associated with the administration and implementation of the Stormwater Drainage and Sediment Control Ordinance.

Sec. 10-538 Enforcement and Violations.

21.06.01. Civil Stormwater Drainage and Sediment Control (Non-Water Quality Violations).

Any person who is in violation of the Stormwater Drainage and Sediment Control Ordinance other than water quality requirements of Greenwood shall be deemed to have committed a civil stormwater drainage and sediment control violation and may be issued a citation by the designated enforcement entity. The Stormwater Drainage and Sediment Control Ordinance of Greenwood is included under a list of ordinances scheduled for the jurisdiction of the Ordinance Violations Bureau.

Each day a violation remains uncorrected is a distinct and separate civil stormwater drainage and sediment control violation subject to an additional citation and fine in the amount prescribed by below, provided a warning ticket has first been issued pursuant to Sec. 10-536 (B).

The monetary fine for each civil stormwater drainage and sediment control violation shall be $50.00, except that for a repeated stormwater drainage and sediment control violation, the following fines shall apply:

Second Citation: $ 75.00
Each Citation in Excess of Two: $100.00

All fines prescribed by this section for civil stormwater drainage and sediment control violations shall be paid within 72 hours to the Violations Clerk of the Ordinance Violations Bureau, who shall render to the person making the payment a receipt stating the amount and purpose for which the fine has been paid, and duplicate of which shall be made a part of the records of the Plan Commission. All fines thus received shall be deposited with the City of Greenwood Clerk-Treasurer.

21.06.02. Citation for Civil Stormwater Drainage and Sediment Control (Non-Water Quality) Violations.

The Director and/or his duly authorized designees, as designated at a Board of Works meeting, may issue a civil stormwater drainage and sediment control violation other than water quality requirements to a person who commits a civil stormwater drainage and sediment control violation to the legal owner, the contract vendee, or any person or entity with a possessory interest in the real estate upon which the violation occurs. The citation may be served by personal service, by certified mail, or by placement in a conspicuous place on the property where the violation occurs and shall serve as notice to a person that he or she has committed a civil stormwater drainage and sediment control ordinance violation.

No citation shall be issued for the first offense unless the person who commits a civil stormwater drainage and sediment control violation, or the legal owner, the contract vendee, or any person or entity with a possessory interest in the real estate upon which the violation occurs has been issued a warning ticket before the issuance of the citation to allow said person to correct the violation to come into compliance with the prescribed stormwater drainage and sediment control ordinance or regulations.

A person who receives a warning ticket or a citation may either choose to abate the violation or file a petition for a drainage plan, a Stormwater Drainage and Sediment Control Ordinance waiver, or other means provided by this Chapter to correct the violation, as prescribed below. A person who elects to file such a petition shall indicate this intent in writing to the issuing agency. A person shall have 10 working days after issuance of the warning ticket to file the petition, and additional monetary fines as prescribed in this section shall be stayed upon the filing of such petition, as long as the violation does not continue at the real estate. A person who files the petition within said time period shall pursue the petition in an expeditious fashion. If the petition is denied, withdrawn, or dismissed for want of prosecution, and the civil stormwater drainage and sediment control violation continues at the real estate, then a lawsuit will be commenced by the designated enforcement entity in a court of competent jurisdiction in Johnson County, Indiana.

If a person believes that the warning ticket or citation received results from an incorrect interpretation of the Greenwood Municipal Code by a municipal official, the aggrieved person may file an administrative appeal of the decision for a hearing by the Board of Zoning Appeals. Said appeal shall be on the form prescribed and shall include payment of the appropriate filing fee. A person who elects to file such an appeal shall indicate this intent in writing to the issuing agency. A person shall have 10 working days after issuance of the warning ticket to file the appeal, and additional monetary fines as prescribed in this section shall be stayed upon the filing of such appeal, as long as the violation does not continue at the real estate. A person who files the appeal within said time period shall pursue the appeal in an expeditious fashion. If the board upholds the interpretation of the Stormwater Drainage and Sediment Control Ordinance which led to issuance of the warning ticket or citation, and the civil stormwater drainage and sediment control violation continues at the real estate, then a lawsuit will be commenced by the designated enforcement entity in a court of competent jurisdiction in Johnson County, Indiana.

If the violation is determined by the Board of Public Works and Safety or its designee to be a threat to public health or safety, the Board of Public Works and Safety or its designee may order the land use or activity to cease and desist immediately, regardless of whether a warning ticket or citation has been issued.

The warning ticket shall be in the form prescribed by the plan commission.

The Citation shall appear on serialized, designated form and be in the form prescribed by the plan commission.

21.06.03. Trial for Civil Stormwater Drainage and Sediment Control (Non-Water Quality) Violations.

A person who receives a citation may elect to stand trial for the offence by indicating on the citation his intent to stand trial and returning a copy of the citation to the City Engineering Department. The returned copy of the citation shall serve as notice of the person's intent to stand trial, and additional monetary fines prescribed in Sec. 536 (A) shall be stayed upon receipt of the notice. On receipt of the notice of intention to stand trial, a lawsuit will be commenced by the city attorney in a court of competent jurisdiction in Johnson County, Indiana. The matter shall be scheduled for trial, and a Summons and Order to Appear shall be served upon the Defendant.

If a person who receives a citation fails to pay the assessed fine within 72 hours and fails to give notice of his intention to either file a petition or appeal or an appeal as prescribed in Sec. 10-536 (B), or to stand trial as prescribed in this section, the city attorney may file a civil lawsuit as prescribed by applicable laws and ordinances, and seek penalties as prescribed in this section.

A person adjudged to have committed a civil stormwater drainage and sediment control violation other than water quality requirements is liable for the court costs and fees. No cost shall be assessed against the enforcement agency in any such action. Any person who violates this ordinance or fails to comply with any of its requirements shall, upon conviction, thereof be fined $50.00 and, in addition, shall pay all costs and expenses involved in the case, including but not limited to mediation costs, court costs, coverage of reasonable attorney fees, short-term and long-term mitigation of damages, and restoration and restitution. Each day such violation continues shall constitute a separate offense.

(Ord. No. 02-07, §1, 3-18-02)
(Ord. No. 04-55, §31, 1-17-05)

In proceedings before the court for a civil stormwater drainage and sediment control violation other than water quality requirements, the Indiana Rules of Trial Procedure shall govern. The designated enforcement entity has the burden of proving the civil stormwater drainage and sediment control violation by a preponderance of the evidence.

Seeking a civil penalty as authorized by this section does not preclude the city from seeking alternative relief from the court in the same action, or from seeking injunctive relief or other remedy in a separate action for the enforcement of this Code.

21.06.04 Enforcement of Water Quality Requirements.

In the case of non-compliance with the water quality requirements of the Greenwood Stormwater Drainage and Sediment Control Ordinance, the City Engineering Department has the right to issue abatement orders, to issue stop work orders, to seek injunctions, to retain or call in performance surety and/or to revoke Stormwater Mangement Approvals.

The City Engineering Department may revoke a Stormwater Management Plan Approval where the submittal packet, plans, and/or other supporting documents reflect either:

1. A false statement or misrepresentation as to material fact; or

2. Failure to comply with the requirements of the Ordinance.

Whenever the City Engineering Department discovers the existence of any of the circumstances listed below, it is empowered to issue an order requiring the suspension of the land alteration. The stop-work order shall be in writing and shall state to what land alteration it is applicable and the reason for its issuance. One (1) copy of the stop-work order shall be posted on the property in a conspicuous place and one (1) copy shall be delivered to the applicant, and if conveniently possible to the person doing the land alteration and to the owner of the property or his agent. The stop work order shall state the conditions under which land alteration may be resumed. A stop-work order shall be issued if:

a. Land alteration is occurring in violation of a drainage requirement and in such manner that if land alteration is allowed to proceed, there is a probability that it will be substantially difficult to correct the violation; or

b. Land alteration has been accomplished in violation of a drainage requirement and fifteen (15) calendar days has elapsed since written notice of the violation or noncompliance was either posted on the property in a conspicuous place or given the person doing the land alteration, without the violation or noncompliance being corrected; or

c. Land alteration for which a Stormwater Management Plan Approval is required is proceeding without a Stormwater Management Plan Approval being in force. In such an instance the stop-work order shall indicate that the effect of the order terminates when the required Stormwater Management Plan Approval is obtained.

Failure to maintain an approved BMP and/or detention/retention facility in good working order in accordance with the approved Stormwater Management Plan Approval is a violation of the Greenwood Stormwater Drainage and Sediment Control Ordinance. Should a developer/owner commit such a violation, the City Engineering Department may:

1. Issue abatement orders;

2. Seek injunctive relief in a separate action for the enforcement of the Stormwater Drainage and Sediment Control Ordinance and the Greenwood Municipal Code;

3. Impose the penalties set forth in *21.06.05*, below:

4. Perform, or cause to be performed, the repairs and maintenance, with the costs taken as a lien against the property; or

5. Any other lawful action deemed necessary to bring the BMP and/or detention/retention facility into compliance with the approved Stormwater Management Plan Approval.

21.06.05 Penalties for Water Quality Stormwater Drainage and Sediment Control Ordinance Violations.

1. Illicit Connection and/or Illegal Dumping:	A fine of not less than $500.00 or more than $5,000.00 per violation, plus cleanup cost.
2. Failure to Maintain an Approved BMP and/or retention/detention facility:	A fine of not less than $200.00 or more than $1,000.00 per BMP or facility per violation.
3. Failure to maintain plan approved easements:	A fine of not less than $100.00 or more than $500.00 per violation.
4. Failure to have annual inspection of BMP and/or retention/detention facility:	$300.00 fine for each BMP and/or retention/detention facility

Sec. 10-539 Implementation of Ordinance

21.07.01. Disclaimer of Liability.

The degree of protection required by this Ordinance is considered reasonable for regulatory purposes and is based on historical records, engineering and scientific methods of study. Larger storms may occur or stormwater runoff depths may be increased by man-made or natural causes. This Ordinance does not imply the land uses permitted will be free from stormwater damage. This ordinance shall not create liability on the part of the City of Greenwood or any officer or employees thereof for any damage that may result from reliance on this Ordinance or on any administrative decision lawfully made thereunder.

21.07.02. Corrective Action.

Nothing herein contained shall prevent the City of Greenwood from taking such other lawful action as may be necessary to prevent or remedy any violation. All costs connected therewith shall accrue to the person or persons responsible.

21.07.03. When Effective.

This Ordinance shall become effective upon its final passage and approval in accordance with Indiana Law.

21.07.04. Exempt Projects.

Any subdivision or construction project which has had a final drainage plan approved by the City Engineer prior to the effective date of this Ordinance shall be considered legally non-conforming. As such, the plan may be implemented as approved. If, however, the project is expanded or otherwise altered, these regulations shall apply.

THE FOLLOWING TABLES ARE THE TABLES REFERENCED IN SECTION 10-533 THROUGH SECTION 10-539 OF THIS CHAPTER:

TABLE 1 (TR-55 Table 3-1)
Runoff Coefficient's for Use in the Rational Method Calculations for Pipe, Channel and Detention Design

TABLE 2 (TR-55 Table 3-1)
Roughness coefficient's (Manning's n) for sheet flow to be used in Time-of-Concentration calculations

TABLE 3 (TR-55 Table 2-2a)
Runoff Curve Numbers For Developed and Developing Urban Areas

TABLE 4 (TR-55 Table 2-2b & 2-2c)
Runoff Curve Numbers For Non-urban and Undeveloped Areas

TABLE 5
IDF Equation Values

TABLE 6
IDF Table

TABLE 7
IDD Table

TABLE 8
Median Time Distributions of Heavy Storm Rainfall at a Point

TABLE 9
Roughness coefficient's (Manning's n) for Street and Pavement Gutters

TABLE 10
Manning's n Values for Pipes

TABLE 11
Roughness coefficient's (Manning's n) for Open Channel Surfaces

TABLE 12
Desirable Maximum Velocities for Open Channel Linings

TABLE 13
Huff Curve Ordinates

MISCELLANEOUS TABLE 14
Unit Hydrograph Ordinates

(Ord. No. 04-55, §1-32, 1-17-05)

TABLE 1 (TR-55 Table 3-1)

Runoff Coefficient's for Use in the Rational Method Calculations for Pipe, Channel and Detention Design

TYPE OF SURFACE	RUNOFF COEFFICIENT
Non-Urban Areas	
Bare Earth	0.55
Steep Grassed Areas (slope 2:1)	0.60
Turf Meadows	0.25
Forested Areas	0.20
Cultivated Fields	0.30
Urban Areas	
All Watertight Roof Surfaces	0.90
Pavement (concrete, asphalt)	0.85
Gravel	0.85
Impervious Soils (heavy)	0.55
Impervious Soils (with turf)	0.45
Slightly Pervious Soil	0.25
Slightly Pervious Soil (with turf)	0.20
Moderately Pervious Soil	0.15
Moderately Pervious Soil (with turf)	0.10
Business, Commercial & Industrial	0.85
Apartments & Townhouses	0.70
Schools & Churches	0.55
Single Family Lots < 10,000 sft.	0.45
Lots < 12,000 sft.	0.45
Lots < 17,000 sft.	0.40
Lots > ½ Acre	0.35
Park, Cemetery or Unimproved Area	0.30

Source: 210-VI-TR-55, Second Edition, June 1986

(Ord. No. 04-55, §1-32, 1-17-05)

Table 2 (TR-55 Table 3-1)

Roughness coefficient's (Manning's n) for sheet flow to be used in Time-of-Concentration calculations

Surface Description	n
Smooth Surfaces (concrete, asphalt, gravel, bare soil)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover </= 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short Grass Prairie	0.15
Dense Grass	0.24
Bermuda Grass	0.41
Range (natural)	0.13
Woods:	
Light Underbrush	0.40
Dense Underbrush	0.80

Source: 210-VI-TR-55, Second Edition, June 1986

(Ord. No. 04-55, §1-32, 1-17-05)

Table 3 (TR-55 Table 2-2a) Runoff Curve Numbers

For Developed and Developing Urban Areas

Urban Areas – Average runoff condition and Ia = 0.2S

Fully Developed Urban Areas (Vegetation Established)

Cover Type	Hydrologic Condition		Average Percent Impervious (1)	Hydrologic Soil Group			
				A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, etc.) (2)	Poor condition	grass cover < 50%		68	79	86	89
	Fair condition	grass cover 50-75%		49	69	79	84
	Good condition	grass cover > 75%		39	61	74	80
Impervious areas	Parking lots, roofs, driveways, etc. (excluding right-of-way) (3)			98	98	98	98
	Streets and roads	Paved: curbs and storm sewers (excluding right-of-way)		98	98	98	98
		Paved: open ditches (Including right-of-way)		83	89	92	93
		Gravel (Including right-of-way)		76	85	89	91
		Dirt (Including right-of-way)		72	82	87	89
Urban districts	Commercial and business		85	89	92	94	95
	Industrial		72	81	88	91	93
Residential districts by average lot size	1/8 acre or less (town houses)		65	77	85	90	92
	1/4 acre		38	61	75	83	87
	1/3 acre		30	57	72	81	86
	1/2 acre		25	54	70	80	85
	1 acre		20	51	68	79	84
	2 acres		12	46	65	77	82

Developing Urban Areas

Cover Type	Hydrologic Condition	Average Percent Impervious	Hydrologic Soil Group			
			A	B	C	D
Newly graded areas	Pervious areas only, no vegetation (4)		77	86	91	94
Idle lands		See Table 4 – Runoff Curve Numbers for non-urban and undeveloped areas.				

(1) The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic conditions.

(2) CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

(3) All parking lots and driveways must be considered to have a paved hard surfaced. Crushed stone parking lots and driveways are considered impervious surfaces with a CN of 98.

(4) Composite CN's to use for the design of temporary measures during grading and construction should be computed based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

(Ord. No. 04-55, §1-32, 1-17-05)

Table 4 (TR-55 Table 2-2b & 2-2c) Runoff Curve Numbers

For Non-urban and Undeveloped Areas

Rural Areas – Antecedent moisture condition II and Ia = 0.2S

Land Use or Cover	Treatment or Practice (1)	Hydrologic Condition (2)	Hydrologic Soil Group			
			A	B	C	D
Fallow	Straight row		77	86	91	94
Row crops	Straight row	Poor	72	81	88	91
		Good	67	78	85	89
	Contoured	Poor	70	79	84	88
		Good	65	75	82	86
	Contoured and terraced	Poor	66	74	80	82
		Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	Contoured and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes or rotation meadow	Straight row	Poor	66	77	85	89
		Good	58	72	81	85
	Contoured	Poor	64	75	83	85
		Good	55	69	78	83
	Contoured and terraced	Poor	63	73	80	83
		Good	51	67	76	80
Pasture, grassland, or range (3)		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
		Fair	25	59	75	83
		Good	6	35	70	79
Meadow – continuous grass, protected from grazing and generally mowed for hay		Good	30	58	71	78
Brush –brush-weeds-grass mixture with brush the major element (4)		Poor	48	67	77	83
		Fair	35	56	70	77
		Good	30 (5)	48	65	73
Woods – grass combination (orchard or tree farm) (6)		Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79
Woods (7)		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30 (5)	55	70	77
Farmsteads			59	74	82	86
Rural roads – including right-of-way	Dirt		72	82	87	89
	Hard surface		74	84	90	92

(1) Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

(2) Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or closed-seeded legumes, (d) percent of residue cover on the land surface (good $\geq$ 20%), and (e) degree of surface roughness.

(3) **Poor:** <50% ground cover or heavily grazed with no mulch. **Fair:** 50 to 75% ground cover and not heavily grazed. **Good:** >75% ground cover and lightly or only occasionally grazed.

(4) **Poor:** <50% ground cover. **Fair:** 50 to 75% ground cover. **Good:** >75% ground cover.

(5) Actual curve number is less than 30; use CN=30 for runoff computations.

(6) CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

(7) **Poor:** Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. **Fair:** Woods are grazed but not burned, and some forest litter covers the soil. **Good:** Woods are protected from grazing, and litter and brush adequately cover the soil.

(Ord. No. 04-55, §1-32, 1-17-05)

Table 5 IDF Equation Values

Return Period	a	b	N	R^2
2	32.852	7	0.7780	0.99966
5	46.060	8	0.7859	0.99958
10	56.974	9	0.7953	0.99952
25	72.739	10	0.8115	0.99942
50	84.475	11	0.8147	0.99940
100	92.718	11	0.8145	0.99942

TABLE 6: IDF Table

		Return Period – Rainfall Intensity (in/hr)					
Hours	Minutes	2	5	10	25	50	100
0.08	5	4.75	6.14	6.99	8.08	8.83	9.69
0.17	10	3.63	4.75	5.48	6.40	7.07	7.77
0.25	15	2.97	3.92	4.55	5.34	5.94	6.53
0.5	30	1.98	2.64	3.09	3.65	4.10	4.50
1	60	1.25	1.67	1.96	2.31	2.62	2.88
2	120	0.76	1.02	1.20	1.40	1.59	1.75
3	180	0.56	0.75	0.88	1.03	1.17	1.29
6	360	0.33	0.44	0.52	0.60	0.68	0.75
12	720	0.20	0.26	0.30	0.35	0.39	0.43
24	1440	0.11	0.15	0.17	0.20	0.22	0.25

TABLE 7: IDD Table

		Return Period – Rainfall Depth (in)					
Hours	Minutes	2	5	10	25	50	100
0.08	5	0.40	0.51	0.58	0.67	0.74	0.81
0.17	10	0.61	0.79	0.91	1.07	1.18	1.30
0.25	15	0.74	0.98	1.14	1.34	1.49	1.63
0.5	30	0.99	1.32	1.55	1.83	2.05	2.25
1	60	1.25	1.67	1.96	2.31	2.62	2.88
2	120	1.52	2.04	2.40	2.80	3.18	3.50
3	180	1.68	2.25	2.64	3.09	3.51	3.87
6	360	1.98	2.64	3.12	3.60	4.08	4.50
12	720	2.40	3.12	3.60	4.20	4.68	5.16
24	1440	2.64	3.60	4.08	4.80	5.28	6.00

(Ord. No. 04-55, §1-32, 1-17-05)

Table 8: Median Time Distributions of Heavy Storm Rainfall at a Point

	Cumulative Storm Rainfall (percent) for Given Storm Type			
Cumulative Storm Time (Percent)	First Quartile	Second Quartile	Third Quartile	Fourth Quartile
5	16	3	3	2
10	33	8	6	5
15	43	12	9	8
20	52	16	12	10
25	60	22	15	13
30	66	29	19	16
35	71	39	23	19
40	75	51	27	22
45	79	62	32	25
50	82	70	38	28
55	84	76	45	32
60	86	81	57	35
65	88	85	70	39
70	90	88	79	45
75	92	91	85	51
80	94	93	89	59
85	96	95	92	72
90	97	97	95	84
95	98	98	97	92

(SOURCE: Rainfall Frequency Atlas of the Midwest by Huff and Angel)

Table 9: Roughness coefficient's (Manning's n) for Street and Pavement Gutters

Type of Gutter or Pavement	n
Concrete	0.012
Asphalt Pavement:	
Smooth Texture	0.013
Rough Texture	0.016
Concrete Gutter – Asphalt Pavement:	
Smooth	0.013
Rough	0.015
Concrete Pavement:	
Float Finish	0.014
Broom Finish	0.016
For Gutters with small slope, where sediment may accumulate, increase the "n" values above by:	0.002

Source: USDOT, FHWA, HDS-3 (1961)

(Ord. No. 04-55, §1-32, 1-17-05)

Table 10: Manning's n Values for Pipes

Pipe Material	n
Concrete Pipe	0.012
Concrete Boxes	0.012
Corrugated Metal Pipe or Pipe Arch:	
2 2/3" x ½" Helical Corrugation	0.022
2 2/3" x ½" Annular Corrugation	0.022
15" to 36"	0.025
42" to 96"	0.024
3" x 1" Corrugation	0.027
5" x 1" Corrugation	0.025
Structural Plate Pipe or Pipe Arch:	
6" x 2" Corrugation	0.033
9" x 2 ½" Corrugation	0.035
Spiral Ribbed Corrugated Metal Pipe (7½" x ¾" x ¾")	0.013
Smooth High Density Polyethylene (HDPE)	0.012
Smooth Lined Interior Polyvinyl Chloride (PVC)	0.012
Smooth Interior Corrugated HDPE *0.012*	
Ductile Iron Pipe	0.012

Table 11: Roughness coefficient's (Manning's n) for Open Channel Surfaces

Open Channel Surface Material		n
Concrete		0.012
Gravel Bottom with sides	- Concrete	0.020
	- Mortared Stone	0.023
	- Rip-Rap	0.033
Natural Stream Channels:		
Clean, Straight Stream		0.030
Clean, Winding Stream		0.040
Winding with weeds and pools		0.050
With Heavy Brush and Timbers		0.100
Flood Plains:		
Pasture		0.035
Field Crops		0.040
Light Brush and Weeds		0.050
Dense Brush		0.070
Dense Trees		0.100

Chow, 1959

(Ord. No. 04-55, §1-32, 1-17-05)

Table 12: Desirable Maximum Velocities for Open Channel Linings

Typical Maximum Velocities for Open Channel Linings

Open Channel Lining Material	Desirable Maximum Velocity (ft/s)
Concrete, Trowel Finish	15
Concrete, Broom or Float Finish	15
Rip-Rap	10
Gabions	10
New Earth (Uniform, Sodded, Clay)	3-5
Existing Earth (Fairly Uniform, with Some Weeds)	3-5
Dense Weeds	3-5
Swale with Grass	3-5

Table 13 Huff Curve Ordinates

% Storm Time	% Precipitation
0	0
5 *	2.7
10	6.5
15 *	11.0
20	18.1
25 *	26.0
30	35.9
35 *	44.7
40	52.9
45 *	61.0
50	67.9
55 *	72.5
60	76.5
65 *	80.2
70	83.8
75 *	87.2
80	90.7
85 *	93.3
90	95.9
95 *	97.9
100	100.0

* Estimated Values

SOURCE: Purdue, et al, "Statistical Characteristics of Short Time Increment Rainfall"

(Ord. No. 04-55, §1-32, 1-17-05)

Miscellaneous Table 14: Unit Hydrograph Ordinates

Time Ratios (t/T_p)	Discharge Ratios (q/q_p)	Mass Curve Ratios (Q_a/Q)
0.0	0.000	0.000
0.1	0.030	0.001
0.2	0.100	0.006
0.3	0.190	0.017
0.4	0.310	0.035
0.5	0.470	0.065
0.6	0.660	0.107
0.7	0.820	0.163
0.8	0.930	0.228
0.9	0.990	0.300
1.0	1.000	0.375
1.1	0.990	0.450
1.2	0.930	0.522
1.3	0.860	0.589
1.4	0.780	0.650
1.5	0.680	0.705
1.6	0.560	0.751
1.7	0.460	0.790
1.8	0.390	0.822
1.9	0.330	0.849
2.0	0.280	0.871
2.2	0.207	0.908
2.4	0.147	0.934
2.6	0.107	0.953
2.8	0.077	0.967
3.0	0.055	0.977
3.2	0.040	0.984
3.4	0.029	0.989
3.6	0.021	0.993
3.8	0.015	0.995
4.0	0.011	0.997
4.5	0.005	0.999
5.0	0.000	1.000

SOURCE: SCS National Engineering Handbook, Chapter 4 (NEH-4)

(Ord. No. 04-55, §1-32, 1-17-05)

THE FOLLOWING WORKSHEETS ARE THE WORKSHEETS REFERENCED IN SECTION 10-533 THROUGH SECTION 10-539 OF THIS CHAPTER:

WORKSHEET 1
Time of Concentration or Travel Time Worksheet

WORKSHEET 2
Composite Curve Number Computation Worksheet

MISCELLANEOUS WORKSHEET 3
(INDOT Figure 36-12F): Storm Drain Computation Sheet

MISCELLANEOUS WORKSHEET 4
(INDOT Figure 36-10K): Inlet Spacing and Gutter Spread Computation Sheet

MISCELLANEOUS WORKSHEET 5
(INDOT Figure 36-13D): Hydraulic Grade line Computation Sheet

(Ord. No. 04-55, §1-32, 1-17-05)

Worksheet 1: Time of Concentration or Travel Time Worksheet

Worksheet 1 – TR-55 Time of Concentration (T_c) or Travel Time (T_t)

Project: ______________________________ Designed By: ____________________

Date: ______________________________

Location: ______________________________ Checked By: ____________________

Date: ______________________________

Check one: Present ☐ Developed ☐

Check one: T_c ☐ T_t ☐ through subarea: ______________________________

NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to T_c only) Segment ID				
1. Surface description (Table 3-1)				
2. Manning's roughness coeff., n (Table 3-1)......				
3. Flow length, L (total L $\leq$ 300 ft)................ft				
4. Two-year 24-hour rainfall,......................in				
5. Land slope, s......................................ft/ft				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t..................hr		+		=

Shallow Concentrated Flow Segment ID				
7. Surface description (paved or unpaved)..........				
8. Flow length, L...................................ft				
9. Watercourse slope, s...........................ft/ft				
10. Average velocity, V..........................ft/s				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t..................hr		+		=

Channel Flow Segment ID				
12. Cross sectional flow area, a.....................ft^2				
13. Wetted perimeter, P_w......................................ft				
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r.......ft				
15. Channel Slope, ...ft/ft				
16. Manning's Roughness Coeff., n				
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V............ft/s				
18. Flow Length, L.................................ft				
19. $T_t = \frac{L}{3600\,V}$ Compute T_t..................hr		+		=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11 and 19)..........hr ☐

(Source: 210-VI-TR-55, Second Edition, June 1986)

(Ord. No. 04-55, §1-32, 1-17-05)

Worksheet 2: Composite Curve Number Computation Worksheet

Project_____ By_____ Date_____

Location_____ Checked_____ Date_____

Circle one: Present Developed _____

1. Runoff curve number (CN)

Soil Name and hydrologic group	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐ acres ☐ mi^2 ☐ %	Product of CN x area
				Totals =		

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____; Use CN = ☐

(SOURCE: 210-VI-TR-55, Second Edition, June 1986)

(Ord. No. 04-55, §1-32, 1-17-05)

Miscellaneous Worksheet 3 (INDOT Figure 36-12F): Storm Drain Computation Sheet

Storm Drain Computation Sheet

Date_____ **Project**_____ **Route**_____
Computed By:_____ **Checked By:**_____ **Sheet**_____ **of**_____

Structure		Length (ft)	Drainage Area (acres)		Runoff Coefficient C	A X C		Flow Time (min)						Velocity fps						
From	To		Increment	Total		Increment	Total	To Upper End	In Section	Rainfall Intensity (in/hr)	Total Runoff Q	Diameter Of Pipe (in)	Full Capacity (cfs)	Flowing Full	Design Flow	Upstream Invert Elevation	Downstream Invert Elevation	Manhole Invert	Depth of Cover	Slope of Pipe (ft/ft)

(Ord. No. 04-55, §33, 1-17-05)

Miscellaneous Worksheet 4 (INDOT Figure 36-10K): Inlet Spacing and Gutter Spread Computation Sheet

Inlet Computation Sheet

Date_____ **Project**_____ **Route**_____
Computed By:_____ **Checked By:**_____ **Sheet**_____ **of**_____

Location		Gutter Discharge (Design Frequency)				Gutter Discharge (Allowable Spread _____)									Inlet Discharge			Remark
Inlet No.	Stat.	Drain Area "A" (acre)	Runoff Coefficient "C"	Time of Concentration "T_c" (min.)	Rainfall Intensity "i" (in/hr)	Flow "Q" (cfs)	Grade "S_o" (ft/ft)	Cross Slope "S_x" (ft/ft)	Prev. Runby (cfs)	Total Gutter Flow (cfs)	Depth "d" (ft)	Gutter Width "W" (ft)	Spread "T" (ft)	W/T	Inlet Type	Intercept "Q_i" (cfs)	Runby "Q_r" (cfs)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

(Ord. No. 04-55, §33, 1-17-05)

Miscellaneous Worksheet 5 (INDOT Figure 36-13D): Hydraulic Grade line Computation Sheet

Hydraulic Grade Line Computation Sheet

Date_____ **Project**_____ **Route**_____

Computed By:_____ **Checked By:**_____ **Sheet**_____ **of**_____

Station	TW	D_o	Q_o	L_o	V_o	$V_o^2/2g$	H_o	Sf_o	H_f	K_o	C_D	C_d	C_Q	C_P	C_B	K	$K(V_o^2/2g)$	EGL_o 2+7	EGL 10+18+19	HGL EGL-7	TOC ELEV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)

(Ord. No. 04-55, §33, 1-17-05)

Pages 1089.141 through 1089.146 are reserved for the following Figures in connection with Section 10-533 through Section 10-539 of this Chapter

FIGURE 1
Average Velocities for Estimating Travel Time for Shallow Concentrated Flow

FIGURE 2
Indianapolis IDF Curve

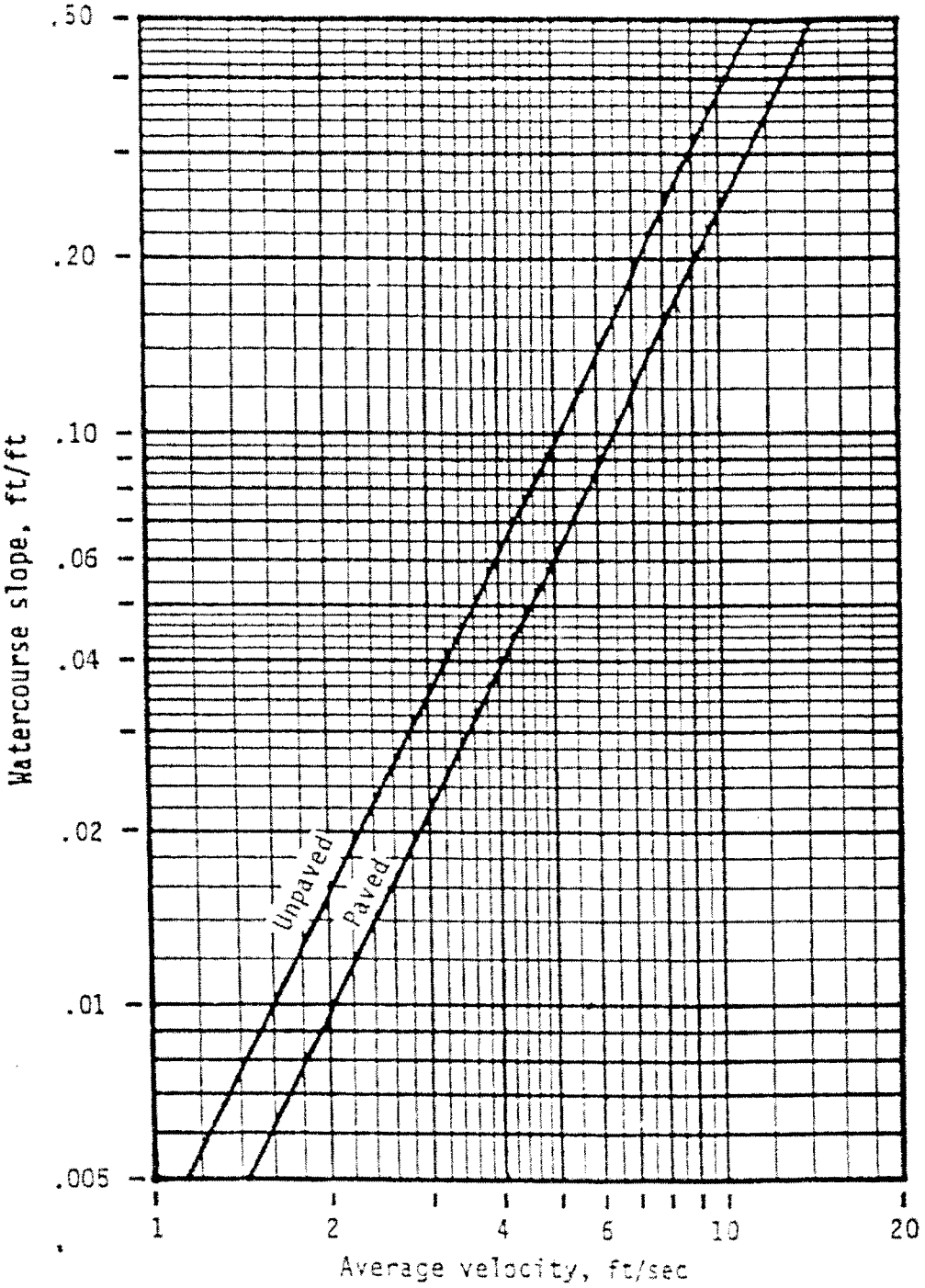
FIGURE 3
Second Quartile Huff Rainfall Distribution

FIGURE 4
Soil And Water Features – Johnson County

FIGURE 5
Nomograph for Solution of Manning Equation

FIGURE 6
Dimensionless Unit Hydrograph and Mass Curve

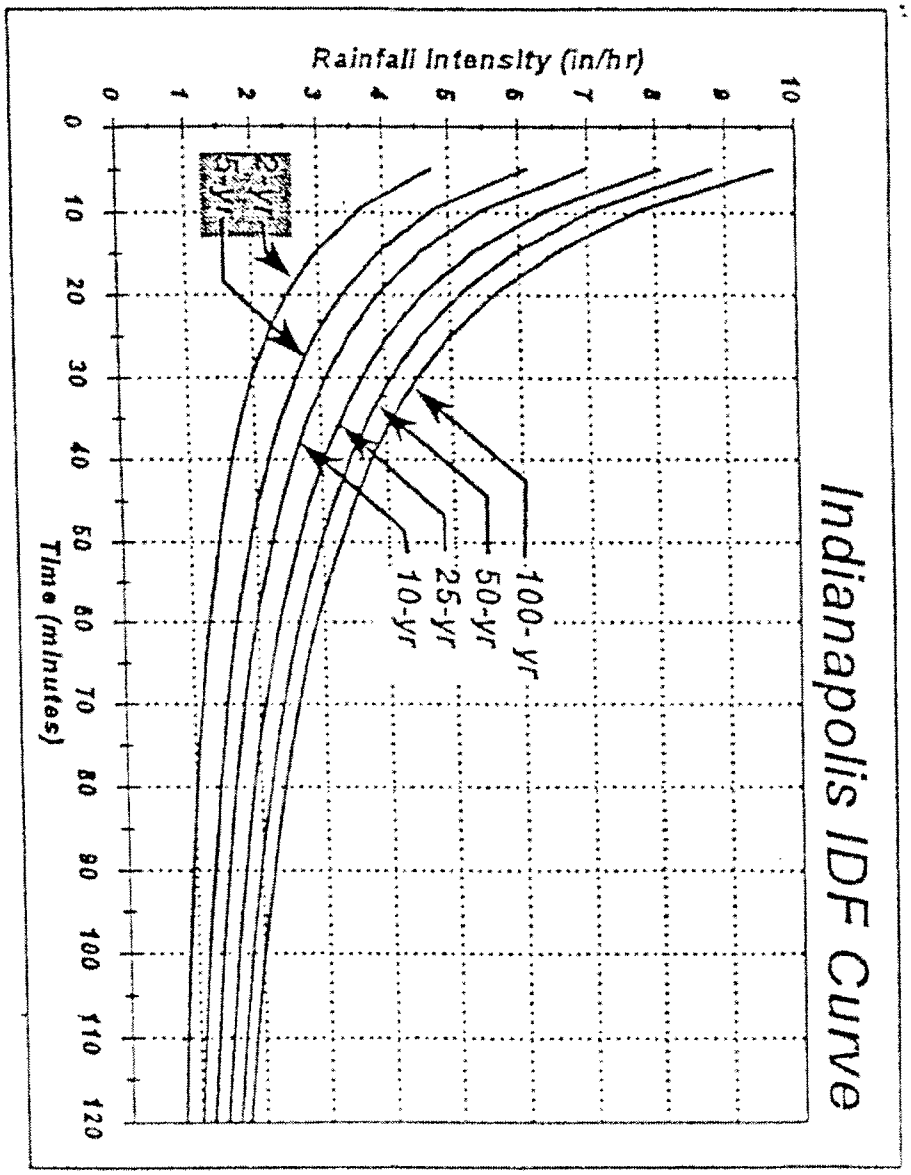
FIGURE 1
Average Velocities for Estimating Travel Time for Shallow Concentrated Flow



Source: 210-VI-TR-55, Second Edition, June 1986

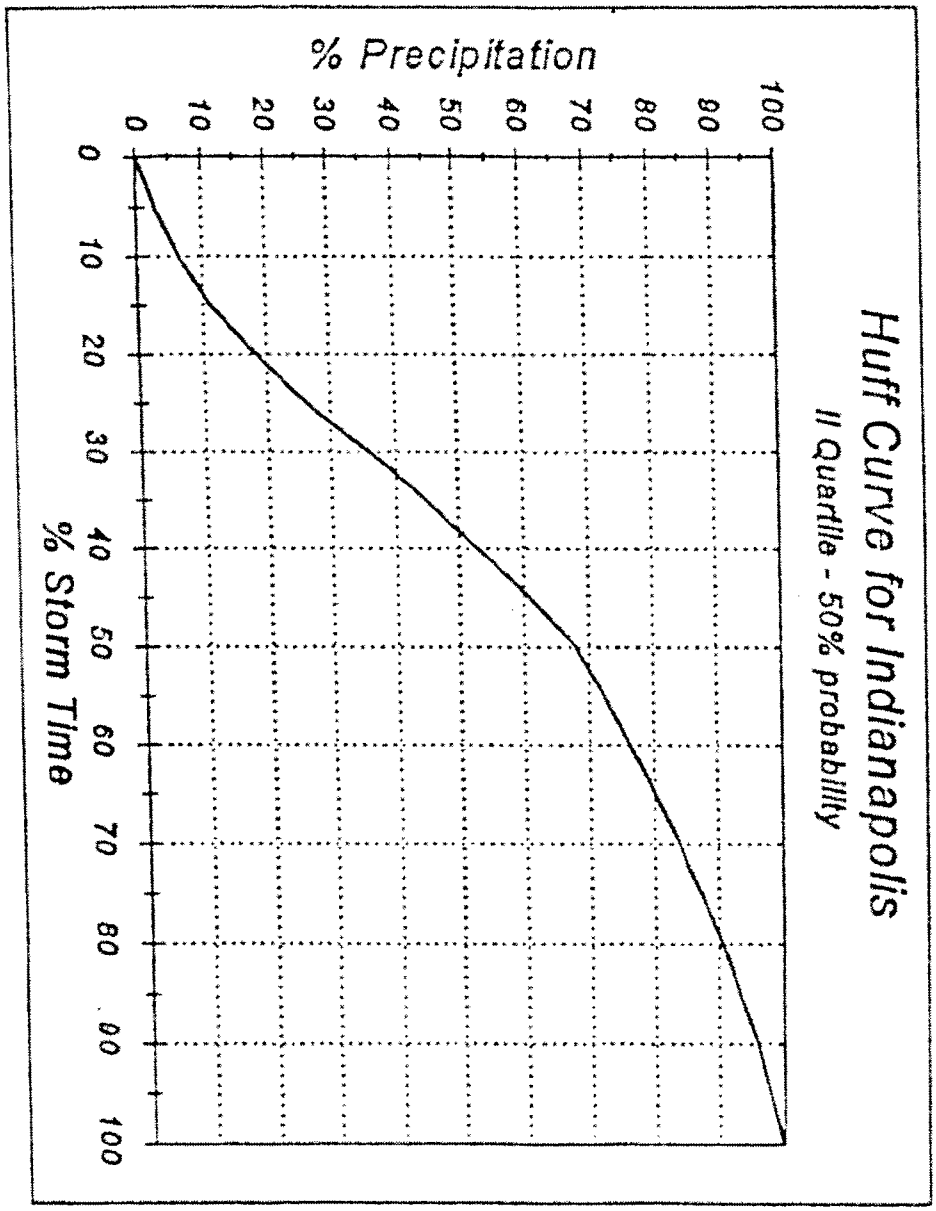
(Ord. No. 04-55, §33, 1-17-08)

FIGURE 2
Indianapolis IDF Curve



(Ord. No. 04-55, §33, 1-17-05)

FIGURE 3
Second Quartile Huff Rainfall Distribution



Source: Purdue, et al, "Statistical Characteristics of Short Time Increment Rainfall"

(Ord. No. 04-55, §53, 1-17-05)

ZONING, PLANNING & DEVELOPMENT

FIGURE 4

Soil And Water Features – Johnson County

shes indicate that the feature is not a concern. See text for desc[illegible] of hydrologic groups. The symbol < means less than; > means [illegible] than]

Soil series and map symbols	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			*In*		
Brookston: Br	B/D	Frequent	Brief	Dec.–May	0–1.0	Apparent	Dec.–May	>60		High.
Crosby:										
CrA	C	None			1.0–3.0	Apparent	Jan.–Apr.	>60		High.
CsB2[1]:										
Crosby part	C	None			1.0–3.0	Apparent	Jan.–Apr.	>60		High.
Miami part	B	None			>6.0			>60		Moderate.
Eel: Ea	C	Frequent	Brief	Oct.–June	3.0–6.0	Apparent	Jan.–Apr.	>60		High.
Fincastle: FnA	C	None			1.0–3.0	Apparent	Jan.–Apr.	>60		High.
Fox: FoA, FoB2, FxC2[1]	B	None			>6.0			>60		Moderate.
Genesee: Ge	B	Frequent	Brief	Oct.–June	>6.0			>60		Moderate.
Hennepin: HeF	B	None			>6.0			>60		Moderate.
Hickory: HkD2, HkF	C	None			>6.0			>60		Moderate.
Miami: MnB2, MnC2, MnD2, MnE, MtB3, MtC3, MtD3.	B	None			>6.0			>60		Moderate.
Muren: MuA	B	None			3.0–6.0	Apparent	Mar.–Apr.	<60		High.
Muskingum: MxG	C	None			>6.0			20–40	Rippable	Moderate.
Nineveh: NnA	B	None			>6.0			>60		Moderate.
Ockley: OcA, OcB2	B	None			>6.0			>60		Moderate.
Palms: Pa	A/D	Frequent	Long	Nov.–May	0–1.0	Apparent	Nov.–May	>60		High.
Parke: PkB2, PkC2	B	None			>6.0			>60		High.
Rensselaer: Re	B/D	Frequent	Brief	Dec.–May	0–1.0	Apparent	Dec.–May	>60		High.
Ross: Rs	B	Common	Brief	Jan.–Apr.	4.0–6.0	Apparent	Feb.–Apr.	>60		Moderate.
Shoals: Sh	C	Frequent	Brief	Jan.–May	1.0–3.0	Apparent	Jan.–Apr.	>60		High.
Sleeth: Sk	C	None			1.0–3.0	Apparent	Jan.–Apr.	>60		High.
Sloan: Sn	B/D	Frequent	Brief	Oct.–June	0–0.5	Apparent	Nov.–June	>60		High.
Wellston: WdC2	B	None			>3.0	Apparent	Mar.–May	>60	Hard	Moderate.
Westland: We	B/D	Frequent	Brief	Dec.–May	0–1.0	Apparent	Dec.–May	>60		High.
Whitaker: Wh	C	None			1.0–3.0	Apparent	Jan.–Apr.	>60		High.

[1]This mapping unit is made up of two or more dominant soils. See description of the mapping unit for the composition and behavior characteristics of the mapping unit.

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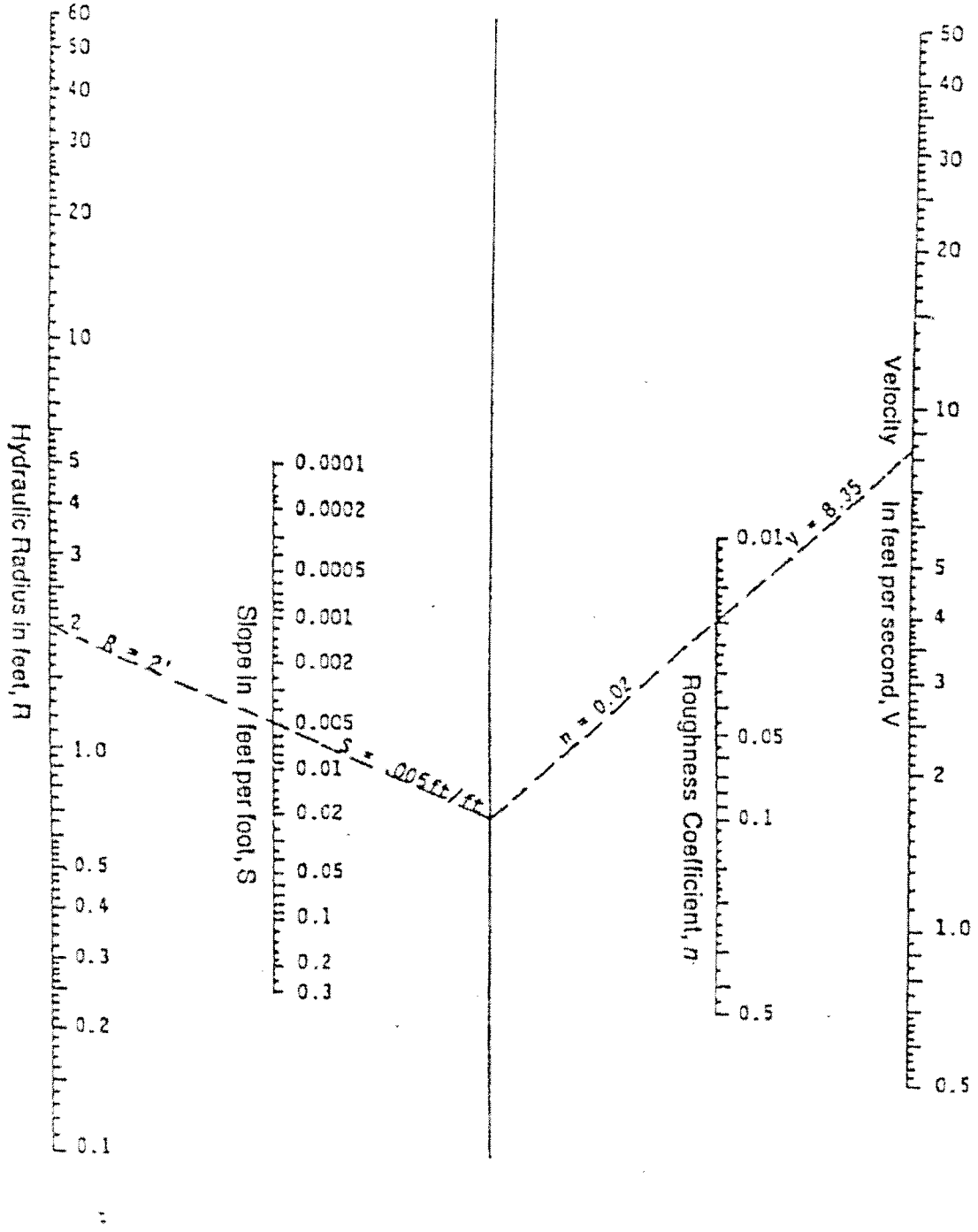
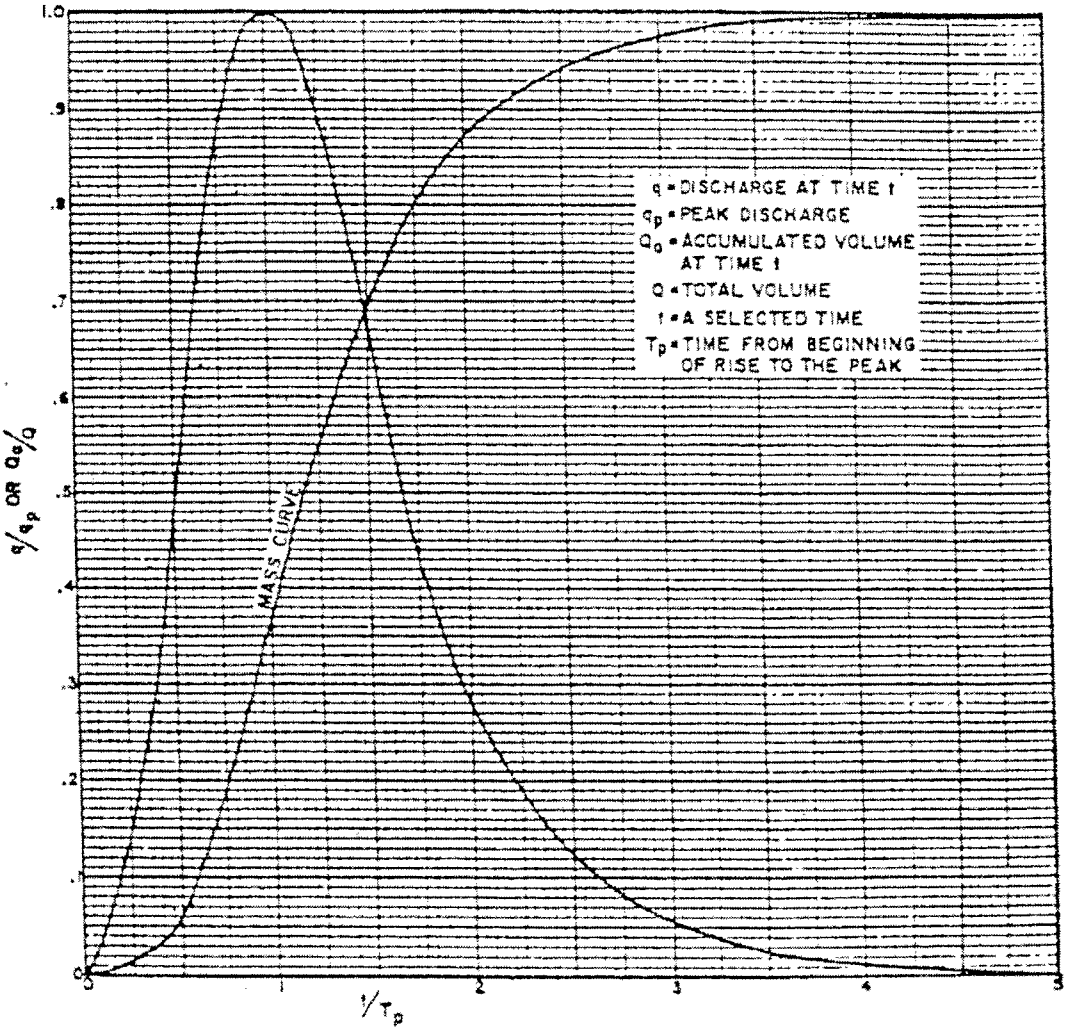
FIGURE 5
Nomograph for Solution of Manning Equation



Source: North Carolina Erosion & Sediment Control Planning & Design Manual, 09/01/88

FIGURE 6
Dimensionless Unit Hydrograph and Mass Curve



Source: SCS National Engineering Handbook, Chapter 4 (NEH-4)