

VIRGINIA DEPARTMENT OF TRANSPORTATION

**LOCATION AND DESIGN DIVISION**  
**INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM**

GENERAL SUBJECT: Sinkholes	NUMBER: IIM-LD-228.1
SPECIFIC SUBJECT:  Guidelines for the Discharge of Stormwater at Sinkholes	DATE: September 12, 2008
LOCATION AND DESIGN DIVISION APPROVAL: Mohammad Mirshahi, P.E. State Location and Design Engineer Approved September 10, 2008	
MATERIALS DIV. APPROVAL: Charles A. Babisch, P.E. Approved August 26, 2008	ENVIRONMENTAL DIV. APPROVAL: Stephen J. Long Approved August 28, 2008

Changes are shaded.

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CURRENT REVISION

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- Revised IIM to change the Scoping Form LD-430 to PM-100.
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EFFECTIVE DATE

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- These instructions are effective upon receipt.
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PURPOSE

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- The purpose of these guidelines is to:
  - Increase awareness of the regulatory requirements for controlling stormwater runoff into sinkholes and identify the applicability of this guidance and the environmental regulations.

2. Provide design guidance for the discharge of stormwater into sinkholes.
  3. Provide design details for addressing sinkholes directly impacted by the roadway embankment.
  4. Provide guidance to comply with the Environmental Protection Agency (EPA) regulatory requirements to complete an inventory of “improved” sinkholes.
- These guidelines are applicable to roadways and drainage outfall facilities that are constructed and maintained by VDOT and similar facilities that are constructed by others but which will be ultimately maintained by VDOT, such as subdivision streets and associated drainage outfalls.
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## BACKGROUND

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- Sinkholes are found in areas of karst terrain. Karst terrain is generally formed over limestone and dolomite formations. Karst terrains primarily occur within the Valley and Ridge Physiographic Province of western Virginia. Karst type terrains are also known to occur in very limited areas of the Blue Ridge, Piedmont and Coastal Plain Physiographic Provinces of Virginia. While information contained in these guidelines is directed more to those sinkholes located in the Valley and Ridge Physiographic Province, the same considerations should be applied to sinkholes located in other areas of the state.
  - Karst terrain is characterized by closed depressions (sinkholes), caves, and underground drainage resulting from the solutions of the calcium and/or magnesium carbonates. Sinkholes may develop either by solution of the surficial rocks or collapse of underlying caves. The actual rock cavity may or may not be choked by residual soil and debris. It is the potential instability of the sinkhole infilling, most often associated with changes in the local hydrology, which traditionally has been the concern of the construction industry. Those concerns have now broadened to include the potential impacts of construction on the area's hydrology and water quality.
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## REGULATIONS

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- Pursuant to the Safe Drinking Water Act, the Environmental Protection Agency (EPA) regulates the discharge of stormwater runoff into “improved” sinkholes through their Underground Injection Control (UIC) Program. The improvement of sinkholes, and subsequent directing of water into the subsurface, is classified as underground injection. Improved sinkholes used for this purpose are classified as a Class V Underground Injection Wells and may require a permit to function as a recipient of stormwater runoff.
- The EPA classifies the following activities as sinkhole “improvements”:
  - Cleaning out a sinkhole to facilitate drainage.

- Cutting a ditch to the base or mouth of a sinkhole.
  - Piping stormwater runoff to a sinkhole.
  - Cutting brush to facilitate stormwater flow to a sinkhole.
  - The EPA does not regulate (i.e., require a permit for) stormwater discharges that flow naturally into sinkholes without modification to the sinkhole.
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## CONCERNS

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- Both the EPA and VDOT have concerns with changes to the existing hydrology at sinkhole locations. These concerns include:
  - Water Quality – Sinkholes are often direct links to underground sources of drinking water. Stormwater runoff from highways could potentially contain various constituents such as oil, grease, heavy metals and salt that could enter and impact these water supplies. The underground ecosystems could potentially be impacted by highway runoff containing sediment generated both during and following highway construction and material from potential spills resulting from traffic accidents once the highway is operational.
  - Water Quantity – Directing additional stormwater flow to a sinkhole can result in the enlargement of the feature, create surface failures and erosion and cause flooding of adjacent property. Increasing the quantity of stormwater runoff flowing to a sinkhole can also cause the characteristics of the sinkhole opening to change in such a manner so as to restrict the flow into the subsurface, resulting in greater surface ponding in and around the area of the sinkhole.
  - Instability – The area within and surrounding a sinkhole can settle or sink unexpectedly, resulting in loss of competent structural material and damage to overlying structures.
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## DESIGN CONSIDERATIONS

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- The following design considerations must be followed for any projects involving the construction of highways or drainage outfalls in areas where sinkholes are present:
  - Avoidance – Determine if there are any feasible alternatives that would avoid construction in the area of the sinkhole. Where the sinkhole is the natural outfall for the stormwater runoff from the roadway area, determine if the stormwater runoff can be diverted away from the sinkhole to an adequate surface water channel. It should be recognized that drainage facilities to accommodate the diversion of stormwater runoff may require significant additional grading and right of way. In addition, stormwater quantity management facilities may be

required at the point where the diverted flow is released from the project right of way in order to avoid the liabilities inherent with stormwater runoff diversion.

- Minimization of Impacts from Direct Discharges – If avoidance is not possible, drainage outfalls from the roadway should include natural buffer zones between the outlet of the roadway drainage structure and the sinkhole in order to provide for a natural filtering process. Where stormwater runoff naturally terminates in sinkhole areas, vegetated flow areas (minimum 80' – 100' in length), runoff spreaders and vegetated swales should be used between the outlet of the roadway drainage structure and the bottom of the sinkhole in order to provide for filtering of the flow. If concentrated flow from the roadway pavement area is being directed into the bottom of the sinkhole, a stormwater management water quality basin or other type of water quality filtering device should be incorporated into the design. The water quality basin or filtering device should not be located in the bottom (throat) of the sinkhole (where the flow enters the ground) but rather should be located as close to the roadway or discharge point as practicable. Stormwater management basins constructed in these areas may require an impermeable lining in order to prevent impacts to the underlining soil and subsurface area. The District Materials Section should provide recommendations regarding this issue. A stormwater management basin may also be needed to provide attenuation of any increased flow quantity that may be directed toward the sinkhole.
- If stormwater runoff from a roadway project must be directed to a sinkhole, the area of the sinkhole should be investigated to determine if any existing ponding occurs during rainfall events. The drainage design for the project should reflect how the sinkhole is anticipated to function after completion of the construction activities. The project should be designed to avoid any flood damages resulting from potential blockage and ponding in the sinkhole area.

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## COORDINATION

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- During the Scoping Phase of the Plan Development Process, the District Materials Section should identify those projects where visible sinkholes are present along the project corridor. The presence of sinkholes should be noted on Form PM-100 (LD-430), Scoping Report and, if possible, the approximate location of observed sinkholes should be identified. The project survey shall provide an accurate and detailed location and description of all identifiable sinkholes located within the survey boundaries.
- During the hydraulic analysis phase of the project development process, the Hydraulics Engineer should coordinate with the District Materials Section and the District Environmental Section if the project Scoping Report or survey data indicates the presence of sinkholes and if it is anticipated that those sinkholes might be impacted by stormwater runoff from the project.

## PLAN DETAILS

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- Where the roadway traverses over or through a sinkhole area, the sinkhole should be treated in accordance with one of the typical details shown on Standard Insertable Sheet No. isd/msd 2944 unless otherwise directed by the District Materials Engineer.
  - Detail No. 1 should be used for sinkholes that receive stormwater runoff from relatively large areas and have a well-defined opening (throat). This treatment involves cleaning out soil and debris to expose the throat, installing a length of pipe to convey surface drainage into the sinkhole and backfilling with riprap and successive layers of smaller aggregate and a geotextile fabric prior to the placement of the regular roadway embankment material.
  - Detail No. 2 should be used for sinkholes with broad, flat depressions and which have no defined throat. These sinkholes typically receive stormwater runoff from relatively small areas. The width of the roadway embankment is generally less than the width of the depression. This treatment involves the placement of riprap in the bottom of the roadway embankment to allow for the continued infiltration of surface flows. The riprap is capped with successive layers of smaller aggregate and a geotextile fabric before placement of the regular roadway embankment material.
  - Detail No. 3 should be used for small shallow sinkholes that receive stormwater runoff from relatively small areas and where the roadway embankment will cover most or all of the depression. This treatment involves filling the depression with successive layers of smaller aggregate and a geotextile fabric before placement of the regular roadway embankment material. Since this treatment effectively “caps” the sinkhole and precludes the entry of surface water, a drainage ditch or other hydraulic conveyance is typically required along the edge of the roadway embankment to convey stormwater runoff to an adjacent outfall.
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## ROADSIDE DITCHES

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- In areas of karst topography, roadside ditches with a gradient of less than 5% may need to be lined to inhibit the infiltration of surface waters. The District Materials Section should make this determination during the preliminary soils investigation phase of the project and, where applicable, include their recommendations for ditch lining with those other recommendations requested on Form LD-252 - Request for Supporting Data. Where ditch lining is recommended, the roadside ditches should be lined with concrete using Standard PG-2A or PG-5 (as applicable) or similar details. When using Standard PG-2A or PG-5 concrete ditches in these areas, the standard detail drawings will need to be modified to include the following:
  - Add a 30-mil polyethylene film beneath all joints (to extend 4 feet longitudinally in each direction).

- Show the location of the curtain wall (normally placed adjacent to each expansion joint) 4 feet downgrade of the expansion joint (to coincide with the end of the 30-mil polyethylene film).
  - In areas where these modifications apply, the plan description should note "St'd. PG-2A Modified" or "St'd. PG-5 Modified", as applicable. The details for these modifications are included on the Sinkhole Insertable Sheet.
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## REPORTING REQUIREMENTS

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- If direct discharge of runoff into a sinkhole is the only feasible option available and improvements (modifications) such as cleaning, clearing, etc. are needed in the lowest section of the sinkhole (where water enters the ground), the details of such improvements (modifications) must be discussed with the District Environmental Section in order that they can determine what permits and/or reporting will be required. Typical sinkhole improvements (modifications) that would fit into this category are depicted in Detail 1 and Detail 2 on Standard Insertable Sheet No. isd/msd 2944. These "improved" sinkhole sites are brought to the attention of the District Environmental Section early in project development process in order to allow adequate time for coordination with the EPA and other applicable regulatory agencies. The Environmental Division's Form EQ-120 must be completed for those sites where it is determined necessary to "improve" a sinkhole and where it is determined such improvements would be regulated under the EPA's UIC Program. The Hydraulics Engineer shall be responsible for completing Form EQ-120 and submitting it to the District Environmental Hazardous Materials Manager for further processing.
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## SUBDIVISIONS AND FACILITIES BUILT BY OTHERS

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- These Guidelines shall apply to roadways that are designed and constructed by others and which will ultimately be maintained by VDOT. In addition, where a sinkhole is being utilized as a drainage outfall, an acceptable legal agreement shall be executed that absolves VDOT of any liability and maintenance responsibilities associated with the sinkhole. The agreement should identify the County as the responsible party in the event that the developer or homeowners association cannot (or will not) assume the responsibility for liability or maintenance. A sample legal agreement can be found in Secondary Roads Division's publication "GUIDE FOR ADDITIONS, ABANDONMENTS, AND DISCONTINUANCES – SECONDARY SYSTEM OF STATE HIGHWAYS". The sample agreement shown in this publication is for stormwater management facilities but it can be modified slightly to cover the use of a sinkhole as a drainage outfall. The development of the agreement for the use of a sinkhole as an outfall should be coordinated with and approved by the Local Assistance Division in the Central Office.

## SUMMARIZATION

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- Quantities relative to sinkholes (Aggregate Material, Dry Rip Rap, etc.) are to be summarized in a separate summary.
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## PAY ITEMS

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- Standard PG-2A Modified, Paved Ditch, S.Y./m<sup>2</sup>
  - Standard PG-5 Modified, Paved Ditch, S.Y./m<sup>2</sup>
  - 30-mil Polyethylene Film is included in the bid price for Standard PG-2A Modified and/or Standard PG-5 Modified Paved Ditch.
  - Grate for EW-1 is included in the bid price for Standard EW-1 Endwall for Pipe Culverts.
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## INSERTABLE SHEET

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- The following insertable sheets are available on Falcon DMS under the **UPC# eng\_ser**, Division, for applicable plan assemblies:
    - Sinkhole Details, Drawing No. isd 2944 (Imperial), msd 2944 (Metric)
    - Paved Ditch PG-2A/ PG-5 Modified, Drawing No. isd 2945 (Imperial), msd 2945 (Metric)
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## FORM EQ-120 SINKHOLE INVENTORY

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- Form EQ-120 is available inside VDOT at:

<http://bioapp10:89/>