

Karst Geology

Karst landscapes are usually formed on limestone from the surface and subsurface removal of rock mass by dissolution of calcite or dolomite. This forms irregularities on the land surface. Karst areas normally have caves that developed as a result of dissolution along joints, bedding planes, or other openings. As ground water dissolves subsurface limestone, cave systems enlarge and eventually the overburden causes roofs of caves to collapse creating, on the surface, a bowl shaped land feature called a **sinkhole**. Sinkholes are a direct conduit to ground water. Because the dissolution along the joints and bedding planes, ground water can travel extremely fast relative to ground water in other types of aquifers. Adsorption to aquifer material, biological uptake, and microbial activity are a few processes that reduce ground water pollution. However, in a karst region, ground water flows through joints and along bedding planes much like water flows through pipes in our homes. This fast flow rate does not allow adsorption, microbial activity, or uptake processes to remove pollution from the ground water before it is pumped from the ground by a landowner. **Nearly all spills that occur in karst areas have the potential to be lethal to the animals that live in the cave systems.** If a project is located near a sinkhole or other karst feature, the regulatory agencies will require control of the drainage such that the acute and chronic criteria for surface water quality criteria are not exceeded.

Karst features exist in an area of southern Indiana. This area ranges from 10-50 miles wide and stretches from Crawfordsville to the Ohio River (see attached map). Much attention has been given by INDOT in the planning, design, and construction of road projects in the karst area. There are, however, certain responsibilities assigned to construction activities. INDOT has entered into a **Memorandum of Understanding** (attached) with other agencies in an effort to minimize any deleterious effects of construction projects in the karst area and to regulate certain activities in these areas. Included in this Memorandum of Understanding is a commitment from INDOT, Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service to determine the location of sinkholes, caves, underground streams, and other related karst features and their relationship prior to determining the potential impacts of the proposed rehabilitations or construction.

Roadways typically have runoff such as salt and unknown spills that pollute soils near the road. In karst terrain, construction activities may cause soil releases to ground water via nearby sink holes. Excess silt introduced into a sink hole may seal a fissure system effectively removing means of draining the roadway. A wide range of toxic contaminants adhere to soils and may be liberated when soils are introduced into water. Contractors are required to have an erosion control plan, however, timely implementation of the plans are very important in the karst terrain. Maintenance of heavy machinery, such as oil changes, should be done in a designated area which should not be near the sinkhole. After adverse weather conditions, check erosion control measures for damage. The use of peat and other types of filters and wide grassy areas to catch and clean contaminants are some methods currently being used by INDOT to protect the groundwater. Likewise a project in a karst area might include the construction of

detention and/or retention basins. Regular inspections should be scheduled to ensure minimum and satisfactory compliance with the Memorandum of Understanding. Clearing right-of-way, grading, excavation, tile drains, pesticide and herbicide treatment, and runoff from roadways are a few activities that may endanger the ground water quality in karst regions. It is important therefore, that you are aware of potential environmental impacts that could occur if construction activities were conducted in the usual manner. In addition to the possible lethal effects on wildlife, contamination of ground water used for drinking water could occur. Regular inspections should be scheduled to ensure minimum and satisfactory compliance with the Memorandum of Understanding, particularly erosion control features. Any sinkhole modification may result in the need for an EPA Injection Well Permit. The Division of Operations Support should be contacted in this event or to answer any questions concerning karst area activities.

MEMORANDUM OF UNDERSTANDING

This memorandum of understanding is made and entered into this thirteenth day of October: 1993 between the Indiana Department of Transportation, Indiana Department of Natural Resources, Indiana Department of Environmental Management and the U.S. Fish and Wildlife Service for the purpose of delineating guidelines for construction of transportation projects in karst regions of the state.

Whereas, Indiana Department of Transportation, Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service wish to cooperate in the identification, study and treatment of drainage in karst regions related to the construction of transportation projects and,

Whereas, Indiana Department of Transportation, Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service accept responsibility to ensure the transportation needs of Indiana are met in an environmentally sensitive manner that protects the habitat of all species and,

Whereas, design and constructions practices must protect ground water quality, public health and safety, and the environment.

Whereas, Indiana Department of Natural Resources will conform to the terms and conditions of this MOU on their transportation projects. Likewise, it will be Indiana Department of Natural Resource's responsibility to provide standard biological review for project in the karst region.

Therefore, in consideration of the terms and conditions set forth herein the Indiana Department of Transportation, Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service agree as follows:

1. Indiana Department of Transportation in cooperation with the Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service shall determine the location of sinkholes, caves, underground streams, and other related karst features and their relationship prior to proposed alterations or construction in karst regions of the state. A consultant with expertise in karst geology/hydrology may assist in the identification and characterization of the karst features. The choice of the consultant retained by Indiana Department of Transportation will be subject to the review of Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service.

2. Tasks to accomplish this work will include:
Research available from public and private sources for information relative to karst features.

Field check karst and cave features that appear from the first task and identify and additional karst features.

Prepare a draft report, with photographs and maps, drainage areas, and land use of that drainage area for each sinkhole or karst feature, dye-tracing and/or other geotechnical information to determine subsurface flow of water in the project area and surface water drainage patterns of the area. Calculations of estimates of annual pollutant loads from the highway and drainage within the right-of-way will be made, including prior to, during and post construction estimates. The design of the treatment of the karst features will take into consideration treatments necessary to meet the standards of the monitoring and maintenance plan.

That report will be used as a tool to assist in determining the proposed highway alignment. The intent of Indiana Department of Transportation is to avoid karst areas and use alternate drainage where possible.

3. Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will be requested to review and comment on the findings at the early coordination phase of project development.

4. Indiana Department of Transportation, using the input from Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will begin to formulate appropriate measures to offset unavoidable impacts to the karst features. It is understood by all parties that some of the methods proposed at this time will be generic and could be applied throughout the length of the corridor. Other methods may be specific to a particular cave or karst feature. Some of the approaches may require additional investigations to determine their necessity and/or their feasibility. A revised draft report will be prepared by Indiana Department of Transportation's consultant and provided to the Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service as part of the design review process.

5. Drainage entering from beyond the right-of-way will be treated according to the same process as drainage generated by the project.

6. As the project progresses further into the design phase, the Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service will be invited and will attend field checks and meetings dealing with efforts to negate or minimize adverse impacts.

7. Hazardous materials traps (HMT's) will be constructed at storm water outfalls and other locations that will protect karst features from spill contamination.

8. Indiana Department of Transportation agrees to develop a monitoring and maintenance plan for the affected karst features. Indiana Department of Natural Resources, Indiana Department of Environmental Management and the U.S. Fish and

Wildlife Service will be provided an opportunity to review this plan. The establishment of water quality and a point at which a standard is established for remediation will be a part of each monitoring plan. The results of the monitoring will be submitted to Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service on a regular basis.

9. A low salt, and no spray strategy will be developed for each future project. A signing strategy for these items will also be developed for each project.

10. Prior to acceptance of the final design plans an agreement will be developed which will set out the appropriate and practicable measures to offset unavoidable impacts to karst features. This agreement will be signed by the department director of Indiana Department of Natural Resources. The commissioner of Indiana Department of Environmental Management, the commissioner of Indiana Department of Transportation and the supervisor of the U.S. Fish and Wildlife Service Bloomington Indiana field office. The agreement will become a part of the contract documents for the project, will be discussed at the pre-construction conference and will be on file at the office of the project administrator.

11. Indiana Department of Transportation will assure that the terms of the agreement will be completed with all safeguards given to the karst area. Special provisions, which are binding provisions that are a part of the contract, will be included outlining the precautions to be taken. Construction and design strategies for handling karst features will be discussed with the contractor(s) and project administrator during the pre-construction conference. Project administrator shall ensure that the contractor is following the new erosion control standards that meet rule 5 of 327 IAC 15 and any special precautions outlined in the design plans that the sinkhole treatment is being handled correctly. The erosion control plan must be available at the project administrator's office. An emergency response plan will be made a part of the contract documents. In addition, the contract documents will contain a strategy for signing to alert the public to the fact that all types of spills are potentially hazardous to the karst environment. For Indiana Department of Transportation, this plan would be procedure 20 of the Field Operations Manual dated 6/24/92 (attached).

12. The location and nature of the sinkholes and drainage schematic will be provided to the Indiana Department of Environmental Management. They will provide the information to the appropriate local authorities and the hazmat teams. An emergency response plan will be followed. This constitutes procedure 20. Included in this information is an understanding that all types of spills are potentially hazardous to karst regions.

13. Indiana Department of Natural Resources, Indiana Department of Environmental Management, and the U.S. Fish and Wildlife Service personnel will monitor construction and maintenance to the agreed upon terms, as deemed necessary.

14. If during construction it is found that the mitigation agreement must be altered, all of the agencies will be contacted and agreement reached prior to work continuing in that specific area of the project. In order to not unduly delay projects, a two working days response time is needed from the resource agencies.


15. Treatments will be maintained during construction by means of a visual inspection on a weekly basis or after every rain. Corrective action will be taken as needed.

16. If after the above procedure is followed and a state/federal endangered/threatened species is found during construction, work in that area of the project will stop. The Indiana Department of Natural Resources and the U.S. Fish and Wildlife Service will be immediately notified. The Indiana Department of Natural Resources and the U.S. Fish and Wildlife Service will promptly investigate the situation, advise the project administrator and assume responsibility for protecting the endangered species and taking the appropriate action.

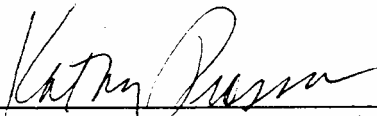
17. This document will be reviewed annually or more frequently at the request of any of the foregoing agencies.



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