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NONRULE POLICY DOCUMENT

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LIST OF ABBREVIATIONS

ARCPACS	American Registry of Certified Professionals in Agronomy, Crops and Soils
ASTM	American Society of Testing Methods
BOD	Biochemical Oxygen Demand
CEC	Cation Exchange Capacity
CERI	Center for Environmental Research Information
CFR	Code of Federal Regulations
CPG	Certified Professional Geologist
CWA	Clean Water Act
FWS	Free Water Surface Constructed Wetland
gpd	Gallons per Day
gpd/ft^2	Gallons per Day per Square Foot
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
ISDH	Indiana State Department of Health
MCL	Maximum Contaminant Level
mg/L	Milligram per Liter
NPDES	National Pollutant Discharge Elimination System
SCS	Soil Conservation Service
spp	Species
SSF	Subsurface Flow Constructed Wetland
STEP	Septic Tank Effluent Pump
T-BOD	Total Biochemical Oxygen Demand
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
UIC	Underground Injection Control
USDA	Underground Source of Drinking Water
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Chapter 1.0

INTRODUCTION

This nonrule policy document is intended solely as guidance and does not have the effect of law or represent formal Indiana Department of Environmental Management (IDEM) or Indiana State Department of Health (ISDH) decisions or final actions. This nonrule policy document shall be used in conjunction with applicable laws. It does not replace applicable laws, and if it conflicts with these laws, the laws shall control. A revision to this nonrule policy document may be put into effect by IDEM and ISDH once the revised nonrule policy document is made available for public inspection and copying. IDEM and ISDH will submit revisions to the Indiana Register for publication.

1.1 AUTHORITY/PURPOSE

This guidance presents the current criteria developed IDEM and ISDH to "insure proper design and ease of operation of water pollution treatment/control facilities," as required in 327 IAC 3-2-3 and the requirements for construction, installation, and modification of commercial on-site wastewater disposal facilities, as set forth in 410 IAC 6-10. Additionally, this guidance presents the criteria IDEM and ISDH currently consider necessary to help ensure that a constructed wetland wastewater treatment facility "will be operated in such a manner that any pollutants released or threatened to be released by the facility into the environment will not cause or contribute to violations of applicable water quality standards, or otherwise cause a significant adverse impact on the environment or the public health," as required by 327 IAC 3-4-3.

Because this guidance does not have the effect of law, persons seeking the appropriate permits from IDEM or ISDH for construction and operation of a constructed wetland wastewater facility are not required to comply with this guidance. Permit applicants who do not comply with this guidance will be required, however, to demonstrate that the facility for which they seek a permit meets the requirements of 327 IAC 3-2-3, 410 IAC 6-10, or 327 IAC 3-4-4 (determined by which agency has jurisdiction over the facility), and all other laws applicable to a constructed wetland wastewater treatment facility.

This guidance is intended to provide the public and regulated community with a framework of the regulatory requirements, technical considerations, and other information relevant to the permitting, design, construction, and operation of a constructed wetland system. The guidance is also intended to assist IDEM and ISDH in their review of permit applications for construction and operation of a constructed wetland wastewater treatment facility. When reviewing such applications, IDEM and ISDH will reference the guidance and follow all applicable laws.

1.2 SCOPE

This guidance pertains to constructed wetland wastewater treatment systems operated as commercial on-site wastewater disposal systems (as defined in 410 IAC 6-10) and water pollution treatment/control facilities used in public or private sanitary sewerage systems (as defined in 327 IAC 3-1-2) that discharge to surface water, ground water or land apply treated effluent. This guidance does not apply to private, individual residential sewage disposal systems that serve one- or two-family dwellings, pursuant to 410 IAC 6-8.1.

This guidance should be used with other applicable technical reference material. For example, soil absorption systems must be designed and constructed according to the ISDH, Bulletin S.E. 13 (referenced in 410 IAC 6-10). Compliance with additional technical reference material may be necessary depending on the system design and application.

1.3 BACKGROUND

Constructed wetlands are engineered systems made up of saturated substrates, emergent and submergent vegetation, and water, designed to reduce biochemical oxygen demand (BOD) and total suspended solids (TSS) concentrations in wastewater. Reductions in pathogens, nitrogen, metals and toxic organics are also possible.

1.3.1 Subsurface Flow Constructed Wetlands

Subsurface flow (SSF) constructed wetlands consist of one or more cells lined with a durable, impermeable liner. The cells are filled with media, typically gravel, that support growth of emergent vegetation and a thin film of microorganisms that are also found on plant root surfaces. Wastewater flows through the system in a horizontal direction and is maintained below the media surface.

1.3.2 Free Water Surface Constructed Wetlands

Free water surface (FWS) constructed wetlands also consist of one or more cells lined with a durable, impermeable liner. The cells are partially filled with soil or gravel media suitable for supporting emergent and/or submergent vegetation roots. The wastewater surface is exposed to the atmosphere and flows horizontally over the top of the media, through the stalks and detritus of the vegetation. Water depth is based upon the tolerance of the wetland vegetation species selected.

1.3.3 Issues for Consideration

IDEM and ISDH present the following issues for the consideration of constructed wetland wastewater facility owners and designers. The first issue is the constructed wetland's ability to adequately remove nitrogen contaminants. Specifically, IDEM and ISDH are concerned about the constructed wetland's ability to nitrify ammonia to nitrate and to

denitrify nitrate to nitrogen gas. Review of discharge data from existing systems and extensive literature research indicates that a constructed wetland designed without additional nitrogen removal treatment technology may result in significant concentrations of ammonia in the discharged effluent. High concentrations of ammonia are acutely and chronically toxic to aquatic organisms and when discharged into ground waters, potentially toxic levels of nitrate can be formed from ammonia. Therefore, persons designing a constructed wetland must consider nitrogen removal.

The second issue pertains to the performance longevity of these systems. There are many design, construction and operation factors that if not carefully considered may result in premature failure of the system. Designers of constructed wetland wastewater treatment systems should pay careful attention to factors that may lead to premature failure and make every effort needed to maximize the performance longevity of the system.

Constructed wetland designers should also be concerned about phosphorus removal in facilities with a surface water discharge. High concentrations of phosphate negatively impact surface water quality.

Additionally, system designers should beware of the characteristics of the wastewater stream entering into the constructed wetland may have an impact on the viability and longevity of the system. Constructed wetland performance depends, in large part, on system hydraulics and the biological processes of living organisms to treat the wastewater. High concentrations of substances such as suspended solids, oils, greases, or toxic chemical compounds should therefore be kept out of the system to avoid major system upsets or failure.

Chapter 2.0

PRE-CONSTRUCTION REQUIREMENTS

This chapter provides information on the permitting process of constructed wetland treatment systems. It also presents the information necessary to evaluate facility plans and specifications and establish permit conditions. The final section of this chapter sets forth construction limitations. All of the requirements discussed in this chapter can greatly affect the design and construction requirements of the constructed wetland treatment system. Consequently, IDEM and ISDH recommend that users of this guidance address these requirements before submitting a construction permit application.

2.1 REGULATORY REQUIREMENTS

Section 2.1.1 of this chapter discusses the factors that will be used to determine whether a proposed constructed wetland treatment facility is regulated by IDEM or ISDH. The remaining sections provide the regulatory requirements of both agencies and distinctions between agency requirements. These sections also provide other information regarding the constructed wetland treatment system permitting process. For an overview of relevant regulatory citations, please refer to Table 1 located in the Appendix.

2.1.1 Jurisdictional Boundaries

This section discusses the factors that will be used to determine whether a proposed facility is under the jurisdiction of IDEM or ISDH.

2.1.1.1 Indiana State Department of Health

ISDH regulates constructed wetland wastewater treatment facilities that discharge treated effluent through a soil absorption system and fall within the definition of a "commercial on-site wastewater disposal facilities" under 410 IAC 6-10. This definition is as follows:

> "Commercial on-site wastewater disposal facilities" means ... "all equipment and devices necessary for proper conduction, collection, storage, treatment, and on-site disposal of wastewater from other than one- or two-family dwellings. Included within, but not limited to, the scope of this definition are building sewers, grease traps, septic tanks, dosing tanks, absorption fields, perimeter drains, and temporary wastewater holding tanks serving such facilities as apartment buildings, campgrounds, churches, commercial establishments, condominiums, medical facilities, mobile home parks, motels, office buildings,
>
> restaurants, and schools." Constructed wetlands are considered to be within the

scope of this definition.

2.1.1.2 Indiana Department of Environmental Management

IDEM regulates all constructed wetland wastewater treatment facilities that:

(A) discharge treated effluent to surface water;

(B) land apply treated effluent; or

(C) discharge treated effluent through a soil absorption system and fall within the definition of a "publicly owned treatment works" (POTW) under 327 IAC 3-1-2. This definition is as follows:

> "Publicly Owned Treatment Works" (POTW) means a treatment works as defined by section 212(2) of the CWA which is owned by the state, or a municipality as defined by section 502 (4) of the Clean Water Act (CWA). This definition includes but is not limited to cities, towns, Regional Sewer Districts and Conservancy Districts.

2.1.2 Operator Certification Requirements

All facilities under IDEM's jurisdiction are required to be under the responsible charge of an operator certified by IDEM, pursuant to 327 IAC 8-12. See Section 4.2 for additional information.

2.1.3 Required Permits

The type and number of permit(s) that may be required are dependent on: 1) which state agency (i.e., IDEM or ISDH) maintains jurisdiction over the facility; and 2) the method of treated effluent discharge or disposal (e.g., surface water, ground water or land application). Both IDEM and ISDH require any person proposing to build a constructed wetland wastewater treatment facility to obtain a construction permit from the appropriate agency prior to the onset of construction. Proposed facilities under the jurisdiction of IDEM may also require either an operational, NPDES, and/or land application permit, depending upon what method of treated effluent disposal is selected by the owner of the proposed facility.

This guidance document does not discuss the permitting requirements of other regulatory agencies. The owner of the proposed facility is responsible for determining the applicable requirements of local, state and federal agencies. These agencies should be contacted directly to determine if additional permits are required for a proposed project.

2.1.3.1 Construction Permit (IDEM: 327 IAC 3-2 or ISDH: 410 IAC 6-10)

Any person proposing to build a constructed wetland wastewater treatment facility that will be used as a water pollution treatment/control facility or a commercial on-site wastewater disposal facility is required to apply for and obtain a valid construction permit prior to the onset of construction. In addition to the submission of the required facility plans, specifications or project design summary with the construction permit application, information obtained from a site-specific field investigation should be supplied. Refer to 327 IAC 3-2 and 410 IAC 6-10 (IDEM and ISDH respectively) for specific construction permit application requirements.

2.1.3.2 NPDES Permit (IDEM: 327 IAC 5-2-2)

A constructed wetland wastewater treatment facility discharging treated effluent to the surface waters of the State as a point discharge, except for exclusions made in 327 IAC 5-2-4, is prohibited unless in conformity with a valid NPDES permit obtained prior to the discharge. Refer to 327 IAC 5-2 for details of NPDES requirements and 327 IAC 5-3 for details of the permit application procedure.

2.1.3.3 Operational Permit (IDEM: 327 IAC 3-4)

Any person who owns or operates a water pollution treatment/control facility that is not subject to the NPDES permit program (327 IAC 5) may be required, at the Commissioner's discretion, to obtain an operational permit pursuant to 327 IAC 5-4-2. Generally, an operational permit is required only when the operation of the facility is considered by the Commissioner to pose a significant threat to the environment. Discharges of treated effluent to the subsurface are considered by the Commissioner to pose a significant threat to the environment and, therefore, require an operational permit. Effluent disposal by land application also requires an operational permit.

An operational permit contains terms and conditions the Commissioner determines necessary to assure that the water pollution control facility will be operated in such a manner that any pollutant released or threatened to be released by the facility into the environment will not cause or contribute to violations of applicable water quality standards, or otherwise cause a significant adverse impact on the environment or the public health. Specific permit terms and conditions are dependent upon many factors including, but not limited to: size of the system, type of treated effluent discharge, site-specific soil characteristics, geology and hydrogeology. Refer to 327 IAC 3-4 for additional information on operational permits.

2.1.3.4 Land Application Permit (IDEM: 327 IAC 6-2-1)

When the treated effluent of a constructed wetland is to be disposed of by application

upon or incorporation into the soil, a Land Application permit is required. In accordance with 327 IAC 6-2-2, when this effluent disposal method is selected, a permit application must be submitted to IDEM at least ninety (90) days prior to the proposed commencement of the operation. Submission of the land application permit application in conjunction with the construction permit application is encouraged to facilitate the permitting process.

2.1.4 Effluent Quality Limitations

This section provides information on how IDEM and ISDH determine effluent limitations for constructed wetland treatment systems. Subsection 2.1.4.2 discusses subsurface discharge effluent limitations, which are determined on a case-by-case basis by the agency with jurisdiction over the proposed project (refer to section 2.1.1 regarding jurisdiction). The final subsection defines and discusses the point(s) of compliance with effluent quality limitations.

2.1.4.1 Surface Water Discharges

As discussed above, any constructed wetland wastewater treatment facility discharging to a surface water of Indiana is under IDEM's jurisdiction. The effluent limitations established by IDEM are based on Water Quality Standards (327 IAC 2-1 and 2-1.5), the procedures for implementing Water Quality Standards (327 IAC 5-2), and technology-based treatment standards (327 IAC 5-5). Effluent limitations for certain types of facilities will be determined in accordance with applicable regulations [e.g. controlled discharge (327 IAC 5-10-3), lake dischargers and sinkhole dischargers (327 IAC 5-10-4), and small sanitary dischargers (327 IAC 5-10-5)].

2.1.4.2 Discharges via Soil Absorption Systems

(A) Indiana State Department of Health

Pursuant to 410 IAC 6-10-9 the Indiana State Department of Health, "may specify in its construction permits any limitations, terms or conditions necessary to provide a functional, easily operated, enduring commercial on-site wastewater disposal facility in accordance with 410 IAC 6-10-10, or to prevent a health hazard, nuisance, surface water pollution or ground water pollution." The ISDH will determine the need for effluent limits and monitoring requirements on a case-by-case basis (410 IAC 6-10-9). Effluent limits deemed necessary by ISDH are included as a condition of the construction permit approval letter.

(B) Indiana Department of Environmental Management

IDEM will establish discharge effluent limitations based on the Interim Ground Water

Quality Standards (327 IAC 2-1-7 or 327 IAC 2-1.5-9) and the requirements for an operational permit (327 IAC 3-4-3). Based on site-specific hydrogeologic investigation results, when situations exist where ground water and surface water bodies are hydrologically connected either by direct ground water to surface water communication due to close proximity, or due to an available transport structure (e.g., drainage tile, or a ditch), IDEM will determine permit limitations that are protective of both ground water and surface water. The effluent limits are established as a condition of the operational permit.

In addition to other limitations necessary to protect ground water and surface water, all soil absorption systems under IDEM jurisdiction will have technology-based effluent limitations (327 IAC 5-5) and a total nitrogen effluent limitation [total nitrogen defined as the sum of Total Kjeldahl Nitrogen (TKN) plus nitrate and nitrite nitrogen].

IDEM will establish a maximum effluent limitation for total nitrogen of 10 mg/l at the end of the constructed wetland effluent pipe, unless the applicant demonstrates that the total nitrogen concentration will be less than or equal to five (5) mg/l at the ground water monitoring system using fate-transport ground water modeling. Such modeling must meet the following requirements:

- The model must use site-specific inputs acquired from soil characteristics, geology, hydrogeology, existing background ground water quality, and existing and future total nitrogen loading conditions.

- The model must quantify the characteristics and delineate the boundaries of the effluent plume while accounting for all site-specific conditions (see Tables 2 thru 5 in Appendix for detail). The attenuation factor assumed in the model should be a conservative, justifiable number and must be accounted for.

- Modeling can only be used when the existing background ground water concentrations of total nitrogen are less than or equal to one-half the Safe Drinking Water Act Maximum Contaminant Level (MCL) for nitrate+nitrite.

- The modeling report must be included with a completed construction permit application. IDEM will review the modeling report for technical merit and determine if subsurface disposal is a viable method for meeting the ground water quality standards at down-gradient, ground water compliance points.

- If the Commissioner determines the modeling report is acceptable and the owner has submitted an administratively complete operational permit application, IDEM will use this report to determine appropriate permit limitations for total nitrogen (i.e., TKN plus nitrate-nitrite nitrogen).

- If the ground water is hydrologically connected to surface water, then nitrogen limits protective of both ground water and surface water will be established.

- The ground water model does not replace the requirements of the hydrogeologic study. Much of the information collected in the hydrogeologic study, however, will be information needed for input into a fate-transport ground water model.

To help ensure protection of ground water resources, in addition to effluent monitoring, IDEM will require ground water monitoring for all effluent discharges of soil absorption systems. The operational permits issued to control these discharges will contain provisions to help ensure that no contamination of Indiana's ground water resources occurs as a result of the discharge.

2.1.4.3 Land Application of Treated Effluent

Constructed wetland effluent may be disposed of at land application sites in compliance with 327 IAC 7-6. Utilizing appropriate conversion calculations, IDEM will determine constructed wetland effluent limitations for total nitrogen based upon acceptable annual land application rates. The constructed wetland effluent limitations established by this process are included as a condition of the land application permit. For additional information on how annual wastewater land application rates are calculated contact IDEM's Land Use Section (see Agency Contacts page).

2.1.4.4 Point(s) of Compliance

The term "point of compliance," as used in this document, refers to the geographic location, or "point," where compliance with established effluent quality limitations should be met.

(A) Consistent with the current NPDES program requirements, constructed wetland treatment systems discharging as a point source to the surface waters of the state must meet effluent limits prior to or at the discharge outfall to the receiving waters.

(B) In the case of discharges via soil absorption systems, two points of compliance are established: (1) a point of compliance is located at the end of the constructed wetland effluent pipe prior to discharge to the soil absorption system; and (2) a point of compliance is established at a ground water monitoring system consisting of three down-gradient and one up-gradient (of the soil absorption system) ground water monitoring wells.

Based on site-specific hydrogeologic investigation results, when situations exist where ground water and surface water bodies are hydrologically

connected either by direct ground water to surface water communication due to close proximity, or due to an available transport structure (e.g., drainage tile, or a ditch) additional points of compliance may be established on a case-by-case basis.

The ground water monitoring system should be derived from site-specific hydrogeologic investigation performed by a qualified ground water scientist (defined in section 2.2.1). The criteria used to determine whether an extensive, site-specific hydrogeologic investigation is required is discussed in section 2.2.

Plans for the ground water monitoring system should identify vertical and geographical location and design of the monitoring wells. The ground water compliance monitoring wells should be located at a minimum, twenty (20) feet within the property boundary in which the soil absorption system exists. The ground water monitoring system should be approved by the Commissioner, to ensure proper location of monitoring wells, prior to initiation of construction.

(C) When land applying treated effluent, the point of compliance is the end of the constructed wetland effluent discharge structure and any other points specified by the operational and/or land application permits.

2.1.5 U.S. EPA Underground Discharge System Reporting Requirement

U.S. EPA classifies soil absorption systems used as a method of disposal for constructed wetland effluent as Class V underground injection wells. Contact the U.S. EPA Region 5 UIC program (see Agency Contact page) to obtain additional information and the necessary form to complete and submit, prior to discharge of the effluent. Upon notification by U.S. EPA, IDEM will share all monitoring data required by the operational permit with the U.S. EPA Region 5 UIC program.

2.2 GEO-TECHNICAL INFORMATION REQUIREMENTS

This section provides an overview of the site geology, hydrogeology, and soil characteristics information needed. Refer to Tables 2-5 located in the Appendix for additional details. This specified information must be prepared by a certified/qualified professional as discussed below.

2.2.1 Certification Requirements

The information requirements discussed in this section must be obtained from certified (or qualified, as discussed below) professionals.

2.2.1.1 On-site Soil Survey for Soil Absorption Systems

In all cases where soil absorption systems are proposed, an on-site soil survey report must be prepared by a soil scientist certified with the American Registry of Certified Professionals in Agronomy, Crops and Soils (ARCPACS).

2.2.1.2 Geologic, Hydrogeologic Investigations

When site-specific field investigation of geology, hydrogeology and when applicable, ground water modeling is required, the investigation must be performed by either:

(A) a Certified Professional Geologist (CPG) certified in Indiana; or

(B) a Qualified Ground Water Scientist as defined by 327 IAC 8-4.1-1, which means a scientist or engineer who:

(1) has received a baccalaureate or postgraduate degree in the physical sciences or engineering; and

(2) "Qualified Ground Water Scientist" means an individual who possesses a bachelor's degree or higher in the physical sciences, for example geology, or engineering with a sufficient level of experience to make sound professional judgements regarding site characterization and hydrogeology. This level of experience may be demonstrated by certification or registration as a professional geologist or engineer, either of whom shall have education or professional experience in geology or hydrogeology or ground water hydrology.

2.2.2 Site Geology, Hydrogeology and Soil Characteristics

All systems discharging to a soil absorption system shall submit the information contained in this section to the appropriate regulatory agency prior to submitting a construction permit application. It is strongly recommended that the regulatory agency be contacted to determine the extent of information needed for a site-specific field investigation of geology and hydrogeology prior to submitting this information. Refer to Tables 2-5 in the Appendix for additional information.

2.2.2.1 Regional Geology

IDEM and ISDH need information regarding a general depiction of surficial and bedrock stratigraphy of the regional area, including regional ground water divides and flow direction to evaluate regional conditions which may provide limitations to subsurface discharges.

2.2.2.2 Local Geology

IDEM and ISDH need information regarding the on-site thickness, areal extent, and nature of soils, surficial deposits (e.g., unconsolidated glacial deposits), and bedrock underlying the site to evaluate the appropriateness of the site to accept subsurface discharges.

2.2.2.3 Local Hydrogeology

IDEM and ISDH need information regarding the depth to seasonal high water table, nature of water-bearing and confining units (e.g., hydraulic conductivity and transmissivity), direction and magnitude (e.g., hydraulic gradient and flow rate) of ground water flow to evaluate the potential for ground water contamination from subsurface discharges.

2.2.2.4 Ground Water and Surface Water Connection

IDEM and ISDH need information regarding the relationship of ground water flow to surface water bodies. Regional description of surface water bodies, drainage tiles, ditches, etc., which may allow for ground water to surface water connection, should be depicted.

2.2.2.5 On-site Soil Hydraulic Loading Rates

IDEM and ISDH need information regarding the soil's hydraulic loading rate. The soil's hydraulic loading rate is a measure of the soil's ability to effectively drain water. Typically, soil hydraulic loading rate is measured in units of gallons per day per square foot (gpd/ft^2). At a minimum, for all sites proposing subsurface soil absorption disposal of effluent, an on-site soil survey performed by a qualified individual should be used to determine the on-site soil hydraulic loading rate. This information is based on information found in ISDH Bulletin S.E. 13 and the texture and structure relationships identified in the soil profile included in the on-site soil survey report.

2.2.3 Background Ground Water Profile

Subsurface discharge systems with an average design capacity greater than or equal to 10,000 gpd are required to submit a ground water profile which should include a description of background ground water quality data for nitrate, nitrite and organic nitrogen. Systems with an average design capacity less than 10,000 gpd may be required to submit ground water quality profiles if, based on site-specific information, the regulating entity determines such information necessary.

2.3 LOADING INFORMATION REQUIREMENTS

This section provides an overview of the information IDEM and ISDH need to determine whether the constructed wetlands are designed properly. The loading information provided to IDEM or ISDH in the construction permit application should include the following:

2.3.1 Peak Daily Wastewater Flow

Some areas of the state experience seasonal fluctuations in population, which result in wastewater flow fluctuations. The design engineer should use the peak daily flow of the highest demand season to determine flow loading.

2.3.2 Contaminant Loading

The design engineer should measure (for existing treatment facilities) or calculate (for proposed facilities) the influent contaminant loading and the removal efficiency of the precedent treatment and proposed constructed wetland. Expected influent BOD, TSS, ammonia (NH_3), nitrate (NO_3) and phosphate (PO_4) loads should be included when providing the contaminant load.

2.3.3 Other Influent Load Characteristics

Identify any influent loads other than those listed above, that the constructed wetland system is expected to treat.

2.4 CONSTRUCTION LIMITATIONS

This section discusses construction limitations and required set back distances. Unless otherwise stated, the authority to require the following construction limitations are found in either 327 IAC 3-2-3; 327 IAC 3-4-3; or 410 IAC 6-10, which references ISDH Bulletin S.E. 13.

2.4.1 Construction Limitations - All Systems

The following construction prohibitions apply to all proposed constructed wetland projects to help ensure protection of human health and the environment.

2.4.1.1 Natural Wetland Protection

The use of any land as part of a constructed wetland is prohibited when that land is an existing “water of the United States,” as defined in 33 CFR Part 328 and subject to regulations found in 33 CFR Parts 320 through 330.

2.4.1.2 Constructed Wetland Vegetation

Certain plant species found in Indiana have invasive and obtrusive qualities. These species have invaded many naturally-occurring Indiana wetlands and lakes, and have impaired their capabilities to support well-balanced, aquatic communities. For example, these plants crowd out diverse, native plant communities and provide very little ecological value to most wildlife species. Because of this, these species pose serious threats to Indiana's aquatic flora and fauna. IDEM's Water Quality Standards Section keeps information on file from professional botanists and plant ecologists about these species.

In accordance with 327 IAC 3-4-3, 327 IAC 2-1-2, 2-1-3, 2-1-6, 2-1.5-4, 2-1.5-5, 2-1.5-8 and 410 IAC 6-10-9, IDEM and ISDH deem it necessary to restrict the use of the following species in constructed wetland wastewater treatment facilities.

Lythrum salicaria (purple loosestrife)
Myriophyllum spicata (Eurasian water milfoil)
Phalaris arundinacea (reed canary grass)
Phragmites australis (common reed)

IDEM and ISDH do not intend to approve the use of *L. salicaria*, *M. spicatum*, or *P. arundinacea* in constructed wetlands. IDEM and ISDH also do not intend to approve the use of *P. australis* in constructed wetlands, unless the facility shows to the satisfaction of IDEM or ISDH that:

(A) no other plant species are available that will provide comparable effluent treatment in constructed wetlands; and

(B) there is no possibility of any dispersal at any time of reproductively viable plant material, including seed, inflorescence, or rhizome fragment, beyond the boundary of the constructed wetland cell. For the purposes of this guidance, "dispersal" means the movement of plant material from within to beyond the wetland cell boundary as a result of either human or nonhuman events, including all actions that the facility may take to operate or maintain the constructed wetland.

The facility must demonstrate to IDEM or ISDH that it has met these tests by presenting scientifically-derived results from well designed studies accepted for publication in peer-reviewed science journals.

2.4.1.3 Flood Plains

Constructed wetland treatment facilities and soil absorption systems may not be constructed in an area located within a 100 year flood plain, as delineated by the Indiana Department of Natural Resources.

2.4.2 Construction Limitations - Subsurface Discharge

The following construction restrictions apply to all soil absorption discharges of constructed wetland effluent. IDEM and ISDH will evaluate proposed sites on a case-by-case basis. Site-specific hydrogeologic investigation may be required to verify acceptability of a proposed site.

2.4.2.1 Karst Areas

Areas of the State which are underlain by soluble bedrock (e.g. limestone) and exhibit predominant ground water flow through solution conduits (e.g. caves) may be un suitable for subsurface discharges. These areas of the State, generally defined by the physiographic provinces of the Crawford Upland, Mitchell Plain, Norman Upland, and Muscatatuck Regional Slope, exhibit mature karst terranes. Karst terranes are defined by the characteristic surface and subsurface geomorphologic features (i.e. sinkholes, sinking streams, springs and caves) developed by the dissolution of soluble bedrock. The hydrology of karst terranes is dominated by the interdependent relationship between surface features and the subsurface conduit system. Because ground water flow and surface infiltration in karst terranes is transported through open conduits and fissures, and limited iter-granular contact with the aquifer material exists, there is minimal potential for pollutant removal by absorptive process (Palmer, 1990). Due to the unique subsurface hydrology associated with karst terranes, the use of soil absorption systems for disposal of effluent in these areas will be evaluated on a case-by-case basis.

2.4.2.2 Subsurface Limiting Layers

Proposed site locations with seasonal high ground water levels or other limiting layers (e.g. glacial till, fragipan, etc.) less than three (3) feet below the soil surface are unacceptable for soil absorption trench systems. ISDH Bulletin S.E. 13 allows for provisions to overcome these limiting layers. Of the provisions allowed in Bulletin S.E. 13, only elevated sand mounds will be allowed to overcome the shallower limiting layers. If elevated sand mounds are required to overcome a limiting layer, no system is allowed if the depth to the limiting layer is less than 24 inches from the bottom of the mound.

Perimeter drains may be used to overcome seasonal high ground water levels less than three (3) feet below the soil surface. Use of perimeter drains is restricted to systems designed for a treatment capacity less than or equal to 10,000 gpd. Systems with a treatment capacity greater than 10,000 gpd will be evaluated on a case-by-case basis. Site-specific field investigation may be necessary to determine acceptability of a site.

2.4.2.3 Soil Hydraulic Loading Rates

Soil absorption systems may only be constructed on sites where soils are determined to have hydraulic loading rates greater than or equal to 0.25 gallons per day per square foot (gpd/ft^2) and less than or equal to 1.2 gpd/ft^2.

2.4.2.4 Shallow Bedrock

Subsurface soil absorption systems may not be constructed at sites where bedrock is less than two (2) feet below the bottom of the soil absorption system trenches.

2.4.2.5 Topographical Slope

Trench absorption systems may not be constructed at sites with topographical slopes greater than fifteen percent (15%). Elevated sand mound absorption systems may not be constructed at site locations with slopes greater than six percent (6%).

2.4.3 Set Back Distances

2.4.3.1 General Separation Distances

Soil absorption system separation distances should comply with the requirements established in Table 1, found on page 5 of ISDH Bulletin S.E. 13. Separation distances from private water wells, building foundations, property lines, streams, lakes, and water supply reservoirs are included for smaller systems in the table.

Based on site-specific information, additional separation distances may be required. IDEM and ISDH will make such determinations as necessary to be protective of human health and the environment.

2.4.3.2 Well Head Protection Areas

Soil absorption systems may not be constructed within 200 feet of a public or private water supply (i.e., well head). Information gained from site-specific well head protection area delineation and/or site-specific hydrogeologic investigations may be used to determine if a larger separation is necessary.

2.4.3.3 Free Water Surface Set Back Requirement

To provide for vector control, FWS constructed wetlands should be located at least one-quarter (1/4) mile from property lines, residences, place of business or public gathering place.

Chapter 3.0

DESIGN and CONSTRUCTION CRITERIA

This chapter provides the minimum design and construction requirements for constructed wetland wastewater treatment systems.

3.1 ADDITIONAL TREATMENT REQUIREMENTS

Additional treatment technologies may be required to help ensure compliance with the effluent limits established for a facility. This section provides a list of some treatment options that may be used in conjunction with a constructed wetland. New or additional technologies may be proposed by the owner and their use will be evaluated by IDEM or ISDH on a case-by-case basis.

The treatment technologies discussed below need not be located before the constructed wetland. In some cases it may be more appropriate to follow a constructed wetland with the additional treatment mechanism.

3.1.1 Septic Tanks

This includes septic tank effluent pump (STEP) systems designed in accordance with ISDH requirements. Typically, septic tanks precede the constructed wetland. Proper servicing of septic tanks is necessary to maintain treatment efficiency. In general, the effluent from septic tanks have demonstrated greater concentrations of organics than the effluent of lagoons. The higher organic concentrations may require longer residence times in the constructed wetland to meet effluent limitations.

3.1.2 Lagoon Treatment

This includes aerated and facultative treatment lagoons or stabilization ponds designed and constructed to achieve the maximum degree of treatment feasible that is consistent with acceptable criteria for lagoon systems. However, provisions should be made to ensure that floating debris, algae, duckweed or other materials are not present in the final lagoon effluent, to avoid clogging wetland cells. SSF constructed wetlands should not follow a lagoon.

3.1.3 Fixed Growth Systems

Fixed growth reactors are often constructed as packed towers or rotating plates. Septic tank effluent passes though these systems, often with the ability to recirculate through the

system to enhance contaminant removal performance. The effluent can then be directed

through a constructed wetland for final treatment.

Fixed growth systems are capable of nitrifying influent ammonia, but do not remove it. Combining a fixed growth system with a constructed wetland system could effectively reduce waste concentrations (specifically nitrogen compounds). There are three main types of fixed growth systems:

3.1.3.1 Trickling Filters

These are filter mechanisms that consist of a bed of media (e.g., sand, rocks, plastic media, or other medium that present a high surface area) where wastewater flows downward by gravity.

3.1.3.2 Upflow Filters

These are similar to trickling filters, except the wastewater is pumped upward through the media.

3.1.3.3 Rotating Biological Contactors

These are biological reactors in which fixed film plates are rotated to allow microorganisms to alternately be exposed to wastewater and oxygen, such that organic material is assimilated by aerobic bacteria.

3.1.4 Peat Filters

This is a filter mechanism that consists of a peat bed from which septic tank or constructed wetland effluent is discharged via distribution piping. As the wastewater moves though the bed, nitrogen compounds undergo nitrification, denitrification and microbial assimilation.

3.2 HYDRAULIC CONSIDERATIONS

Hydraulic factors are vital to the successful performance of constructed wetland and soil absorption systems. The following factors and/or characteristics should be considered for designing successful systems.

3.2.1 Hydraulic Loading on the Treatment System

The hydraulic loading of the constructed wetland and the associated soil absorption system determines the overall system's sizing requirement. Hydraulic loading should be based on actual usage, or for new systems, on the expected peak daily wastewater flow to the system. Refer to Table 6, "Guide for Estimating Wastewater Flows," found in ISDH

Bulletin S.E. 13 to calculate estimated peak daily wastewater flow for commercial establishments. For residences within community systems, use an estimated wastewater flow of 120 gallons per day (gpd) per bedroom in the residence. The minimum residential wastewater flow allowed is 240 gpd per home.

A down-sizing of the soil absorption system's land area requirements may be allowed based on the use of constructed wetland wastewater treatment. Soil absorption system down-sizing will be based on the most restrictive soil loading rate within the proposed absorption field area.

3.2.2 System Hydraulics

Constructed wetlands should be designed to maintain flow conditions throughout each treatment cell to provide for a uniform environment conducive to wetland biota. Uniform dispersal of flow is necessary in each cell to maximize the wastewater's contact in the system.

SSF constructed wetlands should maintain the wastewater flow beneath the surface layer of the bed media. The hydraulic gradient through the system should be sufficient to drive the flow through the media. A uniform distribution of flow across the cross-section of the cell should be maintained in SSF systems. Short-circuiting flow through the system should be prevented to avoid a significant decrease in system performance.

3.2.3 Flow Monitoring

A flow monitoring device should be used at the effluent end of the wetland cell. The preferred device is a flow totalizer unit. Designers of constructed wetland systems are encouraged to install at least one additional flow monitoring device at the inlet end of the constructed wetland cell to allow for measurement of evaporation and evapotranspiration losses occurring across the system.

3.2.4 Flow Level Control

The use of a device to control the level of wastewater flow through the system is required to provide additional control of system hydraulics. Typically, a simple vertically adjustable elbow device placed in the effluent discharge structure is adequate to maintain proper wastewater flow levels.

3.2.5 Retention Time

Retention time of wastewater in a constructed wetland directly impacts the treatment efficiency of the system, especially for nitrogen removal. Constructed wetland systems are recommended to have a minimum of five (5) days wastewater retention in the wetland

cell. If additional treatment (refer to section 3.1) is highly effective in removing nitrogen, shorter retention times may be allowed. IDEM and ISDH will determine if retention times of less than five days are acceptable on a case-by-case basis.

3.3 CELL CONFIGURATION

The constructed wetland should be divided into two or more cells that can operate independently if needed. This requirement does not eliminate the use of multiple, independent treatment units operating in parallel and/or series as part of the overall system. When multiple cells are used, each cell should be designed to allow for complete draining and removal from service while its flow is directed to another cell without compromising the treatment efficiency of the system.

3.3.1 Cell Depth

The depth of each FWS constructed wetland cell should not be greater than the ultimate depth tolerable to the emergent vegetation selected. The minimum acceptable cell depth for SSF constructed wetlands is 18 inches.

3.3.2 Cell Liner

Constructed wetland cells should be constructed with a durable, impervious liner, installed on the bottom and side walls of the cell to prevent wastewater leakage and ground water infiltration into the system.

3.3.3 Cell Media

SSF constructed wetlands typically have two layers of natural or synthetic graded media: (1) a surface layer consisting of media such as pea gravel or mulch that is used to support plant growth, and (2) a subsurface layer, consisting of larger (e.g., 3/8" to ½") media, where the wastewater flow is confined. The use of larger media (e.g., 2" to 4") around the influent distributor and the effluent collection pipe in the first and last two (2) feet of the SSF wetland cell, may reduce the potential for clogging. The use of screened, washed (to remove fines) gravel or river run is recommended.

In FWS constructed wetlands, top soil removed from the area of construction of the wetland is generally suitable for use as the medium for growing wetland vegetation.

3.3.4 Constructed Wetland Vegetation

IDEM and ISDH recommend that the facilities plant and maintain vegetation communities composed of a mix of non-invasive, native species. Additionally, the facilities are encouraged to select plant genotypes that are native to the site location, if

possible. The facilities should seed and transplant vegetation generally during the spring or summer, and should properly control wastewater levels to foster the germination and growth of the plant propagules. Appropriate plant species could include, but are not limited to, the following.

Subsurface Flow Systems	Free Water Systems
Scirpus spp. (bulrush)	*Potamogeton spp.* (pondweed)
Sagittaria spp. (arrowhead)	*Ceratophyllum spp.* (coontail)
Juncus spp. (rush)	*Scirpus spp.* (bulrush)
Carex spp. (sedge)	*Sagittaria spp.* (arrowhead)
Alisma spp. (water plantain)	*Juncus spp.* (rush)
	Carex spp. (sedge)
	Alisma spp. (water plantain)

NOTE: Please see Section 2.4.2.2 for a list of plant species restricted by IDEM and ISDH for use in constructed wetland wastewater treatment facilities.

Chapter 4.0

ADDITIONAL CONSIDERATIONS

This chapter provides recommendations and requirements regarding the operation of the constructed wetland treatment system. Specific operational requirements will be included as conditions of the construction, NPDES, operational or land application permits. These recommendations and requirements help provide for optimal system performance, longevity, safety, and protection of the human health and the environment.

4.1 OPERATOR TRAINING

IDEM and ISDH recommend that system operators obtain training specific to the operation of a constructed wetland wastewater treatment facility. Training needs specific to constructed wetlands include, but are not limited to:

- Plant (i.e., vegetation) maintenance requirements
- Hydraulics control
- Cleaning techniques
- Troubleshooting of system upsets
- Compliance monitoring and reporting

4.2 OPERATOR CERTIFICATION

In accordance with 327 IAC 8-12, operators of wastewater treatment facilities under IDEM's jurisdiction must be certified by IDEM. The certification the operator must hold depends on the classification of the treatment system. The following classifications apply to constructed wetland systems: Class I, Class II, Class III, or Class IV. These classification are based on the population equivalent of the treatment system as, specified in 327 IAC 8-12-2(a)(2-5).

4.3 EDUCATION OF SYSTEM USERS

System users should be educated about their system to help ensure optimal performance and to possibly extend the longevity of the constructed wetland treatment system. System users should be made aware that disposing some household substances into the system could result in decreased wetland performance.

4.4 VECTOR CONTROL

Mosquitos and other vectors have been associated with some open waters (e.g., ponds and lagoons). Since FWS constructed wetlands maintain open water surfaces, vector control must be observed. Vector control mechanisms that use natural agents, such as predatory fish and invertebrates, are effective. If predatory fish are used to control vectors, open water areas must be provided in the basin. At least 20 percent of the FWS basin surface should be open to the atmosphere to provide adequate oxygen to the predatory fish and to promote some aerobic conditions which when combined with anaerobic conditions underlying fully vegetated zones, can be use to get increased nitrogen removal. Project information supplied with the construction permit application should include a narrative description of proposed vector control. Refer to section 2.4.3.3 for required set back distance for FWS constructed wetlands.

4.5 CONTINGENCY IN CASE OF SYSTEM FAILURE

For permitting purposes, a contingency plan should be submitted with facility plans and specifications detailing the possible course(s) of action that will be taken in the event an effluent limit is violated or major system failure occurs. The plan can be limited to an analysis of alternative methods of disposal in the event wastewater can no longer be disposed of via the soil absorption system or land application. Additionally or alternatively, the plan should include analysis of additional treatment technologies that may be added to the facility to provide sufficient treatment to ensure that effluent limits will not continue to be exceeded. As part of the contingency plan, a one hundred percent land area set-aside for the soil absorption system is required.

4.6 FACILITY ACCESS

Fencing around the treatment facility property boundary is required to limit entry into the site by unauthorized individuals or domestic animals.

REFERENCES

Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Mangers. (1993). "Recommended Standards for Individual Sewage Systems."

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Indiana Department of Environmental Management. (1996). "Indiana Environmental Rules: Water." Edited by Marcia J. Oddi, Environmental Information Solutions, Indianapolis, IN.

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Moshiri, Gerald A., Editor, (1993). "Constructed Wetlands for Water Quality Improvement," Lewis Publishers, Boca Raton, Ann Arbor, London, Tokyo.

Palmer, A.N., 1990, Groundwater processes in karst terranes, in Higgins, C.G., and Coates, D.R., eds., Groundwater geomorphology; The role of the subsurface water in Earth-surface processes and landforms: Boulder, CO., Geological Society of America Special Paper 252.

Reed, S., and Brown, D. (1992). "Constructed Wetland Design: The First Generation," PB93-131753, U.S. Department of Commerce, National Technical Information Service. Springfield, VA.

"Selected Environmental Law Statutes," 1994-95 Educational Edition, West Publishing Company. St. Paul, MN.

U.S. EPA. (1993). "Subsurface Flow Constructed Wetlands for Wastewater Treatment--A Technology Assessment," EPA 832-R-93-001, U.S. EPA CERI, Cincinnati, OH.

U.S. EPA-Region 6. (1993). "Guidance for Design and Construction of a Subsurface Flow Constructed Wetland," Water Management Division, Municipal Facilities Branch, Technical Section. Dallas, TX.

U.S. EPA-Region 6. (1996). Water Management Division, Municipal Facilities Branch, Technical Section. Personal Communication.

APPENDIX
(TABLES, FIGURES and ATTACHMENT)

Table 1
Regulatory Requirement Summary

RULE CITATION	AGENCY	TITLE	DESCRIPTION
410 IAC 6-10	ISDH	Commercial On-Site Wastewater Disposal	Requires permits for the construction, installation or modification of a commercial on-site wastewater disposal facility
Bulletin S.E. 13	ISDH	On-site Water Supply and Wastewater Disposal for Public and Commercial Establishments	Guidelines for Architects and Engineers which provides basic requirements for layout and design of on-site water supply and wastewater disposal systems for commercial establishments.
327 IAC 3-2	IDEM	Construction Permits	Requires permits for the construction, installation, or modification of any water pollution treatment/control facility or sanitary sewer.
327 IAC 3-4	IDEM	Operational Permits	May require, at the Commissioner's discretion, obtaining a permit to operate a water pollution control facility. Generally, operational permits are only required where the operation which is not subject to the NPDES permit program, industrial pretreatment permit program, or the facility is considered to pose a significant threat to the environment.
327 IAC 5-2	IDEM	NPDES Permits	Requires a permit for any discharge of pollutants into the waters of the State as a point source discharge -- permit must be obtained prior to the discharge. Does provide several exclusions from this requirement.
327 IAC 6-2	IDEM	Land Application Permits	Requires a permit for the disposal of any industrial, municipal, or semi-public sludge, waste product, and/or wastewater by application upon or incorporation into the soil. Permit is required prior to the discharge. Three exclusions from this requirement are provided for by the rule.
327 IAC 2-1 and 327 IAC 2-1.5	IDEM	Water Quality Standards	Establishes an antidegradation standard applicable to surface waters, designates uses for all waters of the state and establishes the water quality criteria necessary to meet the designated uses for all waters of the state. Ground waters are considered waters of the state.
327 IAC 2-1-7 and 327 IAC 2-1.5-9	IDEM	Interim Ground Water Quality Standards	Establishes narrative ground water quality standards which must be maintained for all ground water. Provides numeric standards for ground water used as public water supply for coliform bacteria, chlorides or sulfates, strontium-90, Radium-226, and gross beta concentrations. In addition, provides numeric criteria for industrial water supply for total dissolved solids and/or specific conductance.
327 IAC 8-12	IDEM	Wastewater Treatment Plant Operator Certification Requirement	Provides a system for the classification of wastewater treatment facilities. Establishes the minimum qualifications for persons operating a wastewater treatment facility and the requirement for state certification of wastewater treatment plant operators.
327 IAC 5-4-2	IDEM	Special NPDES Programs: Underground Injection	Allows the Commissioner to deny requests for underground injection and to issue Construction or Operational Permits to prohibit or control the discharge to prevent pollution of the ground waters of the state.

Table 1
Regulatory Requirement Summary

RULE CITATION	AGENCY	TITLE	DESCRIPTION
40 CFR Part 144	EPA	Underground Injection Control	Authorizes the injection of non-hazardous wastes into or above "Underground Sources of Drinking Water (USDW)" by rule. However, all UIC wells authorized by rule must provide EPA with inventory information, as specified at 40 CFR Part 144.26 and 144.27.

Table 2
SUMMARY OF SITE GEOLOGY INFORMATION

INFORMATION NEEDED	PURPOSE / RATIONALE	COLLECTION METHODS
Geology of unconsolidated materials and soil deposits: ! Thickness and areal extent of units ! Lithology; mineralogy ! Particle size and sorting; porosity ! Hydraulic Conductivity	**For both Unconsolidated and Bedrock:** ! Evaluate the influence of geology on water-bearing units and aquifers ! Evaluate the influence of geology on the release and movement of contaminants ! Obtain information on the engineering geologic aspects of site remediation	**For both Unconsolidated and Bedrock:** ! Determination of regional geology from available information - Published reports (geologic investigations, ground water reports, soil surveys, etc.) - State geologic maps - USGS topographic quadrangles - Descriptions of regional geology from previous reports/Site Investigations
Geology of bedrock: ! Type of bedrock ! Lithology; petrology ! Structure (folds, faults) ! Discontinuities (joints, fractures, bedding planes, foliation) ! Features such as, solution cavities (karst), etc. ! Hydraulic Conductivity	Rationale same as above	! **Primary**: Site Reconnaissance Mapping - Field mapping of surficial soil and unconsolidated units, bedrock outcrops, surface water drainage, springs, and seeps - Analysis of aerial photography or remote imagery - Surface geophysics ! **Secondary**: Subsurface Explorations - Test borings or core borings (with or without sampling) - Test pits and trenches - Description and logging of subsurface geologic materials - Sample collection for laboratory analyses of physical properties and mineral content - Borehole geophysics

Table 3
SUMMARY OF SOIL AND VADOSE ZONE INFORMATION

INFORMATION NEEDED	PURPOSE OR RATIONALE	COLLECTION METHODS	
		GENERAL	SPECIFIC
Soil Characteristics: On-site Soil Survey Information Type, hydraulic loading rate, temperature	Estimate the effect of the properties on infiltration and retardation of leachates and the release of gaseous contaminants	Reports and maps by federal and County agencies, Soil Conservation Service (SCS) -- Soil Series	Borehole sampling, lab measurements (ASTM methods), water budget methods, instantaneous rate method, seepage meters, infiltrometers, test basins
Soil Chemistry Characteristics: Solubility, ion speciation, adsorption coefficients, leach ability, CEC, mineral partition coefficients, chemical and sorptive properties	Predict contaminant movement through soils and availability of contaminants to biological systems	Existing scientific literature	Chemical analysis, column experiments, leaching tests
Vadose Zone Characteristics: Permeability, variability, porosity, moisture content, chemical characteristics, extent of contamination	! Estimate velocity in the vadose zone	Existing literature	Water budget with soil moisture accounting Draining profile methods Measurement of hydraulic gradients Estimates assuming unit hydraulic gradient Flow meters Methods based on estimating or measuring hydraulic conductivity, using: ! Laboratory parameters ! Relationships between hydraulic conductivity and grain size ! Catalog of hydraulic properties ! Field measurements of hydraulic conductivity using single or multiple wells
	! Estimate velocity in the vadose zone	Existing literature	! Tracers ! Calculations using flux values ! Calculations using long-term infiltration date
	! Evaluate pollutant movement in the vadose zone	Existing literature	Four-probe electrical method Electrical conductivity probe Salinity sensors Solids sampling followed by laboratory extraction of pore water Solids sampling for organic and microbial constituents Suction Lysimeters Sampling perched ground water

Table 4
SUMMARY OF SURFACE WATER INFORMATION

INFORMATION NEEDED	PURPOSE OR RATIONALE	COLLECTION METHODS	
		GENERAL	SPECIFIC
Drainage Patterns: • Overland flow, topography, channel flow pattern, tributary relationships, soil erosions, and sediment transport and deposition	Determine if overland or channel flow can result in on-site or off-site flow and if patterns form contaminant pathways	Topographic maps, site inspection, and soil conservation services	Aerial mapping and ground survey
Surface-Water Bodies: • Flow, stream widths and depths, channel elevations, flooding tendencies, and physical dimensions of surface-water impoundments	Determine volume and velocity, transport times, dilution potential, and potential spread of contamination	Public agency data and atlases; catalogs, maps, and handbooks for background data	Aerial mapping and ground survey
• Structures	Effect of manmade structures on contaminant transport and migration	Public agency maps, records and ground survey	
• Surface-water/ground-water relationships	Predict contaminant pathways for interceptive remedial actions	Public agency reports and surveys	Water level measurements and modeling
Surface-Water Quality: • pH, temperature, total suspended solids, suspended sediment, salinity, and specific contaminant concentrations	Provide capacity of water to carry contaminants and water/sediment partitioning	Public agency computerized data files, handbooks, and open literature	Sampling and analysis

Table 5
SUMMARY OF GROUND WATER INFORMATION

INFORMATION NEEDED	PURPOSE OR RATIONALE	COLLECTION METHODS	
		GENERAL	SPECIFIC
GROUND WATER OCCURRENCE			
! Aquifer boundaries and locations ! Seasonal high water table level	Determine areal extent of aquifer potential impacted	Geologic maps and reports (regional)	Well logs, boring data, etc.
! Aquifer ability to transmit water	Determine potentially quantities and rates for treatment options	Pumping and injection tests of monitoring wells	Ground-water level measurements (over time to monitor seasonal variations) Instrument survey of wells for calculation of ground-water elevations Borehole and surface geophysics
GROUND WATER MOVEMENT			
! Direction of flow	Identify most likely pathways of contaminant migration	Existing hydrologic literature specific to the proposed site.	Water level measurements in monitoring wells Testing of hydraulic properties using slug tests, tracer tests, and pump tests (short- or long-duration, single or multiple well) Elevation contours of water table or potentiometric surface Analytical calculations of flow directions and rates Computer generated simulations of ground-water flow and contaminant transport (using analytical or numerical methods)
! Rate of flow	Determine maximum potential migration rate and dispersion of contaminants	Existing hydrologic literature specific to the proposed site.	Generation of site water balance Hydraulic gradient, permeability, and effective porosity from water level contours, pump test results, and laboratory analyses
GROUND WATER RECHARGE/DISCHARGE			
! Location of recharge/discharge areas	Determine interception points for withdrawal options or areas of capping.	Existing site data, hydrologic literature, site inspection	Comparison of water levels in observation wells, piezometers, lakes, and streams Field mapping of ground-water recharge areas (losing streams, inter-stream areas) and ground-water discharge to surface water (gaining streams, seeps, and springs)
! Rate	Determine variability of loading to treatment options	Existing literature specific to the proposed site.	Water-balance calculations aided by geology and soil data
GROUND WATER QUALITY			

Table 5
SUMMARY OF GROUND WATER INFORMATION

	INFORMATION NEEDED	PURPOSE OR RATIONALE	COLLECTION METHODS	
			GENERAL	SPECIFIC
!	pH, total dissolved solids, salinity, specific contaminant concentrations: nitrate, nitrite and TKN	Determine exposure via ground water; define contaminant plume for evaluation of interception methods	Existing literature	Analysis of ground water samples from observation wells

AGENCY CONTACTS

Indiana Department of Environmental Management
Indiana Government Center North (IGCN)
100 N. Senate Avenue
P.O. Box 6015
Indianapolis, IN 46206-6015
1-800-451-6027

Permitting Information:

Office of Water Management
Permitting Branch
IGCN Room #1203
(317) 232-8676

Land Application Information:

Office of Solid and Hazardous Waste
Land Use Section
IGCN Room #1125
(317) 233-6121

For information regarding ISDH commercial on-site wastewater disposal requirements and construction permits contact:

Indiana State Department of Health
2 North Meridian Street
Indianapolis, IN 46204
(317) 233-1325

Office of Consumer Protection
Sanitary Engineering Division
2 North Meridian Street
Indianapolis, IN 46204
(317) 233-7177

For information regarding Underground Injection Control (UIC) requirements contact:

U.S. Environmental Protection Agency Region 5
Underground Injection Control Branch
77 West Jackson Boulevard
Chicago, IL 60604-3590
(312) 886-1492