INFORMATION NEEDS TO GUIDE DECISION MAKING ABOUT DRAINAGE-CHANNEL MAINTENANCE

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INTRODUCTION

This document has been produced in response to recent controversy surrounding the maintenance of drainage channels and agricultural drainage systems in Champaign County. The authors have a combined experience of over 40 years of conducting research on environmental aspects of drainage channels and dealing with environmental and pollution issues confronting drainage district commissioners in Champaign County. The purpose of the document is to outline information needed to make good decisions about drainage channel maintenance - decisions that provide efficient and cost-effective solutions to drainage problems by considering modern engineering practice and applicable environmental mandates. The information needs identified in this report are considered critical to prudent, cost-effective decision-making about drainage maintenance. Five categories of information needs are identified: 1) field drainage, 2) channel capacity, 3) bank erosion and channel stability, 4) short- and long term, and local and system wide issues, and 5) environmental quality. Information from each of these five areas is required to address adequately drainage needs as well as the spirit and specifications of that portion of the drainage code dealing with the environment:

Illinois Drainage Code (70 ILCS 605).

> Sec. 4-15.1. Protection of environmental values. In performing any of the duties and in exercising any of the powers provided in this Code, the commissioners shall use all practicable means and measures, including consideration of alternative methods of providing the necessary drainage, to protect such environmental values as trees and fish and wildlife habitat, and to avoid erosion and pollution of the land, water or air.

Identifying "practicable means" seems to be the crux of recent drainage maintenance controversies in Champaign County. Drainage commissioners are challenged to find and adopt, as practicable, drainage practices that may be new or different from past practices. The emphasis on "all practicable means and measures" indicates that scientific and technical improvements in drainage technology should be evaluated as viable alternatives to traditional drainage practices in an effort to protect environmental values and avoid erosion or pollution. The information needs identified in this report provide the basis for such an evaluation.

FIELD DRAINAGE

The most important part of agricultural drainage is the field drainage system, which consists of underground networks of drainage tiles, and in some instances surface drains. Drainage tile networks terminate at an outlet pipe within drainage channels. The effectiveness of land drainage, and its impact on agricultural productivity and economic return, will only be as good as the condition of the tile lines and tile outlets, regardless of the condition of the drainage channel into which the tiles empty. For best performance, tile lines should be undamaged and tile outlets should be above normal water levels in the drainage channel to assure free drainage. Any maintenance needs assessment should start with an evaluation of the function of the field drainage system.

Information Need #1: The condition of the field drainage system, including the location of existing tile lines and outlets, elevations of outlets above the bottom of channel, the number of tile outlets buried under sediment within the drainage channel, the number of tile lines that are blocked or broken before reaching the outlet.

Information Need #2: The effect of fluctuations in water level in the drainage channel on the overall efficiency of the field drainage system.

To determine the effect of the water elevation in the drainage channel on tile-outflow efficiency information is required on outlet flow rates for different water depths in the drainage channel.

Information Need #3: The amount of time flow of a given depth is maintained in the drainage channel relative to the elevation of the tile outlets.

The depth/time relationship is defined by a stage-duration curve, which represents the percent of time flow in the drainage channel is at a given stage or depth. This information, with information on field drainage outlet elevations, is used to determine the percent of time the outlet is submerged and how much benefit will be achieved by deepening the channel.

DRAINAGE CHANNEL CAPACITY

Effective movement of water downstream through a drainage channel once water is delivered from drainage tiles requires adequate capacity to contain flow within the channel. For the most part, concerns about capacity center on maintaining adequate channel depth for free drainage of tile outlets. However, some concern also centers on maintaining a large enough channel to prevent frequent overbank flooding of adjacent farm fields during high flows. It must be recognized that, in large part, the capacity of a drainage channel is only as good as the location along the channel with the smallest capacity. Locations with limited capacity will in essence act as local dams, backing up water and raising water levels upstream of these locations.

Information Need #4: Cross sections of the existing and modified channel conditions throughout the project and extending upstream and downstream for some distance.

Cross-section data, along with estimates of flow resistance of the channel (which can be obtained from hydraulic manuals) can be used to estimate the capacity, or maximum discharge of water, the channel can contain at various locations along its length. Particularly important in this regard is an evaluation of how much capacity will be gained from maintenance, especially where clearing of streambank vegetation is a maintenance objective.

Information Need #5: The discharge capacity of the channel at bridges.

Bridge openings can be a major factor limiting overall capacity of many drainage channels in east central Illinois. Often the capacity of the bridge opening is smaller than the channel upstream and downstream, resulting in partial damming of water upstream from bridges.

BANK EROSION AND CHANNEL STABILITY

Flow in drainage channels is accompanied by natural processes of erosion and deposition. Deepening the channel and reducing resistance to flow during maintenance can trigger subsequent channel erosion. This erosion may occur quickly or slowly, depending on specific characteristics of the material properties of the channel, the condition of bank vegetation, and the erosive energy of flow within the channel. Over time, however, erosion can become severe enough to compromise the structural integrity of the drainage channel.

Information Need # 6: A detailed inventory of channel bed and bank conditions, including the location, type and mechanism of bank failures within the channel, and an evaluation of the probable factors producing this erosion.

Numerous rapid assessment procedures exist for evaluating bank stability. This information, in conjunction with engineering considerations about appropriate bank treatments, including recently developed bioengineering approaches that provide for long-term natural maintenance approaches to channel stability, are possible alternatives to traditional bank stabilization methods. What is needed is the identification of effective erosion-control practices for specific sites of concern within the channel system.

Information Need # 7: An assessment of erosion generated by conditions external to the channel.

Spoil from past maintenance has been piled along drainage channels, creating pronounced artificial levees. The tops of these levees often stand above the surrounding farm fields. Although such levees have the advantage of increasing the capacity of the channel during high flows, they also tend to pond water on the field side of the levee during periods of storm runoff from adjacent fields. Without adequate provision for drainage of areas on the field side of elevated levees, ponding can be substantial and can threaten to inundate crops in adjacent fields or compromise the bank/levee, leading to failure during a flood. To manage this issue, information is needed both on the elevations of levees along the channel and on the number of surface drains on the field side of the levees. Moreover, in some cases, drainage of ponded water locally through the levees can produce substantial erosion of the levee and channel bank. In extreme cases, such erosion can produce local failure of the channel bank, promoting the development of a tributary gully that erodes headward toward the adjacent field. Locations where the integrity of the levees has been compromised by erosion from ponded water on the field side of the levees should be systematically mapped and evaluated to determine appropriate erosion-control techniques.

SHORT-TERM VS. LONG-TERM AND LOCAL VS. SYSTEM-WIDE RESPONSES

In light of the drainage code requirements to develop practicable means to maintain environmental values and prevent pollution, a maintenance plan for a drainage channel also requires consideration of: 1) short-term and long-term responses of the drainage channel to maintenance, particularly when the investment of limited financial resources is considered, and 2) the possibility of local channel maintenance having system-wide effects. The most critical factor related to these issues is the influence of natural processes of erosion and deposition within modified channels. In most cases, the channel created through maintenance is much different than the channel natural processes would produce if allowed to operate without inference. Over time, these processes work to reconfigure the bottom of the channel to generate a self-sustaining form. In fact, it is these processes that lead to the formation of "silt bars" that are often the focus of channel maintenance.

Information Need #8: the influence of watershed processes, particularly soil erosion and natural channel processes, such as erosion and deposition, on the longevity of any increased channel capacity provided by maintenance

A good set of channel cross sections will provide a starting point for this analysis, but it can be supplemented with field data on the response of existing drainage channels to past maintenance. The primary reason to collect this information is economic. If maintenance produces a situation that will result in a return to reduced drainage channel capacity in a short time then the real, or annual, cost to taxpayers is increased. It is simply prudent to consider alternatives that are more sustainable by natural processes to avoid the need for costly frequent maintenance or inefficient expenditures of funds. If maintenance produces an expected instability in tributaries, upstream or downstream, then this is important information both in maintenance planning and a common sense good neighbor policy for any district. This information is particularly important to address issues of possible sediment pollution produced by the planned maintenance.

Information Need #9: An assessment of the tendency for the drainage channel to develop bars, benches, and other depositional features following maintenance.

The development of silt bars, or benches, within the channel bottom reflects natural adjustments to maintenance. The development of bars or benches creates an inset channel that is sustainable by natural erosional and depositional processes. Recent scientific studies of bars and benches in the Spoon-River channel in Champaign County, a tributary to the Salt Fork, indicate that these features: 1) are stable, and 2) generally lie below the levels of tile outlets. Studies also revealed that these bars and benches provide needed habitat for fish. Studies also indicate that removal of benches during channel maintenance often results in rapid redevelopment of these features after maintenance. Thus the short-term drainage benefit achieved from removing the benches may be rapidly offset by bench redevelopment. Over the long term it may be more economically efficient to retain stable benches in channels, rather than expend funds frequently for maintenance efforts that are fundamentally at odds with natural erosional and depositional processes within the channel. Benches also help to confine low-flow in the large drainage channel within a well-defined small channel in the center of the large channel, thereby protecting banks of the large channel from erosion.

Information Need #10: The relation between local maintenance activity and the effects that may be produced as an unintended consequence of maintenance on neighboring land.

Any action locally within a river system can produce responses upstream and downstream of the affected area. An evaluation should be made of possible effects of maintenance on downstream flooding and sedimentation. Deepening of a main channel, like the Salt Fork, can also trigger erosional responses in tributaries draining into the main channel, thereby causing channel stability problems upstream and deposition within the main channel that could offset sediment removal during maintenance and contribute to sedimentation problems downstream.

ENVIRONMENTAL QUALITY – PROTECTING ENVIRONMENTAL VALUES

Natural drainage channels were present on the landscape well before human arrival in Illinois. These channels were populated by organisms and ecosystems that flourished in the channels and associated channel areas. Creation of drainage districts and development of channels to assist in draining agricultural fields did not eliminate environmental values from the drainage channels, but channelization and maintenance have changed both the environment and the types of organisms present. The present channel system has not eliminated a stream fishery, but some species have been lost due to habitat change and others that were not present originally now occupy drainage channels in Champaign County. A key factor in fish abundance and diversity is the availability of suitable habitat. Recent work by the authors has demonstrated that habitat for fish is intimately tied to the development of bars, benches, and other natural channel structures within drainage channels. In fact, the Spoon River, a tributary to the Salt Fork, is identified on the Illinois listing of biologically significant streams because of the abundant habitat that has produced high fish diversity in this drainage channel. Clearly the streams in east central Illinois have value to a fishery, and to other components of natural ecosystems. Knowing that these conditions exist in drainage channels challenge maintenance planning!

Information Need #11: The type of organisms present in the drainage channel, the connection of organism abundance and diversity to existing habitat conditions, and information on water quality to identify specific pollution issues.

Sources of this information include public agencies charged with identifying environmental value (the Illinois Department of Natural Resources) and managing pollution (the Illinois Environmental Protection Agency). Specific assessment activities need not be a part of drainage maintenance planning because of the rich history of assessment. Excellent data on fish has been collected by the Illinois Natural History Survey for over 100 years in Champaign County. Information on environmental value and pollution problems should be used to develop maintenance plans that take into consideration environmental concerns. For example, streams are robust and the sequence or timing of maintenance will play a role in overall consequence to the stream ecosystems. Simply recognizing that environmental values are present can result in schedule or operational change that, in turn, is a practicable means for protecting environmental value. What is critical in this issue is the consideration of environmental value, along with all of the other practical issues that should be considered to produce a cost-effective project meeting performance expectations.

Information Need #12: The appropriateness of using alternative practices to protect environmental values and avoid pollution.

New techniques for drainage-channel maintenance have been developed to enhance drainage while protecting the environment. Evaluation is required to determine if alternative practices are appropriate for the situation under consideration. For example, benches have environmental value for generating habitat for fish and for filtering sediments and nutrients before they enter the flowing water in a drainage channel. Ongoing work at the U of I and Ohio State University is developing practices for bench use as a practicable means of accomplishing drainage improvement, environmental-value protection and pollution treatment. There is also a good history of practice associated with bioengineering for bank stability, and new models are available to assess hydrology. What is critical in the assessment of “practicable means” is sound engineering advice based on modern engineering practice. Investment in information supports good practice and increases efficiency of expenditures over the long term.

SUMMARY

In sum, owners of the fields that must be drained, taxpayers in drainage districts, upstream and downstream neighbors, and the range of stakeholders interested in environmental value protection or pollution prevention deserve drainage maintenance planning that meets field drainage needs, is cost effective, and meets drainage code mandates. Simply, information is needed that clearly identifies what should be done, supports cost effective approaches to how it should be done, and provides a means to measure the extent to which what is done performs as expected. Planning drainage maintenance projects using good information reflects directly on the wise use of public funds, both for taxpayers within the drainage district as well as for the general public.

Some information needs will require greater expertise than is the present expectation of many drainage districts. Environmental accountability is much greater today that it was when drainage channels were first constructed in the late 1800s and early 1900s. The information needs identified here reflect the fact that society, the economy, regulations, and the role of stakeholders in public decision making have changed over time. These changes place new demands on drainage districts, but the demands need not be onerous if common sense is used to achieve best management practices for the money expended. In addition, drainage districts should learn from the past to plan for the future. Thus, all maintenance performed in the channel, as well as the response of the channel to maintenance, should be documented and effectively archived.

Finally, it should be recognized that drainage channels have multiple functions. While the drainage channel itself is a resource of the drainage district, the water and organisms living in the water within the drainage channel are a public resource. The latter is reflected by the environmental provision of the drainage code. This report has been developed in the hope that identification of appropriate information needs for sound decision making about drainage maintenance will assist in opening a dialogue that leads both to adequate drainage of farmland *and* protection of environmental values at the lowest costs to taxpayers, neighbors, and the environment.