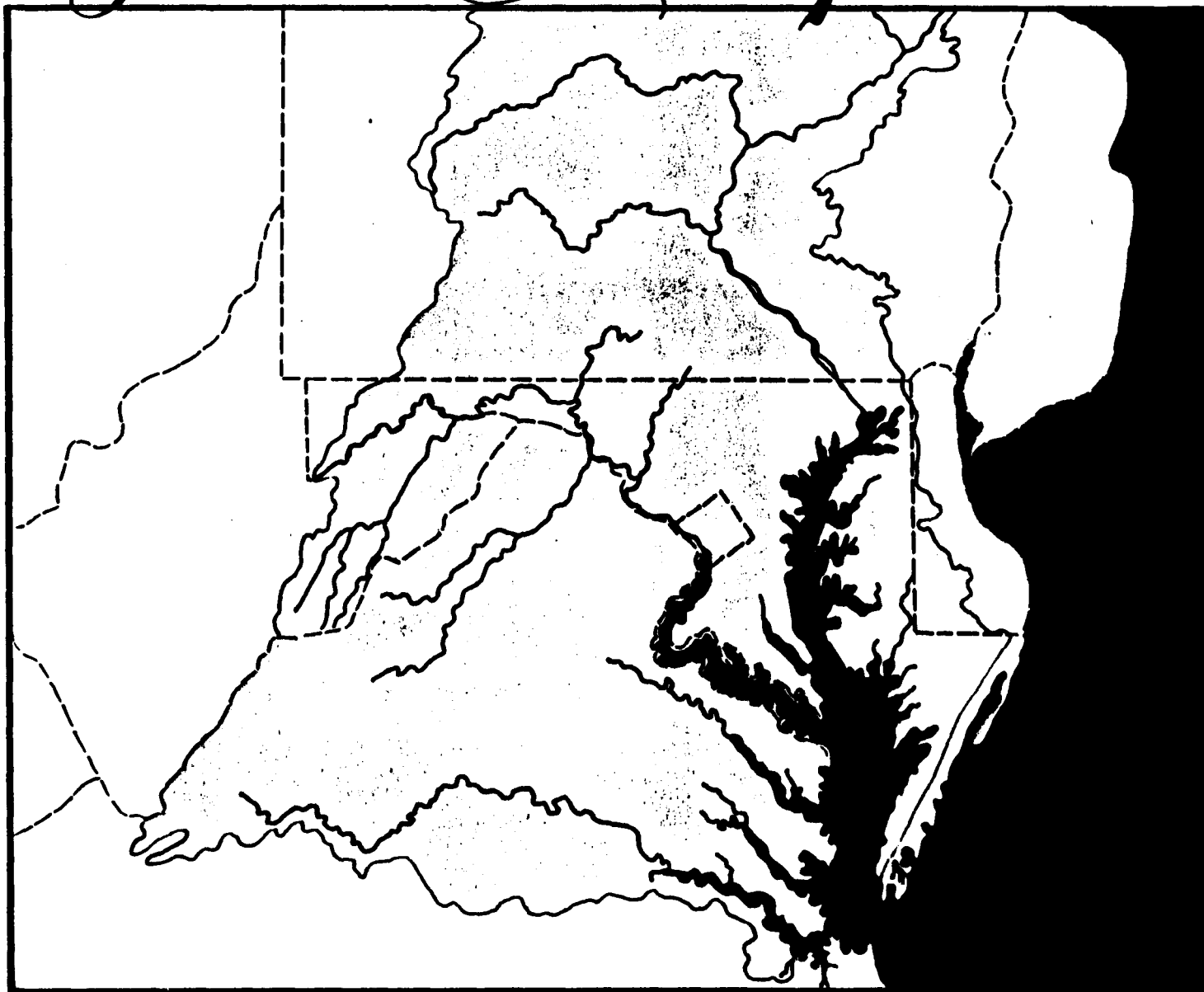


Wetlands of the Chesapeake

**Protecting
the Future of
the Bay**



Proceedings

of the conference held April 9-11, 1985 in Easton, Maryland

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Sponsored by The Waterfowl Festival, Inc., U.S. Environmental Protection Agency and The William Bingham Foundation

**PROCEEDINGS OF THE CONFERENCE --
WETLANDS OF THE CHESAPEAKE**

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FORESTRY AND FOREST MANAGEMENT IMPACTS ON WETLANDS

William H. McKee, Jr.*

Summary: Forested wetlands, a valuable source of timber, need to be harvested through proper management techniques to avoid sedimentation and nutrient enrichment of runoff and the deterioration of the soils and drainage patterns. Management practices that utilize a shelterwood cut, prescribed burning, site preparation, phosphorus fertilization or hazard indices of probability of damage during the wet season will minimize such problems. In areas where soils have been compacted and drainage impaired, site restoration through destruction and bedding and stand regeneration are the proper remedy. While most wetland forests can be bogged using proper management, some are better left alone to avoid destruction of wildlife habitat, impairment of water quality, and reduction of flood protection capacity.

Forested wetlands possess unique properties with respect to their ability to maintain desirable water quality in runoff and to produce timber. Most wetland forests are highly productive and provide good wildlife habitat. These sites, however, are susceptible to damage and change from improper management; if managed improperly, they are a source of sediment that can be washed into other areas. A number of good management practices have been developed to avoid these problems.

The water regime on wet forest sites can be controlled by the way the tree stand is managed. The harvesting of fully stocked stands can create "wetland" through loss of the transpiration gradient. Results of a study on a poorly drained site in the South Atlantic Coastal Plain showed that the reduction of stand density through timber harvesting raises water table levels, and that water table depths during the growing season are highly correlated with functions of stand basal area and precipitation evaporation (Langdon and Trousdell 1978). Also, the study shows that the manipulation of stands on poorly drained sites at time of harvest to control water table levels improves seedling establishment and seedling growth (Figure 1).

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When a mature stand is harvested, water levels rise. Then, if the rainfall pattern causes the water table to remain above or near the soil surface for long periods during the growing season, seed germination and seedling survival rates are impaired which slows seedling growth. Paper companies in the Atlantic Coastal Plain have resorted to drainage and bedding wet sites to improve seedling growth. The landowner without the money for drainage, bedding, or other site-preparation treatments, can use such alternatives as the modified shelterwood system, with the necessary site and seedbed preparation. This system establishes advanced natural regeneration on the site before final harvest of the mature stand which circumvents—in part, at least—the effects of subsequent high water table levels when the seedlings are most vulnerable. The key is to select mixed species of trees that can grow in poorly drained soils (Hook, 1978). Poor soil drainage (wetness) has a strong effect on hardwoods: yellow-poplar and cherrybark oak dominate moderately well to somewhat poorly drained second bottoms; sweetgum and sycamore are found on wet flats that are poorly drained; green ash and red maple are found on first bottoms that are very poorly drained; and bald cypress and water tupelo are associated with swampy conditions.

Hydrologic studies of forests on wet lower Coastal Plain sites indicate that most forest management practices do not have an adverse effect on water quality if conducted properly. However certain more intensive management practices, such as drainage on wet sites, can impair water quality.

A number of studies illustrate these conclusions. Askew and Williams (1984) observed that sediment concentrations of water leaving a 5,900-acre Carolina bay undergoing conversion to loblolly pine remained low for 13 storms over a 2-year period

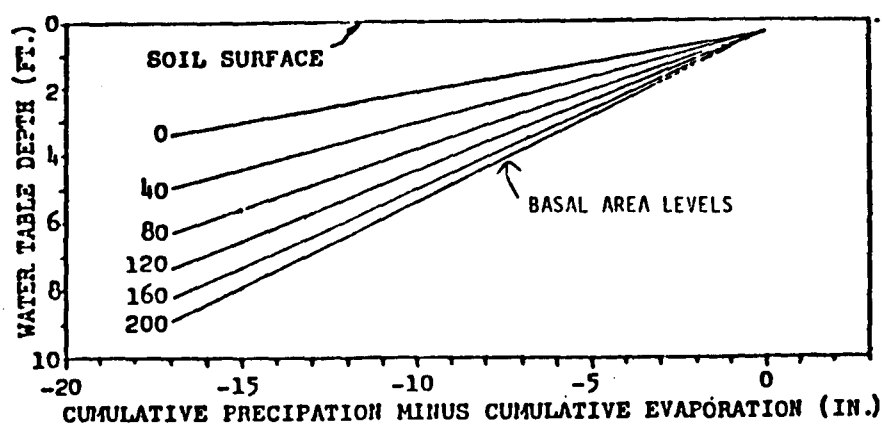


Figure 1. Effects of cumulative precipitation and evaporation from February 1 and of stand basal area on water table depths on a poorly drained loblolly pine site, Bigwoods Experimental Forest, N.C. (Langdon and Trousdell 1978)

(Figure 2). Road erosion and ditch installation produced the highest suspended sediment concentrations, which decreased substantially with increasing distance from the sediment source. Logging and site preparation did not cause an appreciable increase in suspended sediment when equipment did not operate in the drainage ditches. The output of sediment for the entire area was 16.0 parts per million compared with the mean of 2.5 parts per million for the undisturbed hardwood site. Installing new drainage ditches and subwatersheds with main haul roads or skidding across ditches showed significant increases in suspended sediment concentrations over that of undisturbed hardwood areas. Main ditch sediment concentration was reduced by 50% within 1 mile downstream from the source. One way to minimize the impact of these activities is to use a drainage system that contains a length of main channel between sediment sources and sensitive areas. A discussion of road construction and drainage systems is beyond the scope of this paper except to note that technical expertise is needed in the design and layout of these structures to avoid sedimentation in runoff.

Richter, et al. (1982) found that prescribed fire in the southeastern coastal plain is not likely to have an appreciable effect on the quality of ground or stream waters. They claim that considering the utility of prescribed fire in the multi-resource management of these forests, it is doubtful that alternative practices would generate such minimal environmental costs.

Logging operations can seriously damage forest sites by destroying soil structure, blocking drainage, damaging seedlings, and transporting nutrients (McKee, unpublished data, 1985). Much of the damage can be prevented by the land manager through careful planning and full preparation of the site for the logging operation.

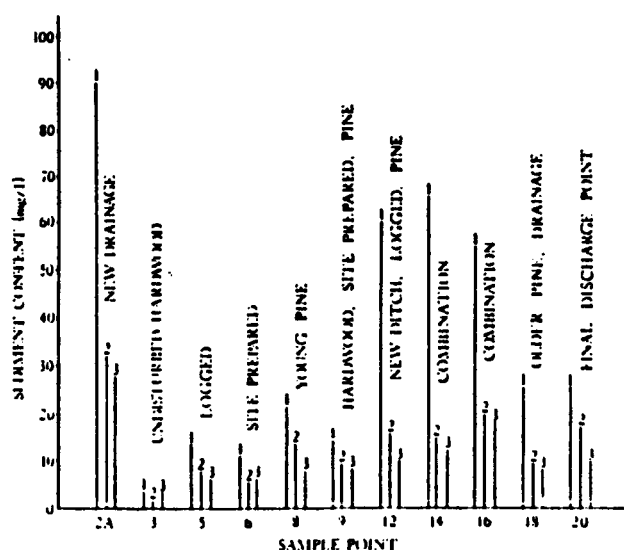


Figure 2. Mean sediment loads for subwatershed sample points for each of the 3 sampling days (sampling day indicated at top of each bar) (Askew and Williams 1984).

Methods to Minimize Site Damage

Methods for minimizing site damage before logging include preparing the timber stand for cutting, determining when to log, laying out skid trails, and choosing the proper equipment. Planning before the sale allows the manager to understand the environmental hazards of logging a site and to devise practices suited to the site. For example, visibility can be improved to enable the skidder operator to avoid obvious wet spots. Prescribed burning is the most economical way to improve visibility on a logging site. This technique is especially suited to even-aged pine stands. Machine operators can see the ground and avoid many low, wet places that would otherwise be masked by thick underbrush. It is also easier to locate skid trails in such stands, to the advantage of both the logger and the manager. Herbicides may be a satisfactory substitute for prescribed burning where fire is likely to lower the quality of the harvested stand, where the forest floor will not carry a fire, or where fire may increase soil erosion.

In much of the southern Coastal Plain, the water table is at or near the soil surface during some portion of the year. In other seasons, the water table may be quite deep and the soil hard enough to support the heaviest of equipment. It is common sense to avoid logging such sites when the water table is high. Some site damage during logging often is inevitable, but careful location of skid trails can concentrate soil damage on limited areas, thereby minimizing the costs to restore. The greatest concern is disruption of drainage—logging trails can dam water or change a drainage course. Correcting these problems can add to costs of site restoration. The best solution is a careful layout of logging trails before harvest.

By studying county soil surveys, which include descriptions of drainage, trafficability, and other soil characteristics, a manager can gain insight into how equipment can be used with the least impact. Frequently, soil maps can be used to locate roads, log decks, and skid trails on the least productive soils, leaving the most productive sites free of logging damage. Area conservationists with the Soil Conservation Service can help with soil mapping.

The layout of roads and skid trails must be a compromise between a design that will do the least harm to the site with one that meets the requirements of the logging operation. Normally, rubber-tired skidders can operate from 500 to 1,000 yards from a log deck while track-type vehicles can be used up 600 yards from the deck. Skidding distance for cable rigs is about 300 yards. Other factors such as design of the specific equipment, size of logs skidded, and tree density are part of the formula. Some basic guides in locating skid trails are:

1. Concentrate trails, where possible, to minimize the area affected.
2. Do not cross stream channels or excessively wet areas.
3. If a choice is available, locate skid trails on sandy rather than clayey soils, which are more susceptible to compaction.

Some helpful ideas for locating log decks are:

1. Locate decks to avoid skidding across wet, unstable soils and to limit length of skid trails.
2. Avoid creeks or obvious wet areas.
3. Place decks no lower than 130 feet from any stream channel to prevent sediment concentration in the channel.

The type of logging equipment that is used is a primary determinant of the amount of logging damage that will be sustained. A typical rubber-tired skidder puts a force of 20 pounds per square inch on the soil. A crawler tractor exerts about half the amount, and wide flotation machines may exert only 5 pounds of pressure per square inch on the soil. A cable logging setup lifts the logs from the ground and exerts no pressure. The amount of compaction damage sustained is roughly proportional to the pressure exerted on the soil.

Damage also depends upon the type of soil and its wetness. We have developed a hazard index by which a site can be classified according to the soil texture (sand, silt, or clay) and the depth to the water table in the wet season (Figure 3). The rating is designed to give an indication of the probability of damage during the wet season. During dry periods, most soils dry sufficiently to support logging equipment. The objective of the index is to guide loggers in choosing methods that will keep the plotted point of pounds per square inch force (PSI) for vehicle and depth to wet-season water table below the diagonal line for the particular soil type. The widths of tires and tracks strongly influence the pressure placed on the soil, so it is best to get a specific value for the equipment that is available in your area. By selecting equipment that falls below the hazard line in terms of soil texture and wetness, loggers can minimize damage to areas logged.

With most kinds of equipment, poorly drained sites are sometimes too wet to log without damage. The point at which logging should stop must be specified. The limitations of soil wetness depend on the drainage characteristics of the soil and the equipment used. As drainage deteriorates, the sensitivity of the site to compaction and puddling increases. Compacted or puddled soil loses its ability to provide air to plant roots, and sensitivity of soil to compaction and puddling increases as texture varies from

sandy to clay soil and as soil organic matter decreases. In all cases, soil becomes more sensitive to physical forces as the moisture content increases. Conditions are probably too wet when skidders produce ruts more than 10 inches deep in one or two passes or when the soil has reached its "liquid limit." The susceptibility of soil to compaction again is variable and a knowledge of local soil conditions is needed. Most soil compaction occurs during the first pass of equipment; it takes only two or three additional trips to compact as much as is possible. For this reason, most land managers attempt to concentrate skid trails to limit the area affected by logging.

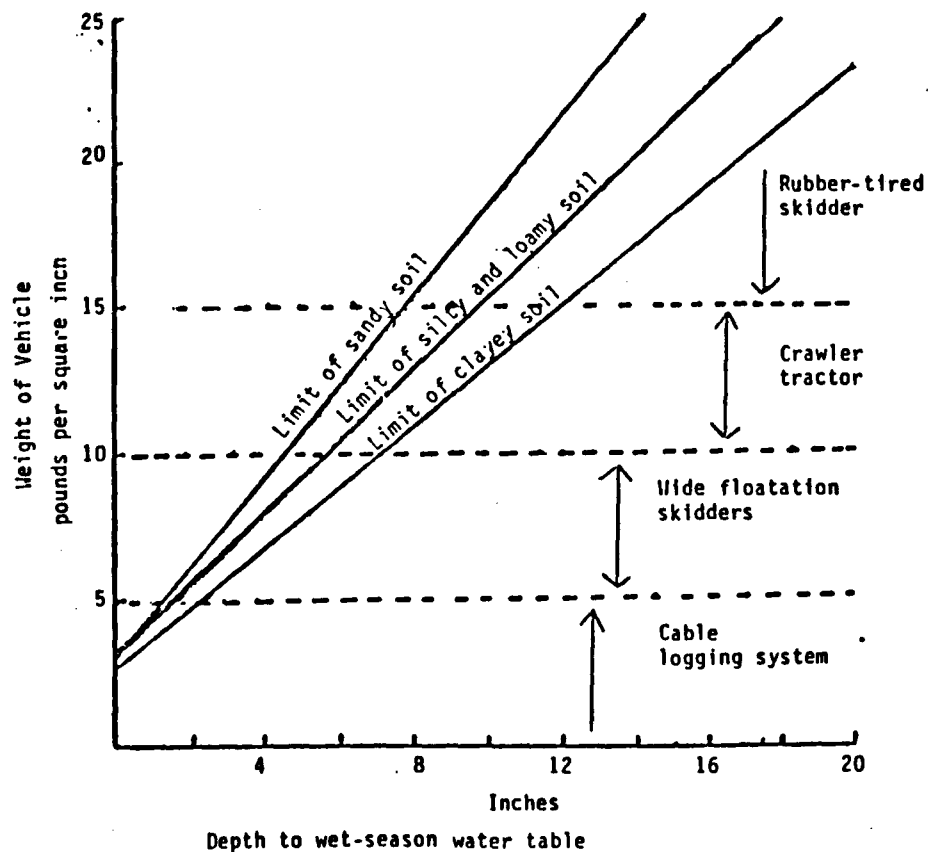


Figure 3. Index of hazard of rutting during wet-season logging. Vehicle weights which fall below the line for soil texture represent conditions with low hazards for rutting. (McKee, unpublished data)

Methods to Restore Damaged Sites

To alleviate the damage to compacted or puddled soil, restoration should be concentrated where the damage is most severe, such as at logging decks. The equipment used to repair a site is often as heavy as the logging equipment that caused the original damage, so repair should be attempted only when the soil is dry enough to support the equipment and when tillage will cause soil fracturing. Ruts cause water to form ponds and displace soil or they sometimes dam water and restrict surface runoff. Such conditions can be alleviated by disking or bedding during site preparation.

Because of the relationship between soil water tables and tree density, the problem of stand regeneration becomes critical where previously mesic sites become hydric. On large-scale industrial holdings, the answer has been the construction of drainage systems that normally lower water tables by at least 12 inches (Terry and Hughes, 1978). Another alternative, at least for pine management is the application of phosphorus fertilizer. Very poorly drained sites in South Carolina indicate a 50% increase in basal area of loblolly pine from application of phosphorus fertilizer as concentrated super phosphate (0-46-0) at 250 pounds of material at age ten (McKee and Wilhite, 1985). The stem volume was increased by 900% with phosphorus, whereas bedding of these sites, which increases drainage, roughly doubled growth with or without the fertilizer. A generalized approach to the relationship of drainage and fertility indicates that as drainage becomes poorer, a higher level of fertility is needed to maintain an equivalent degree of site productivity (Langdon and McKee, 1980). More recently, work has indicated that phosphorus fertilizer alters the basic physiology of loblolly pine roots, allowing them to live anaerobically (DeBell, et al., 1984).

Caution should be exercised, however, with a group of soils called "cat clays" that contain a high level of iron sulfide (Ponnamperuma, 1972). When "cat clays" are drained, the sulfide oxidizes to sulfuric acid, resulting in extreme acidity and pollution of runoff water. Care should be taken not to drain these soils.

Conclusion

The management of wet forest sites has a direct effect on the productivity of the site and quality of water runoff. Evapo-transpiration will remove significant quantities of water during the growing season, essentially changing a site from hydric to mesic. Timber harvesting reverses this process. Harvest should be done to minimize the logging effect, generally by a shelterwood cut. Normal forest practices, such as harvesting,

prescribed burning, and site preparation, have not been found to increase sedimentation or nutrient content of water runoff if done properly. Ditching and roadbuilding on at least a short-term basis can increase the sediment load in runoff; appropriate measures should be taken to reduce this impact. The need of drainage for coniferous, mesic species can be reduced or eliminated in many cases with phosphorus fertilization. While most wetland forest sites can be logged for timber, it should be recognized that there are situations where stands should be left alone to avoid destruction of wildlife habitat, loss of water quality, reduced flood protection, or other values.

LITERATURE CITED

Askew, G.R., and T.M. Williams

1984 "Sediment Concentrations from Intensively Prepared Wetland Site," Southern Journal of Applied Forestry 8:152-157.

DeBell, D.S., D.D. Hook, W.H. McKee and J.L. Askew

1984 "Growth and Physiology of Loblolly Pine Roots Under Various Water Table Levels and Phosphorus Treatments," Forest Science 30:705-714.

Hook, D.D. "Management of Wetland Hardwoods for Timber Production,"

1984 Proceedings of Soil Moisture - Site Productivity Symposium, Ed. W. E. Balmer, pp. 237-243.

Langdon, O.G., and W.H. McKee, Jr.

1980 "Can Fertilization of Loblolly Pine on Wet Sites Reduce the Need for Drainage," Proceeding of the First Biennial Southern Silvicultural Research Conference, Ed. by J.P. Barnett, pp. 212-218.

Langdon, O.G., and K.B. Trousdell

1978 "Stand Manipulation: Effects on Soil Moisture and Tree Growth in Southern Pine and Hardwood Stands," Proceedings Soil Moisture-Site Productivity Symposium, Ed. by W.E. Balmer, pp. 221-236.

McKee, W.H., and L.P. Wilhite

1985 "Loblolly Pine Response to Bedding and Fertilization Varies by Drainage Class on Lower Atlantic Coastal Plain Sites," Southern Journal of Applied Forestry 9: (In Press).

Ponnamperuma, F.N.

1972 "The Chemistry of Submerged Soils," Advances in Agronomy 24:29-96.

Richter, D.D., C.W. Ralston and W.R. Harms

1982 "Prescribed Fire: Effects on Water Quality and Forest Nutrient Cycling," Science 215:661-663.

Terry, T.A., and J.H. Hughes

1978 "Drainage of Excess Water—Why and How," Proceedings of Soil Moisture-Site Productivity Symposium. Ed. by W.E. Balmer, pp. 148-166.