WORKING PAPER NO. 3

AN EVALUATION OF
THE NATURAL ORDINARY HIGH WATER ELEVATION
IN MINNESOTA LAKES

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Contents

Preface

This paper is a supporting document for a study of lake management to be completed in December 1978. The salient points of this paper will be summarized in the comprehensive study, but the detailed evaluation is presented here for reference and review.

This report has been prepared by Joseph Mayasich, Brandt Richardson, and Don Vagstad of the Department of Natural Resources Water Policy Planning Project. It is a product of the Water Supply, Allocation, and Use Work Group of the Minnesota Water Planning Board and does not necessarily reflect the views or policies of the Department of Natural Resources or other state agencies involved in the Framework Water and Related Land Resources Plan development.

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Abstract

The Natural Ordinary High Water (NOHW) elevation is a fundamental concept of Minnesota water law and prescribes a boundary between public and private interests in riparian land. The establishment of such elevations has been complicated by uncertainty over both the legal definition and the means of determining NOHW.

This report reviews the effects of extended high water on the lakeshore and examines available means of NOHW determination, including those employed by other states. Definitions of the NOHW elevation from common law, federal regulations, state rules, and the legal consequences of each are considered.

We conclude that the common law definition of NOHW fails to provide a stable and widely applicable basis for establishing high water elevations. Though the Minnesota Department of Natural Resources relies on a more appropriate "vegetation test", it has done so on administrative authority only. The NOHW determination method presently used relies heavily on interpretive skills, which may weaken its acceptability in public hearings.

I. INTRODUCTION

The determination of a "Natural Ordinary High Water" (NOHW) mark provides a fixed boundary line between upland over which a riparian has unqualified title, and a lakebed, exposed or submerged, over which the state exerts a trusteeship for the people of the state.

The determination of NOHW, based on the analysis of physical and biological characteristics created by the extended presence and action of water on the lakebed, has been subject to dispute.

An example of such a dispute occurred in the recent Big Marine, Big Carnelian, and Little Carnelian Lakes public hearing, in which a dispute over the method of NOHW determination resulted in an interim report order instructing the DNR to recompute the NOHW evaluation. Such problems may result from misunderstanding of subject matter by the hearing examiner, inadequacy of DNR NOHW presentations, or confusion over the legal definition of NOHW to be used. The dispute was settled in the final report which accepted the original DNR NOHW determinations.

Though a resolution was achieved, the controversy is indicative of problems in the overall understanding, application, and determination of NOHW. Such disputes provide evidence of the need for a consistent, reproducible, and legally defensible means of NOHW establishment.

This report reviews the physical and biological indicators of extended high water and examines alternative methods of establishing NOHW elevations. The importance of NOHW in Minnesota water law is discussed, with specific consideration of the conflicting common law and administrative NOHW definitions.

II. DETERMINATION OF HIGH WATER

A. Effects of Water Levels on Lakeshore Morphology and Biota

The effects of fluctuating water levels have received considerable attention in scientific literature. (Teskey and Hinckley, 1977). However, most research has provided only limited information useful for lake NOHW establishment because of its emphasis on river ecosystems and its restricted geographic applicability. The following discussion examines the effects of high water in two general categories; physical and biological, and emphasizes indicators which could be useful in NOHW elevation determinations.

Physical Effects

Erosion and deposition produce the physical features for NOHW determinations. Waves from high winds erode lake basin slopes creating a beach scarp, or escarpment, which appears as a miniature cliff (Figure 1). The beach ridge is a depositional feature on the wave cut slope (Knochenmus 1967). Fluctuations in water level create ridges at various levels on the slope but only the highest ridge is of significance in NOHW determination.

Viv' stratification of beach deposits occurs on lake shorelines subject to beach erosion, at the base of beach scarps. The deposits result from wave erosion which differentially transport the detritus away from uplands. This transportation of suspende material results in a systematic decrease in average grain size and a tendency for the particles to become equal in size (Kurmbein and Sloss, 1962). The result is a marked difference between upland parent material and the eroded material present on the shore (Figure 1).

Bays and vast expanses of open water increase erosion and deposition. Bays have converging shorelines and when coupled with gradually sloping bottoms, waters impelled by the atmospheric pressure gradients and winds of sufficient velocity are concentrated and erosion is increased. Vast expanses of open water, with a large fetch or exposure to wind, also increase the erosive potential of seiches and waves (Weinberg and Neuman 1976).

When a frozen lake cracks and refreezes, an ice sheet of greater area than before can occur. This larger sheet may then exert pressure on the shore forcing gravel and stones landward and creating an "ice push" or "ice rampart" which appears as a mound or ridge on the shoreline (Buckley, 1900; Hobbs, 1911; Scott 1926).

Biological Effects

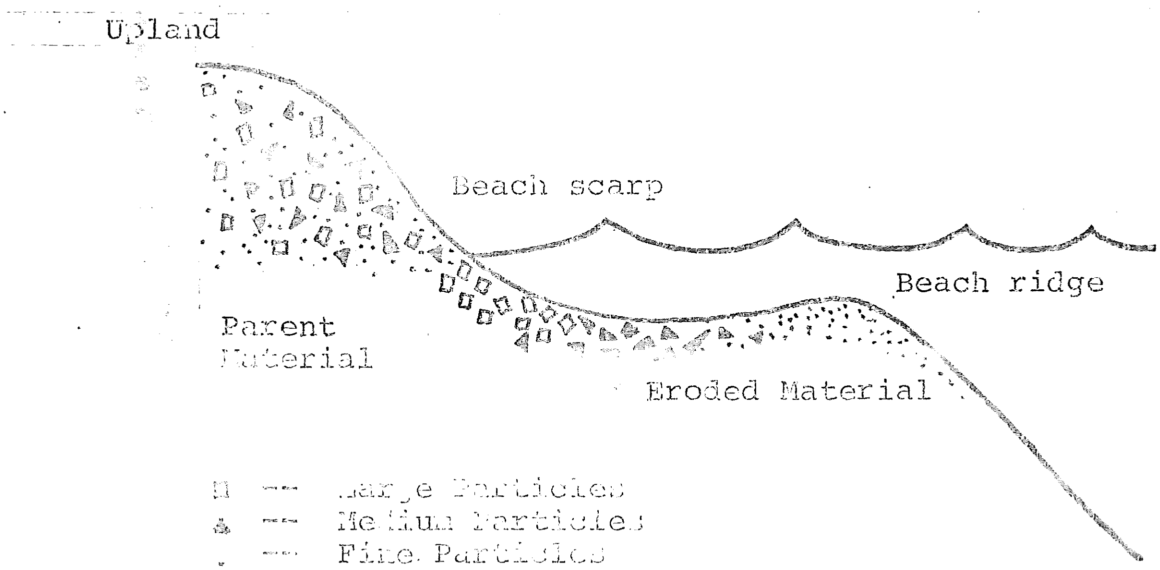
Vegetation shows a zonation across the littoral zone and shoreland from the benthic (bottom dwelling) to terrestrial plants. This zonation results from both physical determinants and the response or tolerance of the biota to them. Physical determinant include illumination, pressure, substrate, inundation, temperatur and exposure to wind and waves.

During long periods of high water the lower boundaries of each zone are displaced landward (Quennerstedt, 1958). Terrestrial plants die or develop tolerance mechanisms such as vine-like habit, long internodes and petioles, adventitious roots, and swelled buttresses as a result of the roots' inability to transport oxygen. When water levels displace air from soil pore spaces and create an oxygen deficiency, the immediate effect appears in the shoot as reduced stem elongation, downward bending of leaves and petioles, and wilting and chlorosis of lower leaves (Burrows and Car, 1969).

The effect of flooding on plants is dependent on the timing and duration of inundation (Teskey and Hinckley, 1977). For most species, flooding during the dormant season has few harmful effects because root growth and oxygen requirements are reduced. However, in the growing season, oxygen requirements are high, oxygen in flood water is quickly respired, and

FIGURE 1

PHYSICAL FEATURES OF A LAKE SHORELINE



root death usually occurs. The life stage of the plant is also a factor; seedling survival is much more influenced by flooding than germination. The distribution of a species is influenced largely by the hydrologic conditions during early life stages, though later inundations may also cause mortality.

Adaptations to flooding attempt to decrease the effects of an anaerobic environment on the root system. Degrees of flood tolerance can be distinguished by comparing the number and rates of tolerance mechanisms employed (Dubinina, 1961). Green (1947) gives a summary of the tolerances of woody species in Swan Lake, Illinois (Table 1). Hall, Penfound, and Hess (1946) showed the susceptibility of woody and herbaceous plants to flooding in the Tennessee Valley (Table 2). Flood plain vegetation often develops a higher tolerance to water than lake bank vegetation because of the rapid and extreme level fluctuations of a flood plain.

Fluctuating water levels also affect littoral fauna, such as sponges, flatworms, leeches, snails, etc. Littoral fauna have the ability to follow water levels, but migrations are slow and limited with species moving at different rates. Migrations are caused by erosion and deposition which alters the physical nature of the bottom and destroys macrovegetation serving as food, shelter, and spawning ground. Hynes (1961) and Hunt and Jones (1971) found that faunal density recovers but species composition may be altered.

Table 1. Water tolerance of woody species, from Green (1947).

SPECIES	YEARS SURVIVED	REMARKS
Sand-Bar Willow	2	Mostly dead first year
River Birch	2	Survived well first year
Cottonwoc	2	Survived well first year
Silver Maple	3	Mostly dead second year
Elm	3	Mostly dead second year
Huckberry	3	Fair growth second year
Red Oak	3	Scarce on river bottom
Bur Oak	3	Mostly dead second year
Swamp White Oak	3	Fair growth second year
Pin Oak	3	Mostly on higher ground
Alder	3	Hardly to second year
Green Ash	4	Hardly second year, fair third
Black Willow	4	Third year hardy, fourth dead
Deciduous Holly		Hardly to fourth year
Red Osier Dogwood		Hardy to fourth year

Table 2. Susceptibility of plants to flooding, from Hall, Penfound, and Hess (1946). (Includes only species native to Minnesota).

Intolerant - Those which do not survive continuous flooding to a depth of one foot for one growing season:

Silver Maple	White Oak	Black Walnut
Ironwood	Red Cedar	Wild Black Cherry
Basswood	Shagbark Hickory	White Ash

Moderately Tolerant - Those which survive one year of flooding but die if inundated the second season:

Lead Plant	Red Mulberry	Wild Grape
Hackberry	Hawthorn	Box Elder
River Birch	American Elm	

Tolerant - Those which survive continuous inundation by water more than 1 foot deep for two growing seasons:

Silver Maple	Red Maple	Green Ash
Cottonwood	Sand-bar Willow	Black Willow

B. Analytical Techniques For Determining NOHW

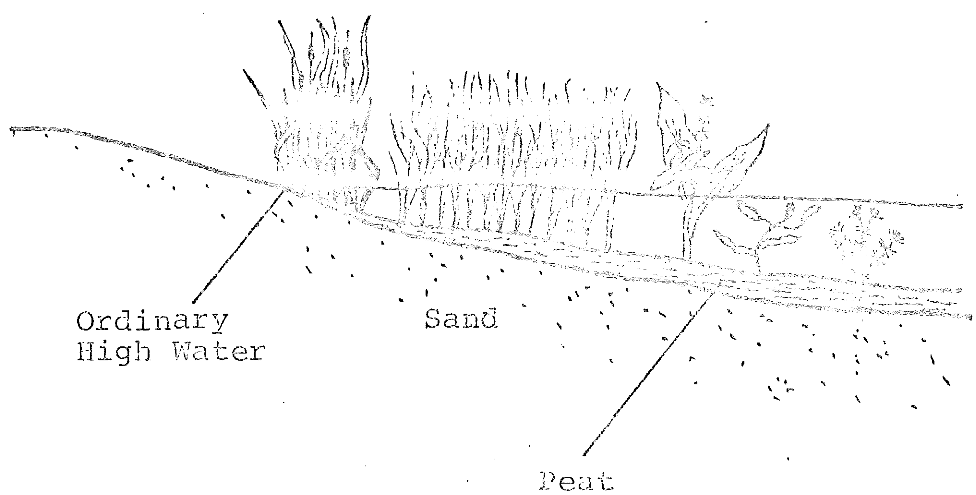
Because only shore processes and vegetation leave detectable and lasting impressions on lake basins, they provide the basis for most NOHW determinations. The reestablishment of faunal density after water level fluctuations renders it useless for NOHW determinations, and changes in faunal composition would require elaborate population studies for maintaining a comparative baseline. Several potential analytical techniques remain.

Change in Composition of Soil

Peat is an accumulation of partly decomposed and disintegrated organic material, derived largely from aquatic plants (Davis, 1946). It is usually found on shorelines protected from wave action, characterized by a dense growth of aquatic vegetation such as arrowhead, water lilies, sedges, grasses, rushes, etc., which thrive on peat substrate (Bishop, 1967). Since peat forms only in water and tends to oxidize when not inundated, the landward termination of peat deposits (Figure 2) is a good indicator of the NOHW mark.

FIGURE 2

TYPICAL PEAT MARSH SHORELINE



To assist in making a NOHW determination using soil other than peat, a narrow trench is dug perpendicular to the shoreline to provide a cross-sectional view of the sedimentary and erosional features. After making a topographic profile of the shore along the trench, soil samples are taken at frequent intervals along the profile just below the surface. The primary information desired from these samples is a sediment particle size analysis.

Determinations are usually made by sieving or from observation of settling velocity, microscopic examination, etc.. After statistical analysis of the results, average grain diameter and degree of sorting (the variance of grain size around the average diameter) can be determined. Because the largest eroded material is transported the shortest distance and the unsorted nature of uneroded parent material, a sudden improvement in sorting and occurrence of the largest average grain size may reveal the NOHW position (Cole, 1977).

Geomorphological Features and Debris

Natural levees, beach ridges and scarps formed by hydromechanical processes can indicate the position of NOHW.

Natural levees are low ridges which parallel a river course and slope gradually away from the channel. They may be a mile or more in width, and their greatest height is near the stream channel due to the deposition from the loss in transporting power when a river overruns its banks (Thornbury, 1954). The NOHW mark is therefore usually on the steep or river side of the levee and slightly below the crest.

Beach ridges usually have a convex shape and are asymetric with their apex offset landward. The average height of a typical ridge is about half a foot. The beach scarp is a miniature cliff created by erosion (Knochenmus, 1967).

The significance of the scarp and ridge in lakes is that the scarp is usually developed with its base or toe just above the elevation of NOHW while the crest of the highest ridge is slightly below the NOHW elevation. Scarps are also found in river systems at the extremes of flood plains, and may be at some distance from the NOHW mark. A more significant scarp would be found in the form of undercut slopes and cut banks, near the meander channel (Cole, 1977).

Geomorphological features should be used with caution since they can take a relatively long time to develop and, if the water level is in the process of rising or falling, there could be several sets of these features. At such times, only the most landward scarp and ridge along with other types of evidence (debris, vegetation, etc.) should also be used to resolve ambiguity.

The elevation of the most landward edge of debris deposits, drift-wood, etc., may be coincident with the NOHW. These indicators are simple and trustworthy on large lakes that have the necessary soils, fetch and debris, but may lack long-term validity.

Tree Analysis

Tree analysis is based on the relationship between inundation and tree success, such that the presence or characteristics of a particular species provides a reliable indicator of water elevations within the lifetime of the tree. This relationship depends both on the species of tree and the nature of the inundation--time of the year, flood frequency, flood duration, or water depth. Relationships, involving frequency are most useful for NOHW determination, since frequency is implicit in defining an "ordinary" water mark. Teskey and Hinckley (1977) report that flood frequency is an important factor in the establishment of trees. Bedinger (1978) indicated that in some cases data relating flood frequency to species presence is sufficient to estimate flood frequency from observed tree types and elevations; he also reported that a model (SWAMP) has been developed to simulate the effects of flooding on vegetation. Such statistically proven relationships could provide the foundation for a NOHW determination method within certain geographic and ecological constraints.

One type of tree analysis is used by the Minnesota DNR for its establishment of NOHW elevations. The technique relies heavily on the interpretive skills of the investigator and is apparently not scientifically documented. This lack of detailed evidence gives the appearance of subjectivity to a method which may have a sound basis. The technique uses a relationship between the diameter of a lakeshore tree trunk and its elevation above the zone of soil saturation, based on the premise that a tree requires a depth of unsaturated soil about equal to its trunk diameter for growth and maintenance. The relationship varies according to species, condition, and type of soil.

The NOHW elevation is determined by subtracting the approximate diameter product (constant x diameter) for the tree species from the elevation of the base of the tree (Meyer, 1958), as follows:

Species	Elevation Above Saturated Soil (Diameter Product)
Willow	1/2 trunk diameter
Elm, Cottonwood, Poplar, Birch, and Ash	1 trunk diameter
Oaks	1-1/2 trunk diameters

The method is widely applicable where lakeshore trees have been subject to water stress and is of course limited to stresses occurring within the life of the trees. These relationships between rooting depth and NOHW elevation are only rules-of-thumb used by experienced individuals and have not been well documented in scientific literature.

Change in Character of Vegetation

Davis (1973), reported a botanical approach to determine both the position of the NOHW mark and the approximately time it occurred. Although not intended for final legal determinations, the method was proposed for the establishment of mean high-water monuments in Florida lakes.

The method is based on the intolerance of xerophytes to inundation and the preference of hydrophytes for inundation. At a site possessing berms, beach ridges and scarps, xerophytic and hydrophytic vegetation base elevations of randomly selected representatives are determined. The elevations of hydrophytes represent the presence of water, those of xerophytes represent the absence of water. The point between the two elevations is the NOHW elevation. The use of facultative hydrophytes which can tolerate but do not prefer high water, can cause unreliable determinations.

To determine the date of NOHW, xerophytic and hydrophytic trees are aged by ring counts and the year growth began is calculated. The approximate occurrence of NOHW preceeded the date when xerophytes initiated growth and postdated the initiation of growth by hydrophytes.

Statistics

A statistical approach may also be used to determine a NOHW elevation based on the frequency of occurrence of a particular water elevation. For example, the elevation may be specified as that point below which the water level occurs 75% of the time, or an average high water level experienced in a given period of time. Frequency-of-occurrence determinations can rely on either daily or monthly mean lake level observations without creating significant differences in results (Butler and Epstein, 1976), but they require a length of record unavailable in most cases. However, the calibration of a lake hydrologic model and long-term simulations based on precipitation records could provide a means of "reconstructing" lake level fluctuations.

Photography

Davis (1973) elaborated on the uses of photography, both aerial and ground, to aid existing techniques in the determination of NOHW. Black and white scaled aerial photos of the U.S. Department of Agriculture, Soil Conservation Service, in conjunction with USGS quadrange maps, can be used to locate significant features of topography and vegetation. Commercial infrared aerial photography can be used to pinpoint exact places and trees to inspect. Low altitude (400 to 1,000 ft.) black and white photographs can sometimes show littoral zones of vegetation. Ground photography is useful as a record and to verify the visual observations made.

Other Methods

There are numerous other features which, when present, are sometimes indicative of NOHW. Water marks on trees and man-made features, heights of physical structures such as docks, and affidavits from local residents can be used (Cole, 1977). Meyer, (1958) used the bottom of the line of growth of lichens genus Gyrophora, Lecanora, and Parmelia. Caution should be used when relying on these features as they are not as reliable as the previously discussed methods.

C. Methods Used by Selected States

Wisconsin

The Wisconsin DNR determines NOHW locations on its Great Lakes on a "case by case" basis. The DNR field staff has determined NOHW locations through numerous on-site investigations where distinct erosion or vegetation destruction has occurred and by analysis of shore morphology, debris deposits, vegetation and soils. The result is a number of NOHW elevations which are more representative, on a very large lake, than a single statistically based elevation approach which fails to account for coastal variability and long-term water level fluctuations.

Great Lakes field work has determined that coastal variability influences NOHW locations in several ways. Erosion and deposition on shore by wave action, during long-term level fluctuations, change the location of biological and physical indicato used for NOHW determinations. Until these indicators are re-established, erosion marks on bluffs have been used to set NOHW elevations. If accretion or erosion occurs, the NOHW location moves landward with erosion and waterward with accretion. This "elevation" approach determines a single fixed vertical boundary, but not a fixed lateral mark which remains flexible throughout varying shoreland conditions, water regimes, and deposits of shoreland material.

Application of the elevation approach where river mouths and lakes intersect requires that the boundary between the two physical provinces be determined. This determination is complicated because lake effects often extend upstream and vice versa. Field personnel determine whether an elevation approach or a reliance on biological indicators is most appropriate.

In very large lakes, embayments and shores exposed to maximum fetch exhibit more pronounced effects of daily and hourly water level fluctuations produced by barometric pressure gradients (seiches) and winds. Impelled water is concentrated by converging shorelines in bays and the effects of the water raises the location of the NOHW elevation. Shores exposed to maximum fetch receive greater wave run-up which also raises NOHW elevation.

On very large lakes, where differences in latitude between northern and southern shores are significant, longer periods of ice cover protect northern shores from wave run-up and seiches. This lowers the location of NOHW on northern shores. However, trees on southern shores provide shade which also creates longer periods of ice cover in the spring.

Wisconsin's "case by case" approach on the Great Lakes is success because where no "mark" can be found, one can be transferred through stage or elevation readings from another location on the lake, though the maximum distance of NOHW elevation can be transferred is not specified (Weinberg and Neuman, 1976).

Florida

Florida does not have an established methodology for the determination of "ordinary high water" (OHW) nor is there a statutory definition. The rapidly increasing value of the uplands bordering inland lakes together with a growing awareness of the necessity for protecting these waters for public use is resulting in a demand for precise determinations of OHW.

After telephone questioning, Mr. George M. Cole, Bureau of Coastal and Land Boundaries, Florida DNR, sent a draft copy of proposed surveying techniques used to determine the OHW mark on inland lakes. Change in soil composition, analysis of geomorphological evidence, changes in vegetation and water level records were reviewed.

Florida makes OHW mark determinations when boundary disputes arise or when requested by a riparian land owner. A small survey crew with rod and transit, biologist, and geologist have made OHW mark determinations on about 100 of Florida's 7,000 lakes. The variability of indicators used by the techniques creates a very flexible approach applicable to all types of lakes. The only type which presents a problem is an artifically regulated lake possessing frequent and large level variations which hinders the development of indicators. Acceptance of previous determinations by the courts has been shaky, and Florida is now considering legislation requiring a hydrologic approach to this problem.

Maine

Maine has a statutory definition, but lacks a standardized methodology for what they term "normal high water line." A telephone conversation with Mr. Chuck Ritzey of the Department of Inland Fisheries and Wildlife provided the following information:

A biologist's survey locates the following characteristics existing between the upland and shoreline which are indicative of normal high water line location.

1. A distinct mark on ledges, rocks, masonry or nonerodible materials.
2. The absence of soil and vegetation with bedrock, stones, gravel or other nonerodible material remaining.
3. A soil type associated with high water tables and frequent inundation.
4. The presence of distinctive vegetation types. Sub-shoreline lands may have aquatic or transitional vegetation while uplands have terrestrial forms.

In areas where determinations cannot be made (such as rockslides ledges, rapidly eroding or slumping banks, man-made structures) a determination can be made from adjacent areas showing indicative characteristics.

Determinations are difficult in marsh lakes or those with slowly fluctuating water levels which result in nondistinguishable vegetation zones.

Applications filed by citizens have resulted in normal high water line determinations on 200 to 500 lakes. These determinations have never resulted in any legal disputes.

Michigan

Michigan has an established methodology for determining the "ordinary high water mark" (OHWH) as defined by the Inland Lake and Streams Act. Mr. M. C. Nielson and Mr. Vince McCann, Michigan, DNR, provided information on OHWH determination in inland lakes.

Michigan's three-part method consists of a pre-survey, survey, and data analysis and report. The pre-survey compiles information from available sources and leads to approximate locations of shoreline boundaries, information on previous changes in the locations of shoreline boundaries, and the possible existence of predetermined legal levels.

The survey begins with a preliminary reconnaissance of the lake to note shoreline characteristics such as vegetation, soil character and configuration, and determines the existence of control structures or outlet restrictions that may influence water levels.

Sea level datum is then established by extrapolating the evaluation from a monumented benchmark or by establishing a datum base Vertical reference marks are established by placing stakes level with the water surface around the lake. This method of base line establishment is faster and supposedly more accurate than surveying the entire lake perimeter.

Fifteen to twenty-five elevations of indicative shoreline data, such as the transition from aquatic to terrestrial vegetation and points of soil character or configuration changes, are then determined. Obvious high and low elevations are disregarded and the average of the remaining elevations represents the OHWH elevation.

Slight shore gradients with vast expanses of sedges, grasses, and cattails present problems because readily discernible changes in vegetation and soils are difficult or impossible to locate. In these situations specialists in aquatic botany or geology are consulted for a more detailed analysis.

Michigan determines OHWM when requested to by citizens or when disputes arise. About four dozen inland lakes have had the OHWM determined, which have never been overturned in approximately 400 court cases. Mr. Nielson mentioned that OHWM can be re-determined, on request, if the lake has maintained high levels for an extended time.

Minnesota

Minnesota does not have a statutory definition of "Natural Ordinary High Water" but definitions from previous litigation have been followed.

Personal interviews with Ken Reed and Pete Colin, Division of Waters, Minnesota DNR provided information on NOHW determination on inland lakes.

The procedure for determining NOHW seems to be well established. A review of existing records, maps, files, and general information on the lake is undertaken, followed by a field search for indicative recoverable evidence such as beachlines, washlines, bank or scarp basis, soil stratification, and analysis of upland vegetation growth. Of these factors, upland growth, especially trees, is of primary importance.

Before a tree can be used in a determination the following criteria must be met:

(1) Location near the upper limit of the basin.
(2) Location on a flat slope.
(3) Evidence of the effects of excess water such as: butt swell, rapidly tapered limbs and trunk, exposed roots, and poor canopy development.

The elevation of a qualifying tree is then determined and the corresponding diameter product (see "Tree Analysis") is subtracted from the elevation. The NOHW elevation is thus represented by the elevations of pertinent recoverable evidence, and values determined from tree analysis.

A NOHW determination can be initiated in several ways. A Commissioner's order in conjunction with a public hearing or a Commissioner's order alone results in as good a determination as is possible by the state's hydrographic crew. Accumulations of large amounts of pertinent data and routine field work reports in lake files provide rough estimates for management purposes.

About 50 to 100 lakes have had large scale in-depth NOHW determinations made as the result of Commissioner order and public hearing. These determinations have not been overturned in court, although there has been difficulty in acceptance in some public hearings (e.g., Big Marine Lake).

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III. LEGAL ASPECTS OF HIGH WATER MARKS IN MINNESOTA

A. Legal Significance of High Water Marks

The ordinary or normal high water elevation plays an important role in Minnesota's modified riparian water law system. It is well established that such marks delimit public and private property use rights in riparian lands. In the leading Minnesota case of In re Minnetonka Lake Improvement, also entitled Carpenter v. Board of Commissioners,[1] the court said:

> While the title of a riparian owner on navigable or public waters extends to *ordinary low-water mark,* . . . his title is not absolute, except to *ordinary high-water mark.* As to the intervening space, the title of the riparian owner is qualified or limited by the public right. The state may not only use it for purposes connected with navigation without compensation, but may protect it from any use, . . . even by the owner, . . . that would interfere with navigation . . . . Within the banks, and below *high-water mark,* the public right is supreme . . . .[2] (emphasis added).

This rule has been consistently followed in subsequent Minnesota cases.[3] More recent cases have extended public rights in riparian land below ordinary high water marks beyond the right to preserve the publics right to "navigation." In State v. Korrer,[4] the court referred to "public waters" and held that the riparian owner's rights were inferior to the public right to use for navigation "or other public purpose, . . . present or prospective." In Minneapolis Mill Co. v. Board of Water Commissions,[6] the Minnesota court said:

> The navigation of the stream is not the only public use to which these public waters may thus be applied. The right to draw from them a supply of water for the ordinary use of cities in their vicinity is such a public use, and has always been so recognized.[7]

Mitchell v. City of St. Paul,[8] which specifically approved the above stated rule, held the public right to include flooding to the natural ordinary high water mark for use as a municipal water supply reservoir. The relatively broad scope that Minnesota law gives to public rights waterward of the high-water mark frequently makes determination of this mark a critical issue in litigation.

Minnesota has systematically codified much of its water related law. Some form of high-water mark is a determinative factor at several points. For example, the Shoreland Management Act defines shoreland as:

> [L]and located within the following distances from the ordinary high water elevation of public waters: (1) Land within 1,000 feet of the *normal high watermark* of a lake, pond, or flowage . . . .[9] (emphasis add

In an act restricting dam construction in a specially protected area in the northeastern part of the state, the legislature provided that:

> [D]ams . . . that do not exceed 100 acres in extent may be constructed to maintain temporary water levels not higher than the *normal high water marks* . . . .[10] (emphasis added).

Thus, a determination of a water body's normal high-water mark has important consequences in relation to the suseptibility of land to shoreland zoning requirements, permissibility of dam construction, and in several other areas. Where the normal high water mark lies may mark the difference between a violation of state law and permissable activity.

Significance of Variable Wording

Despite the statutory importance of high water marks, no precise definition is offered in the statutes. Instead, the legislature delegated administrative authority over high water mark determination to the Commissioner of Natural Resources:

> The Commissioner shall have administration over . . . the determination of the *natural ordinary high water level* of any public waters.[11] (emphasis added).

Administrative rules promulgated pursuant to specific legislative acts provide guidance. Rules relating to the Shoreland Management Act define "Normal High Water Mark" as:

> [A] mark delineating the highest water level which has been maintained for a sufficient period of time to leave evidence upon the landscape. The *normal high water mark* is commonly that point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial.[12] (emphasis added).

Rules relating to the Lower St. Croix National Scenic Riverway define "Ordinary High-water Mark" with exactly the same language.[13] It is therefore clear that there is no distinction to be drawn between the use of the adjectives "normal" and "ordinary" with reference to high water marks. This conclusion is further supported by the final report of the hearing examiner in a recent administrative action. The hearing was conducted upon the Washington County Board's application to the Commissioner to determine a lake's natural ordinary high water level under section 105.39 (3). The hearing examiner noted that section 105.39 referred to "ordinary" high water level while rule NR 70 (quoted above) defined "normal" high water mark, but determined that the terms were synonomous and the definition applicable. The examiner said:

> There is no indication, in the statute or rules, of the difference between the two. . . . Since the purpose of that NR 70 line is precisely the same as the NOHW line, it is appropriate that the two lines be measured in the same way. To measure them differently would create chaos, and useless disputes and litigation throughout the state.[14]

It would appear that the use of the two different terms represents nothing more than the rhetorical preferences of different draftsmen.

There is, however, a clear indication in the statutes that "natural ordinary high water marks" and "ordinary high water marks" have a significant distinction. Chapter 110 provides for prescriptive rights to overflow riparian lands which can be established through artifical maintenance of water levels above natural ordinary high water levels for a period of 15 years. Riparian owners who fail to bring an action during this period lose their right to object to such flowage, establishing an easement appurtenant to the dam. The chapter further provides that the state may take over any abandoned water control structure with all such easements running with the dam to the state. The logical corollary to these provisions is that for all intents and purposes, the artificially ordinary high water mark becomes legally a natural ordinary high water mark:

> In any case where the water levels maintained by a dam that shall have existed under the conditions specified in section 110.31 shall have established an *ordinary high water level* above the *natural ordinary high water level* of the waters affected, the ordinary high water level so established shall be deemed to have superceded the *natural ordinary high water level* of such waters, and shall have like effect for all purposes. . . .[15] (emphasis added).

Thus the difference between naturally and artifically maintained ordinary high water levels has great legal significance. Until the statutory period of prescription passes, the overflowed riparian owner retains his cause of action to abate the flowage.

B. Legal Definitions of Natural Ordinary High Water

Common Law Definitions

Because of the sometimes drastic effects on property rights that may be associated with a determination of a water body's natural ordinary high water level, the courts have expended a great deal of effort developing a clear definition to maximize legal certainty. In relation to inland waters, this effort has run squarely up against the highly idiomorphic nature of individual water bodies. It would appear that the courts have not recognized the need for flexible, site-specific determinative criteria. Instead, the trend has bee attempt to force-fit unique and highly variable water bodies into the possibly over-rigid mold of a single natural ordinary high water mark definition.

The leading American case defining natural ordinary high water mark is Howard v. Ingersoll.[16] In that case, the United States Supreme Court distinguished a river's bed (below the ordinary high water mark) from its banks. The Court held:

> It neither takes in overflow land beyond the bank, nor includes swamps or low grounds liable to be overflowed, but reclaimable for meadows or agriculture, or which, being too low for reclamation, though not always covered with water, may be used for cattle to range upon, as natural or enclosed pasture. But it may include spots lower than the bluff or bank, whether there is or is not a growth upon them, not forming a part of that land which, whether low or high, we know to be upland or fast lowland, if such spots are within the bed of the river.[17]

This circular and nebulous language has been interpreted in subsequent cases to have established an agricultural use test for natural ordinary high water mark determinations.

The leading Minnesota case on this issue is In re Minnetonka Lake Improvement (also entitled Carpenter v. Board of County Commissioners).[18] The Minnesota Supreme Court held Lake Minnetonka's natural ordinary high water mark to be:

> [T]he point up to which the presence and action of the water is so continuous as to destroy the value of the land for agricultural purposes by preventing the growth of vegetation, constituting what may be termed an ordinary agricultural crop, - - for example, hay.[19]

This test has been consistently followed in subsequent Minnesota cases and there has, to date, been no authoritative clarifications. The most recent case on the issue to reach the Minnesota court was Mitchell v. City of St. Paul,[20] In Mitchell, plaintiff, riparian landowner, claimed damages in trespass against the City of St. Paul for causing a lake used as a water supply source to excede its ordinary high water level in 1942. Extremely detailed lake stage data were available going back to 1901. The plaintiff attempted to establish the ordinary high water mark as being no higher than the mean extreme high water level for the period 1901 through 1942. The court rejected this approach stating:

> The record here does not show at what elevation the high-water mark is reached. The proper test for the determination of the elevation of the high-water mark as laid down in the Carpenter [Minnetonka] case was not followed.[21]

Mitchell seems to indicate that the agricultural use test presented by Minnetonka is the only acceptable test for natural ordinary high water marks in Minnesota. Although Mitchell was decided in 1948, research has disclosed no subsequent cases which might cast doubt on this conclusion. In fact, that the agricultural use test is the only acceptable test is also supported by the case law of other jurisdictions. Borough of Ford City v. United States,[22] directly faced the question of the proper test for natural ordinary high water marks. An Army Corps of Engineers dam raised the level of the Allegheny River interfering with the plaintiff municipality's sewer outlet and requiring expenditures for pumping operations. Plaintiff sued for damages claiming an unconstitutional "taking" of riparian property rights without due process of law, arising from the raising of the water level above the natural ordinary high water mark. The trial court found for the plaintiff on the basis of expert witnesses' testimony fixing the ordinary high water mark at the point where natural vegetation ceased to grow even though the land above this mark could not be used for agricultural purposes. The Circuit Court reversed finding application of this natural vegetation test to be an error of law. The Court said:

> The district judge . . . errored in law. He categorically held that the Allegheny River bed at Ford City is "land upon which the action of the water has been so constant as to destroy vegetation." . . . This is not the law. What the river or action of the water actually destroys is the value of its soil for agricultural purposes. The difference between the two definitions is vital here . . . .[23]

Not all jurisdictions share the insistence on the agricultural use test embraced by Mitchell and Ford. California apparently follows the mechanical test proposed by the plaintiff in Mitchell and rejected by the court.

> In California, ordinary high water mark is normal high water. It is the "average level of the water attained by . . . a river in its annual seasonal flow . . .[24] (citation omitted).

It appears that the same definition is accepted in Oregon.

> The "ordinary high-water mark" [of a non-navigable lake] is a mean or average of these fluctuating . . . extreme rises . . .[25]

Despite this authority to the contrary, Mitchell stands as undisputed precedent in Minnesota; this must lead to the conclusion that the agricultural use test is the only acceptable test under Minnesota common law.

As is discussed elsewhere in this report, Minnesota's exclusive reliance on the agricultural use test at common law can be criticized as inappropriate in some situations. For example, in addition to the short term annual fluctuations that may disrupt agricultural use of riparian lands, inland water bodies may simultaneously fluctuate over longer periods in response to longer term climatic trends. An extended drought may cause an overall retreat of a water body's base level upon which the seasonal fluctuations will be superimposed. Determinations of ordinary high water levels not taking the long-term fluctuations into account can result in legal definitions at odds with the actual state of the landscape. As the base line fluctuates in response to long-term climatic cycles, the line at which agricultural land use may be successful in any given year may also fluctuate. This situation was experienced in Minnesota during recurring periods of drought. Some lakes temporarily disappeared and their beds were successfully put into agricultural production. The courts then faced the question of public rights in the lake beds; e.g., could the state divert waters to restore the lakes by flooding land that was being used for agriculture? A narrow reading of the agricultura use test would seem to indicate the negative. This reading of the test would result in unstable natural ordinary high water marks which varied with long-term water level fluctuations. Where a water body's natural ordinary high water mark would be set would become a function of the scale of judicial scrutiny. The function of fixed judicial determinations of natural ordinary high water marks is to provide riparian owner and the state with a degree of certainty with regards to their respective rights. A high degree of stability is therefore desirable and a fluctuating legal natural ordinary high water level cannot provide this degree of certainty. In Minnesota, two cases have dealt with this question and have established that the agricultural use test is modified by a limitation of reasonableness, based upon the long-term history of water body levels.[26] This longer-term approach to the agricultural rise test is further supported by Erdman v. Watab Rapids Power Co.,[27] in which the court held high water marks to be:

> [T]hose points where the water usually rises, such rises as may be reasonably anticipated, but does not mean such extraordinary freshets as cannot be anticipated . . . .[28] (citation omitted).

This principle would seem to indicate that records of historical water stages would be an appropriate means of establishing natural ordinary high water marks. Refuting such a contention, however, is the Minnetonka case in which land flooded twenty-six percent of the time was held to lie above the natural ordinary high water mark, and the Mitchell case in which the court held evidence of historical extreme high water to be irrelevant to natural ordinary high water levels, at least in the absence of evidence of the land's suitability for agricultural use. Clearly, the Minnesota court uses a somewhat vague notion of what water levels may be ordinary or extraordinary to mitigate the possibly harsh results of a narrowly applied agricultural use test, but has not permitted hard, historical water stage data to be determinative. To the extent that marks established by the vague agricultural use test provides less certain results than determinations mechanically derived from hard data, the courts reluctance to adopt some variation of the latter test would seem to run counter to the public policy of judicial stability.

Federal Regulatory Definitions

The Army Corps of Engineers (Corps) frequently becomes involved in disputes over natural ordinary high water mark determinations in connection will its mission to regulate navigable waters, as is indicated in the Ford case discussed above. The Corps has attempted to make such determinations more certain through application of a mechanical test based on historical water stages. The Corps' administrative regulations provide:

> "*Ordinary high water mark*", with respect to inland fresh water means the line on the shore established by analysis of all daily high waters. It is established as that point on the shore that is inundated 25% of the time and is derived by a flow-duration curve for the particular water body that is based on available water stage data. . .[29] (emphasis in original).

Such a test has the advantage of providing great certainty, stability, and uniformity of results, but presupposes that the required data is available. Where such data is lacking, the Corps relies on less precise indicators.

> It [*ordinary high water mark*] may also be estimated by erosion or easily recognized characteristics such as shelving, change in the character of the soil, destruction of terrestrial vegetation or its inability to grow, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area;[30]

It is clear, however, that the mechanical test is preferred.

> Physical markings on the lands may be used to determine the mark only where, due to variations of flow, there is no absolute ascertainable level, and where more precise information is not available.[31]

The Corp's regulations, from which these definitions were taken, were recently revoked and new, revised regulations added.[32] The new regulations retain only one definition of ordinary high water mark. All reference to the mechanical water stage test contained in the old definitions is deleted. Instead, a test based on the water's effects on the natural landscape, an alternative test under the prior regulations, is now the only test given. The new definition reads:

> The term "ordinary high water mark" means the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of the soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.[33]

Juxtaposed against the legal certainty of the mechanical test is the test's remoteness from the real concerns of some riparian owners. The length of time land is inundated is closely related to the uses to which it can be put but this need not be the case. Land inundated for 3 months of the year might still be successfully employed for agriculture during the dry period. If the state controlled the water level maintaining it at the ordinary high water mark as established by the mechanical test, then the riparian owner would lose the use of this land without compensation. It was precisely this type of divestment of rights that the common law agricultural use test is designed to avoid. This situation, if brought to the courts, would raise the issue of the constitutionality of the Corps' mechanical test. It is possible that the courts might hold application of the test to violate the fifth amendment prohibit of "taking" of property without just compensation.[34] Research has disclosed no cases testing the constitutionality of the Corps' mechanical test, but the regulations have recognized that this type of problem may arise:

> Although conclusive determinations of navigability [OHWMs are a parameter of navigability] can be made only by Federal courts, those made by Federal agencies are nevertheless accorded substantial weight by the courts. It is therefore necessary that when jurisdictional questions arise, district personnel carefully investigate those waters that may be subject to Federal regulatory jurisdiction under the guidelines set out above. . . . Official determinations by an agency made in the past can be revised or reversed as necessary to reflect changed rules or interpretations of the law.[35]

While the Corps' mechanical test provides desirable certainty, the courts are not required to follow administrative regulations and they might conclude that the common law agricultural use test better fulfills the functional purpose of ordinary high water mark determinations. The Ford case demonstrates that the federal courts are predisposed to rely on the common law agricultural use test even when agricultural lands are not involved.

State Rules Definitions

As was discussed above, the primary advantage of the common law agricultural use test is that it is closely related to one of the actual concerns of riparian owners. It would appear that most of the Minnesota cases in which it developed dealt with agricultural land. However, one could question the practicality and suitability of the test when agricultural lands are not involved, as is frequently the case. As the Stenberg and Anderson [36] cases demonstrate, agricultural use in any given year is inadequate to determine the appropriate mark and in fact it is natural vegetation, usually trees, that is used as indicators in practice as is discussed in the technical section of this report.

Definitions of ordinary high water marks contained in the Minnesota Code of Administrative Rules seem to reflect the Department of Natural Resources' dissatisfaction with the common law agricultural use test and a movement towards a test based on natural vegetation. The definition contained in the Shoreland Management Act Rules,[37] refers only to vegetation and nowhere mentions suitability for agricultural purposes. This rule was adopted in 1970 and has since been copied verbatim in rules dealing with the Lower St. Croix Scenic Riverway Act and other legislation.[38] The most recently adopted rule defining ordinary high water mark deals with the Public Waters Permits Program.[39] In its relevant part, the rule reads as follows:

> "Ordinary high water mark" for purposes of these regulations means an elevation delineating the highest water level which has been maintained for a sufficient period of time to leave evidence upon the landscape. The ordinary high water mark is commonly that point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial . . . .[40]

The significant change from the language of the earlier rules is the direct reference to "natural" vegetation.

Rules adopted pursuant to the Minnesota Water Bank Program,[41] define ordinary high water mark with nearly identical language, but the adjective "natural" was not used.[42] The Water Bank Program is specifically designed to protect wetlands from drainage for agricultural purposes. It would appear that this is exactly the type of situation in which the agricultural use test has its most rational application. The deletion of the reference to "natural" vegetation may leave open the option of applying the common law agricultural use test where it seems to fit the situation.

The Minnesota Department of Natural Resources (DNR) is currently using the nat vegetation test in its determinations of natural ordinary high water levels un section 105.39 (3), despite the absence of explicit common law, statutory, or authority to do so. Recently, in such a proceeding the hearing examiners con the hearing because none of the expert testimony related to the suitability of the land in question for agricultural purposes as was required by the Minnetonka and Mitchell decisions. But, when the hearing was reconvened, the examiner found the agricultural use test to be inapplicable to uncontrolle lakes and applied the natural vegetation test found in the Shoreland Managemen Act rules.[43] The examiner stressed ordinary high water marks are a natural phenomenon and that the DNR merely intreprets the evidence. Natural vegetation such as trees, because they are long-lived and provide a record of the long-term base line fluctuations, were seen as the best indicators.[44] The question of whether the courts will acquiesce to abandonment of the common law agricultural use test is an open question which will be resolved only if the issue reaches the Minnesota Supreme Court. Since the issue was last litigated 30 years ago in Mitchell, the court's perspective may have changed.

Within the framework of the appropriate general legal tests, the location of natural ordinary high water marks is an issue of fact and is usually established through the testimony of expert witnesses. Courts and administrative agencies have been reluctant to develop specific technical criteria. The DNR's Water Bank program rules, when proposed, contained a list of aquatic vegetation types to guide determinations made on the basis of a natural vegetation test:

> Aquatic vegetation includes, but is not limited to grasses, bulrushes, spikerushes, cattails, arrowhead, pickerelweed, smartweed, naiads, cluckweed, spatter docks and wild rice;[45]

These technical criteria were deleted when the rules were adopted.[46] Omission of technical criteria from legal definitions may reflect a desire to provide enough flexibility to fit the needs of the state's idiomorphic lake types.

Conclusions

Determinations of natural ordinary high water marks are important in Minnesota's modified riparian water law system. A common law definition based on land suitability for agricultural purposes has developed but is not practical or suitable, especially where non-agricultural lands are at issue. Since the last Minnesota case dealing with this issue more than thirty years ago, an alternative definition has been adopted in administrative rules which relies on the distinction between aquatic and terrestrial natural vegetation. Though Minnesota's case law precedent mandates the obsolete definition, recent NOHW determinations have been made on the basis of vegetation. It is unknown whether the Minnesota Supreme Court would endorse such a test; precedent indicates that it would not, but the intervening thirty years since the last decision leaves the question open. Resolution of this problem would require adoption of a statutory definition compatible with the vegetation - based definition in agency rules to clearly supercede the inadequate common law definition.

Further complicating NOHW elevation establishment is the dependence of the determination method on the interpretive skills of the examiner. This dependence not only limits the ability of field personnel and others to establish such elevations, but also fails to provide the specific technical criteria and supportive scientific evidence desirable for public hearings. This problem is often compounded by hearing examiners with little knowledge of botany or hydrology and by objecting riparians who perceive ecological interpretations to be disguised arbitrariness. While any well-documented methodology must retain enough flexibility to deal with ecological variations, there appear to be sufficient techniques to set forth specific criteria for NOHW determination. As a minimum, the validity and uniformity of the method presently used should be documented by comparison to long-term observed or simulated water levels in representative lakes.

[1]56 Min. 513, 58 N.W. 295 (1894).

[2]Id. at 520-21, 58 N.W. at 296.

[3]Stenberg v. County of Blue Earth, 112 Minn. 117, 127 N.W. 496 (1910); Anderson v. District Court, 119 Minn. 132, 137 N.W. 298 (1912); Griadck v. Northwestern Improvement and Boom Co., 73 Minn. 87, 75 N.W. 894 (1898).

[4]127 Minn. 60, 148 N.W. 617 (1914).

[5]Id. at 76, 148 N.W. at 623.

[6]56 Minn. 485, 58 N.W. 33 (1894).

[7]Id. at 490, 58 N.W. at 34.

[8]225 Minn. 390, 31 N.W. 2d 46 (1948).

[9]Minn. Stat. § 105.485 (2) (a) (1976).

[10]Minn. Stat. § 110.13 (1976).

[11]Minn. Stat. § 105.39 (3) (1976).

[12]6 M.C.A.R. § 1.70 (d) (1970).

[13]6 M.C.A.R. § 1.2200 (d) (15) (1976).

[14]In re Big Marine Lake, No. DNR-77-005-AK (Minn. 1978).

[15]Minn. Stat. § 110.36 (1976).

[16]54 U.S. (13 How.) 381 (1851).

[17]Id. at 415-16.

[18]56 Minn. 513, 58 N.W. 295 (1894).

[19]Id. at 522, 58 N.W. at 297.

[20]225 Minn. 390, 31 N.W. 2d 46 (1948).

[21]Id. at 398-99, 31 N.W. 2d at 51.

[22]345 F. 2d 645 (3d Cir.), cert. denied, 382 U.S. 902 (1965).

[23]Id. at 651.

[24] People v. Redwood, 225 C.A. 2d 385, , 37 Cal. Rptr. 397, 401 (1964).

[25] United States v. Otley, 127 F. 2d 988, 1000 (C.C.A. Or. 1942).

[26] Stenberg v. County of Blue Earth, 112 Minn. 117, 127 N.W. 496 (1910); Anderson v. District Court, 119 Minn. 132, 137 N.W. 298 (1912).

[27] 112 Minn. 175, 127 N.W. 487 (1910).

[28] Id. at 180, 127 N.W. at 489.

[29] 33 C.F.R. § 209.120 (d) (2) (i) (ii) (a) (1977).

[30] Id.

[31] 33 C.F.R. § 209.260 (j) (i) (1977).

[32] 42 F.R. 37,133 (1977).

[33] 42 F.R. 37,144 (1977) (to be codified in 33 C.F.R. § 323.2 (g)).

[34] U.S. CONST. amend. V.

[35] 33 C.F.R. § 209.260 (m) (1977).

[36] Stenberg v. County of Blue Earth, 112 Minn. 117, 127 N.W. 496 (1910); Anderson v. District Court, 119 Minn. 132, 137 N.W. 298(1912).

[37] 6 M.C.A.R. § 1.70 (d) (1970) (quoted on page 2 supra).

[38] 6 M.C.A.R. § 1.2200 (d) (15) (1976). See also 6 M.C.A.R. § 1.82 (d) (1976).

[39] Minn. Stat. § 105.42 (1976).

[40] 2 S.R. 2054 (1978) (to be codified in 6 M.C.A.R. § 1.5020 (D)).

[41] Minn. Stat. § 105.392 (1976).

[42] 2 S.R. 1927 (1978) (to be codified in 6 M.C.A.R. § 1.5300 (B) (5)).

[43] 6 M.C.A.R. § 1.70 (d) 1970.

[44] In re Big Marine Lake, DNR-77-005-AK (Minn. 1978).

[45] 2 S.R. 1927 (1978) (to be codified in 6 M.C.A.R. § 1.5300 (B) (5)).

[46] Id.