Shoreline Determination Along Gently Sloping Shores: A Multidisciplinary Approach

Richard L. Watson
John W. Tunnell, Jr.
Corpus Christi State University

William N. Lothrop
Professional Land Surveyor

Shannon H. Ratliff, Esq.
McGinnis, Lochridge & Kilgore

Proceedings

of the

Twelfth International Conference of The Coastal Society

Our Coastal Experience:

Assessing the Past, Confronting the Future

21-24 October 1990
St. Anthony Hotel
San Antonio, Texas

Willim M. Wise, Editor

Center for Coastal Studies Contribution #13

Shoreline Determination Along Gently Sloping Shores: A Multidisciplinary Approach

Richard L. Watson
John W. Tunnell, Jr.
Corpus Christi State University

William N. Lothrop
Professional Land Surveyor

Shannon H. Ratliff, Esq.
McGinnis, Lochridge & Kilgore

Abstract

Shoreline determinations along gently sloping coastal lands present challenges to both the scientific and legal professions. Along the extensive, gently sloping shores of the Laguna Madre of South Texas, there have been several legal controversies regarding land ownership and accurate shoreline boundary determination. At the heart of this problem lies the basic question: are the coastal areas often referred to as the "wind-tidal flats" of the Laguna Madre submerged, and therefore owned by the State, or are they not submerged and owned by the private owner of the adjacent uplands?

The determination of shoreline locations in areas with obvious relief is relatively simple. In contrast, accurate shoreline determination may be difficult in areas where wind-tidal flats are present. A wind-tidal flat is defined as a broad, barren flat that is partially inundated at irregular intervals by lagoonal or bay waters under the influence of wind-generated tides. Scientific complexities in the determination of shoreline locations in wind-tidal flat environments include lack of shoreline vegetation and difficulty in measuring normal astronomical tides, coupled with multi-directional and seasonably variable wind-tides. Surveyors have difficulty because of the geographic remoteness of the flats, the miles of level, featureless terrain, and the lack of tide gauges for determination of mean higher high tide or mean high tide. Attorneys are faced with determination of original land grant origin, interpretation of previous judgments, and negotiation and possible litigation with the state, which owns most submerged lands in Texas.

A multi-disciplinary approach has proven beneficial and effective as a means of accurately solving this complex problem. Attorneys, land surveyors, a geologist, and a biologist have worked independently and cooperatively to develop techniques and produce data and results that can facilitate shoreline boundary placement on the wind-tidal flats of South Texas.

Introduction

Special conditions in Laguna Madre

Approximately 360 mi^2 of wind-tidal flats are found adjacent to the shoreline of the Laguna Madre of Texas (Fig. 1) (Brown et al., 1976, 1977, 1980). These flats commonly have slopes on the order of 0.5 ft/mi. Astronomical tidal ranges in the adjacent Laguna Madre are usually less than 0.5 ft. and the flats are primarily affected by multi-directional wind-tides and storm waters. There is often no obvious shoreline or vegetation line.

Legal shore boundary in Texas

Texas state law defines the boundary between submerged lands belonging to the state and uplands belonging to the private land owner as the projection of the level of either mean higher high tide (MHHT) or mean high tide (MHT) on the sloping shoreface. If the land ownership dates from a Spanish or Mexican land grant, MHHT is used as the boundary. MHT is used as the boundary for land grants under common law after Texas independence.

Previous court cases in Laguna Madre

The Laguna Madre, and the boundaries of the adjoining upland, have been the subject of several state and federal lawsuits. These cases include, in chronological order: State v. Balli, 190 S.W.2d 71 (Tex. 1944); Sun Oil Co. v. Humble Oil & Refining Co. 190 F.2d 191 (5th Cir.) reh'g denied, 191 F.2d 705 (1951); Luttes v. State, 324 S.W.2d 167 (Tex.1958); and three separately filed lawsuits styled South Padre Land Co., et al. v. State, Cause Nos. 78-153-C, 78-154-C, and 78-155-C in the 197th District Court of Cameron County, Texas. The location of a segment of the shoreline of the Laguna Madre as it runs through the Land Cut area in Kenedy County is the subject of pending litigation in a case styled The John G. and Marie Stella Kenedy Memorial Foundation v. Garry Mauro, Commissioner of the General Land Office, and The State of Texas, Civil Action No. C-90-36, In the United States District Court for the Southern District of Texas, Corpus Christi Division. In analyzing the case law developed by these prior decisions, it is important to remember that tidal boundaries are, by definition, fluctuating boundaries and therefore subject to re-litigation, if the boundary changes position due to changes in the position of MHT or MHHT on the property.

Purpose of Multi-Disciplinary Approach

The attorney must determine the present ownership of the land and the history of ownership back to the time of the original grant. The attorney ascertains the legal principles which may affect the present boundary location.

Because of arguments frequently made by the state, it is often useful to acquire information about the historical topography and conditions of the disputed area.

The surveyor must find and study all historical maps and boundary documents and, when possible, find the old boundary lines on the ground. He/she must determine an appropriate value for MHHT or MHT, mark the present boundary on the ground, and map the boundary. The surveyor must assist the geologist and biologist with locations, elevations, and tidal data.

The geologist uses studies of sedimentology, topography, hydrography, and climate to provide a qualitative aid in helping to locate the present boundary position and to determine and explain the processes which have operated to change the position of the historical boundary to the present boundary, if it has changed in position. He/she assists the attorney in understanding the complex physical processes affecting the present and historical boundary positions.

The biologist provides qualitative assistance in supporting the location of the modern boundary position based on the presence or absence of inundation-sensitive plants and animals. He/she assists the geologist in faunal interpretation of surface and subsurface environments of deposition and explains the significance of biological indicators of shoreline position to the attorney.

Independent and Collaborative Methods and Results

Legal aspects

In defining the location of the legal boundary of the Laguna Madre, the source of the original grant of the adjacent upland determines the applicable standard (Luttes v. State, 324 S.W.2d 167 (Tex. 1958)). For grants issued by the Spanish or Mexican governments, the shoreline is defined as MHHT, while MHT determines the shoreline for lands granted under the common law or Anglo-American law (Id., 324 S.W.2d at 191). For most, if not all of the Laguna Madre, there is no practical difference between these two tidal values. Regardless of the applicable tidal value, resolving a boundary dispute along any portion of the Laguna Madre will invariably necessitate negotiation and possibly litigation with the General Land Office and the State of Texas. The State of Texas, as the owner of all submerged lands in the State of Texas, will generally be the adverse adjoining property owner. Understanding the jurisdiction, structure, and powers of the General Land Office is invaluable in resolving any boundary dispute along the Laguna Madre.

Under Sections 31.051, 31.052, and 31.063 of the Texas Natural

Resources Code, the Land Commissioner is authorized to manage, supervise, and determine the boundaries of submerged lands belonging to the State of Texas. In most boundary disputes along the shore of the Laguna Madre, the ownership of the minerals in place is a valuable asset of the property, in addition to the commercial development value of the property. The School Land Board, which is chaired by the Land Commissioner, has statutory authority to grant oil and gas leases for the development and production of oil, gas, and other minerals underlying submerged lands (TEX. NAT. RES. CODE § 32.061). The School Land Board is statutorily empowered to schedule a sale for oil and gas leases on submerged lands. There is a tract nomination process by which prospective lessees are allowed to nominate tracts for public bidding (See 31 TEX. ADMIN. CODE § 153.1 (West Supp. 1990)). The School Land Board selects the best sealed bid to purchase an oil and gas lease on a particular tract (See id. § 153.3).

Since the State of Texas is the adverse party in these boundary disputes, it is generally necessary that a private claimant obtain legislative consent to sue the state. The doctrine of sovereign immunity prevents a private claimant from suing the State of Texas to adjudicate title without legislative permission to sue. Consent resolutions can be introduced by a state senator or representative representing any of the five counties adjacent to the Laguna Madre. If a private claimant seeks legislative consent, it must adhere to the requirements set forth in the Texas Civil Practice and Remedies Code, Section 107.001 et seq. (Vernon Supp. 1990). If legislative consent is denied, the factual context of the particular boundary dispute may give rise to a constitutional claim for the taking of property without just compensation or the denial of due process under the Texas and U.S. Constitutions. A federal statute, 42 U.S.C. § 1983, provides a vehicle for asserting such a claim. Alternatively, a claim could be filed against the Land Commissioner under the principles of State v. Lain, 349 S.W.2d 579 (Tex. 1961).

Land surveying

The surveyor's task in a multi-disciplinary approach to shoreline mapping is to determine an elevation or elevations for the line of MHHT or MHT and to place and monument that line on the ground.

The Tides Branch of the National Ocean Service (NOS) of the National Oceanic and Atmospheric Administration (NOAA) is the primary source of information for determining an elevation of MHHT or MHT. Other public data sources include the U.S. Army Corps of Engineers, the Texas Water Development Board, and the Blucher Institute for Surveying and Science at Corpus Christi State University. Tide studies by private oil and gas lease holders may offer additional data.

Primary tide gauges which have been in place for a full tidal epoch

of 18.6 years exist only at Port Isabel, Port Mansfield, and Corpus Christi (Claunch, 1987). Since the location of a tidal boundary is dependent upon the elevation of MHT or MHHT at the location of the property in question, and not at the location of a distant primary gauge, it may be necessary to install additional secondary tide gauges or staffs at the project site.

After the elevation for MHHT or MHT has been determined, the surveyor must monument that elevation contour on the ground. In addition to the problems associated with a scarcity of tidal data, there are few horizontal or vertical survey control benchmarks in the Laguna Madre area. On a shoreline boundary project of considerable length, the tidal boundary meander and other survey lines should be tied to the grid plane of the Texas Coordinate System and to the National Geodetic Vertical Datum (NGVD) (Bouchard, 1970). Monumentation of the national datum and horizontal control network may be distant from the project. The tie-in can be accomplished with conventional surveying methods, but use of Global Positioning System technology may be preferable if distances are long or terrain difficult. If the local survey is tied in with the national network, it will increase the probability of the survey lines being preserved for future use and reference, because they can be reconstructed if local monuments are lost.

In some areas of the Laguna Madre where the shoreface is of very low slope, the contour line representing MHHT or MHT may be difficult to locate. In those circumstances, the surveyor may place his line so that the actual line of MHHT or MHT is somewhat lagoonward of the line placed on the ground. Biological or geological evidence may provide support in these cases. Since a line of mean higher high tide or mean high tide is being placed on the ground, there will be times when bay water will be found landward of the line surveyed and times when dry land will be found lagoonward of the line.

Geology

The geologist assists in qualitatively determining the present tidal boundary, determining if there has been accretion or erosion and the rates of those processes, and evaluating the recent geological history of the area.

Rates of sedimentation can be estimated by collecting numerous short cores on transects across the study area. The cores are analyzed for environment of deposition, based on sediment type and remains of organisms present. Radiocarbon age dates on once-living organisms found in living position within the cores can be used to establish a date at which that level in the core was subaerially exposed. With this information, used in conjunction with the depth of the organism within the core, the long-term sedimentation rate at the site can be determined. Analysis of sedimentation rates throughout the study area, along with study of surface environments of deposition,

Biology

The biologist must know the natural coastal environment well and be able to interpret which aquatic and terrestrial species of plants and animals are inherently associated with the shoreline. However, due to the lack of plants and animals normally seen along the central and lower Texas shoreline, wind-tidal flat shoreline determination by indicator species can be difficult. Salt marsh cordgrass (Spartina alterniflora), which normally inhabits the estuarine intertidal zone, is absent from most of the highly saline Laguna Madre. Therefore, the more salt-tolerant species, such as glasswort (Salicornia spp.), saltwort (Batis maritima), sea purslane (Sesuvium portulacastrum), and shoregrass (Monanthochloe littoralis) must be used. These may also be absent or they may grow on slightly elevated mounds along the shoreline. Furthermore, the main plant which exists on these flats (blue-green algae) has not been sufficiently studied to confidently relate growth forms or abundance to inundation frequencies or duration.

Barnacles, which leave their shells attached to hard substrates (e.g., pilings, fence posts) for years after their death, can aid in water-level determination. Relating barnacle size to growth rate can give an indication of the amount of time an area may have been inundated. However, care must be taken because barnacles can grow above the level of continuous inundation due to waves and splash, and growth rates can differ from one locale to another. Two species of acorn barnacles, Balanus eburneus and live B. amphitrite, within the Laguna Madre area. Their growth rates are slower during the colder winter months and during periods of hypersalinity.

Benthic (bottom) transects have been taken from aquatic areas extending across the apparent shoreline up onto terrestrial areas. Sieving of samples through a screen, then determining and enumerating living species present, allows plotting of species in either aquatic or terrestrial zones and determination of the shoreline according to their distribution. Most areas within the shallow waters of the Laguna Madre support extensive seagrass beds, predominantly shoalgrass, Halodule wrightii, and an associated, characteristic biota. Numerous .species with considerable abundances characterize these grassbeds. A lagoon-margin sand commonly occurs between the grassbed and the shoreline, and it usually has fewer species than the grassbed, but may have high abundances. The terrestrial zone above the shoreline is typically barren, with only a few inconspicuous insects, including brine flies and small beetles.

Discussion and Conclusions

Due to the presence of extensive, nearly flat wind-tidal flats adjacent to the Laguna Madre and a tidal boundary legally defined to be the intersection of the elevation contour of the local MHT or MHHT with that

processes of sediment transport, and sources of sediment supply may aid in determining if there has been accretion or erosion since the date of the original grant.

It may be useful to determine if relative sea level has changed in historical time. Age dating of depth-sensitive organisms within the cores may provide data which can be used to establish relative sea-level at past historical times. Long-term tide gauge records and examination of the scientific literature may also provide information useful in estimating the historical changes in sea level.

The recent geologic history of the coastal zone can be partially understood by examination of the scientific literature; however, it is often best to analyze numerous cores within the study area to determine the specific geologic history of the disputed tract. It is then possible to reconstruct the various environments of deposition on a three-dimensional diagram showing the changes in the location of each environment through space and time. If there is a detailed modern topographic map of the area, it may be possible to produce a probable topographic map of the area for any historical date by "eroding" the present topography back through time using sedimentation rates by which the surface built up to its present configuration. This enables the estimation of surface conditions at various times in the past.

The environments of deposition along the Laguna Madre shores include: continuously submerged shallow lagoon; intertidal lagoon margin; low wind-tidal flats submerged by wind-tides or by the highest seasonal astronomical tides; high flats where aeolian processes dominate, submerged only by storm tides; and vegetated mounds of various types, which are primarily aeolian in origin. Blue-green algal mats may provide a useful indicator, as they cannot live where continuously submerged by waters connected with the lagoon or where they are destroyed by grazing cerithid gastropods (Friedman, et al. 1973).

The geologist must educate the attorney on the geology of the tract and the surrounding areas. In addition, the attorney must be able to read and understand specialized geologic reports and papers and to understand and critically evaluate legal testimony by opposition geologists.

gently sloping surface, it is important to accurately place that boundary on the ground. A small error can result in a great horizontal displacement of the boundary and loss of considerable land to one of the owners. A multi-disciplinary team consisting of attorneys, surveyors, geologists, and biologists can be assembled to confirm the legal location of the boundary.

Acknowledgements

We owe a debt of gratitude to M.L. Claunch, Registered Professional Land Surveyor and Licensed State Land Surveyor, for his guidance and wisdom.

References

Bouchard, H. 1970; Surveying, 5th.ed., International Textbook Co., Scranton, PA, 754 p.

Brown, L.F., J.C. Brewton, J.H. McGowen, W.A. White, C.G. Groat, and W.C. Fisher. 1976, Environmental Geologic Atlas of the Texas Coastal Zone - Corpus Christi Area, Bur. Econ. Geol., Univ. Tex. Austin, Austin, TX, 140 p., 9 maps.

_____. 1980. Environmental Geologic Atlas of the Texas Coastal Zone - Brownsville-Harlingen Area, Bur. Econ. Geol., Univ. Tex. Austin, Austin, TX, 140 p. 9 maps.

Brown, L.F., J.H. McGowen, T.J. Evans, C.G. Groat, and W.C. Fisher. 1977. Environmental Geologic Atlas of the Texas Coastal Zone - Kingsville Area, Bur. Econ. Geol., Univ. Tex. Austin, Austin, TX, 131 p., 9 maps.

Claunch, M.L. 1987. Surveying experiences along the Texas Coast: Symposium on Coastal Boundaries, The Conrad Blucher Institute for Surveying and Science, Corpus Christi State University, p.2 (abs.).

Friedman, G., A.J. Amiel, M. Braun, D.S. and Miller. 1973. Generation of carbonate particles and laminates in algal mats--example from sea-marginal hypersaline pool, Gulf of Aqaba, Red Sea. Amer. Assoc. Petroleum Geologists Bull. 57:541-557.

Pulich, W. and S. Rabalais. 1986. Primary production potential of blue-green algal mats on southern Texas tidal flats. Southwestern Naturalist 31:39-47.