



Historic American Land Surveys: The Mason Dixon Land Survey

4 Hours

**PDH Academy
PO Box 449
Pewaukee, WI 53072
(888) 564-9098
www.pdhacademy.com**

HISTORIC AMERICAN LAND SURVEYS – THE MASON-DIXON LINE SURVEY

BY: NATHAN J. WALKER, PLS

Objective:

As the retracement surveyors of today are called upon to “follow in the footsteps” of those original surveyors who went before, it is useful and instructive to learn how and why the early surveyors conducted their projects. It is likewise worthwhile to consider the outcomes and consequences of the early land surveys that shaped and continue to influence America.

This course seeks to study the historically important Mason-Dixon Line survey, the circumstances that led to the necessity of the survey, the surveyors who conducted the survey, and the methods and techniques they employed to complete their daunting project. Also, the lasting political and cultural effects of the survey will be examined and a timeline of events relating to the survey will be presented.

Course Outline:

The Mason-Dixon Line Survey

- A. Biographical Overview of Charles Mason
- B. Biographical Overview of Jeremiah Dixon
- C. Mason and Dixon's Initial Expedition

Section 1 – Historical Background

- 1. The Province of Maryland
- 2. The Province of Pennsylvania
- 3. The Penn-Calvert Boundary Dispute

Section 2 – Surveying the Lines

- 1. Scope of the Survey
- 2. Celestial Observation and a Commencing Point
- 3. The Point of Beginning
- 4. The Tangent Line
- 5. The West Line and the North Line
- 6. Extending the West Line

Section 3 – Lasting Effects of the Survey

- 1. The Delaware Wedge
- 2. Cultural Implications
- 3. The Mason-Dixon Line and the Civil War

Section 4 – Monuments of the Survey

- 1. The Star Gazer's Stone
- 2. The Post Mark'd West
- 3. The Terminal Point
- 4. The Middle Point
- 5. The Tangent Stone
- 6. Tri-State Monument
- 7. The Fenwick Island Monument

Section 5 – Methods and Techniques

- 1. Astronomy and Surveying
- 2. Establishing North by Astronomical Observation

Section 6 – Resurveys of the Mason-Dixon Line

Section 7 – The Popular Legacy of the Mason-Dixon Line

Section 8 – Chronology of Events

Introduction:

The Mason-Dixon Line is familiar, in name at least, to most Americans but its origin, location, and cultural significance are certainly worthy of further study, particularly for those interested in historic land boundaries and the circumstances surrounding their creation. What began as a survey to establish the border line dividing the lands of Pennsylvania and Maryland in time came to signify the boundary line dividing the Union and the Confederacy. By use of conventional land surveying techniques in conjunction with astronomical and navigational methods, Mason and Dixon marked boundaries upon the ground that for over two and a half centuries have shaped the history and culture of America.

In an address before the Historical Society of Pennsylvania in 1854, Maryland inventor John H.B. Latrobe remarked of the Mason-Dixon Line:

“There is, perhaps, no line, real or imaginary, on the surface of the earth – not excepting even the equator and the equinoctial – whose name has been oftener in men’s mouths during the last fifty years. In the halls of legislation, in the courts of justice, in the assemblages of the people, it has been as familiar as a household word. Not that any particular interest was taken in the line itself; but the mention of it was expressive of the fact that the States of the Union were divided into slaveholding and non-slaveholding – into Northern and Southern; and that those, who lived on opposite sides of the line of separation, were antagonistic in opinion upon an all-engrossing question, whose solution, and its consequences, involved the gravest considerations, and had been supposed to threaten the integrity of the Republic.”

Biographical Overview of Charles Mason

Charles Mason (1728-1786) was born in Gloucestershire, England. He spent the early years of his career serving as an assistant to Astronomer Royal, Reverend James Bradley. Mason devoted much of his professional effort toward the perfection of Tobias Mayer’s Lunar Tables, a critical resource in maritime navigation.

In 1761, Mason embarked upon a sea voyage to Bencoolen in the Island of Sumatra to observe the transit of Venus (the passage of Venus across the face of the Sun as viewed from the Earth) for the purpose of collecting data as part of an organized international scientific effort to compute the distance between the Earth and the Sun. Due to a delay caused by an attack on the H.M.S. Seahorse by a French naval vessel, Mason’s team observed the transit instead from the Cape of Good Hope in South Africa and then continued to the Island of St. Helena where Mason assisted famed British astronomer, Nevil Maskelyne in collecting tidal data until the end of 1761.

Beginning in 1763, Mason began his work with Jeremiah Dixon (who had accompanied Mason on the expedition) and a group of assistants, at the request of Lord Baltimore and William Penn, to survey and settle the boundary line between Pennsylvania and Maryland. Mason kept a detailed journal of astronomical observations and cultural information collected during the course of the survey.

Upon completion of the Mason-Dixon Line survey, Mason returned to Greenwich, England and in 1769, was employed by the Royal Society on an astronomical assignment at Cavan, Ireland. Upon this exceptionally eventful six-month assignment, Mason observed another transit of Venus, a partial solar eclipse, the moons of Jupiter, and the Great Comet of 1769.

Continuing his astronomical works, Mason catalogued 387 stars based upon James Bradley's observations, which were incorporated into the Nautical Almanac for the year 1773. Further, Mason resumed his work of perfecting Mayer's Lunar Tables on behalf of the Board of Longitude.

In 1786, Mason relocated with his family to Philadelphia, but became ill and died in October of the same year.

Biographical Overview of Jeremiah Dixon

Jeremiah Dixon (1733-1779) was born in Cockfield, County Durham, England, one of seven children born to a wealthy Quaker family of the Landed Gentry. Dixon was educated at Barnard Castle, taking an early interest in mathematics and astronomy.

Dixon served as an assistant to Charles Mason on his 1761 expedition, observing the transit of Venus from the Cape of Good Hope. Dixon later returned to the Cape of Good Hope to participate in Nevil Maskelyne's experiments with gravitation.

Dixon arrived with Charles Mason in Philadelphia in November of 1763 to begin their famed survey of the boundary line separating Pennsylvania and Maryland. Completing the survey in 1766, both men remained to conduct an additional survey on the Delmarva Peninsula, which is named for Delaware, Maryland, and Virginia, on behalf of the Royal Society and to perform several gravitational measurements prior to returning to England in 1768.

In 1769, Dixon traveled to Norway with William Bayly to observe another transit of Venus from Hammerfest Island.

Dixon was installed as a Fellow of the Royal Society in 1773.

Returning to England, Dixon resumed his profession as a land surveyor in County Durham. Dixon remained unmarried until his death in 1779 at the age of 45. He was interred in the Quaker Cemetery at the village of Staindrop.

Dixon's surname is the origin of the nickname "Dixie," commonly used to refer to the American South.

Mason and Dixon's Initial Expedition

Prior to becoming famous for their work in North America, Mason and Dixon achieved renown in England for their scientific work in observing the 1761 transit of Venus across the face of the sun, an event which had not occurred since 1639. The celestial phenomenon was to be visible in Asia, Australia, the East Indies, northern Europe, and the Arctic. To the observer, Venus would appear as a tiny black dot first appearing on the east edge of the Sun. For

approximately six hours, Venus would make its way across the face of the Sun, completing its transit on the western side.

The time required to complete the transit was variable based upon the location of the observer. The transit time as well as the path of Venus across the face of the Sun was carefully recorded by teams of scientists at several different locations across the Earth. By comparing the data collected from the observations at the several locations, astronomers could attempt to compute the distance between the Sun and the Earth, which was at this time still unknown to science.

The geometric concept involved in the computation was fairly straightforward. Two observers separated by a known length, observing the same object at the same moment in time may construct an isosceles triangle with a known base and known vertical angles. However, the seemingly simple concept was extraordinarily difficult in reality. For example, the Sun and Venus appear to shift in position as the observer moves. Further, both Venus and the Earth are in constant rotation upon their axes and constant orbit about the Sun. Complicating the computations was the fact that the Earth was known to be an irregular spheroid, but the precise shape of the planet was not yet understood. These variables, when paired with the difficult task of measuring angles in fractions of seconds challenged the finest minds of Europe's scientific community.

Setting sail for Bencoolen in January 1761, Mason and Dixon arrived, out of necessity, at the Cape of Good Hope in April of the same year.

Mason and Dixon had been supplied by the Royal Society with the following equipment:

1. Two reflecting telescopes manufactured by James Short. Each telescope had a focal length of 24 inches and a magnification of 120 times. One of the telescopes was equipped with an "object-glass micrometer" with a focal length of 495.48 inches.
2. An astronomical clock manufactured by John Ellicott.
3. A quadrant with a one-foot radius manufactured by John Bird, which was loaned to them by the Earl of Macclesfield, president of the Royal Society.

Dr. James Bradley, Astronomer Royal, provided written instructions to Charles Mason as follows:

"Locate the observatory where there is a clear view toward the northeast, north, and northwest. Observe the first and second contacts of Venus with the limb of the Sun. Then measure the distance of Venus from the limb of the Sun to ascertain the nearest approach of Venus to the center of the Sun's disk. Measure the diameter of Venus. Set up the clock so that the observers at the telescopes are immediately accessible to it. Observers must be careful not to prejudice one another in their judgments of events and times. Make a preliminary trial of the clock with its pendulum adjusted as it was at Greenwich to ascertain how much it loses in a sidereal day. Then adjust it to solar time. Keep a record of the temperature in the clock case. Record how much the pendulum must be changed in length to keep solar time at Bencoolen."

After much preparation, Mason and Dixon made their observations of the transit of Venus on June 6, 1761. Remaining at the Cape of Good Hope through September, Mason and Dixon observed the positions of stars and astronomical phenomena for the purpose of establishing the latitude and longitude of their temporary observatory. They then set sail for St. Helena, arriving on October 16 to work with Nevil Maskelyne on further astronomical research.

This first scientific expedition by Mason and Dixon signified the beginning of a professional relationship that would span the next fifteen years and forever change the course of history.

SECTION 1: HISTORICAL BACKGROUND

The Province of Maryland (1632-1776)

George Calvert, or Lord Baltimore, was an English politician who served in Parliament and later as the Secretary of State to King James I. Calvert was interested in American colonization initially for financial gain but later for the establishment of a refuge for Roman Catholics being persecuted in England. Catholics were a minority in England in the seventeenth century, mistrusted and discriminated against by the Anglican majority

Calvert first became the proprietor of Avalon on the Island of Newfoundland but was demoralized by the harshness of the Canadian climate and determined to locate a more hospitable location further south along the Atlantic coast. Calvert sought a new royal charter for the settlement of the region which would become the modern-day State of Maryland.

Calvert died on April 15, 1632, just a few weeks before the new charter for the Province of Maryland was sealed. Calvert's son Cecilius succeeded him, while his son Leonard became the first Colonial Governor of Maryland.

On June 20, 1632, King Charles I in the eighth year of his reign granted to Cecilius Calvert, Lord Baron of Baltimore as follows:

“All that part of the Peninsula, or chersonese, lying in the parts of America between the ocean on the east, and the Bay of Chesapeake on the west, divided from the residue thereof by a right line, drawn from the promontory or headland called Watkin's Point, situate upon the bay aforesaid, and near the river Wighco on the west, unto the main ocean on the east, and between that boundary on the south, and that part of the Bay of Delaware on the north, which lieth under the fortieth degree of latitude, where New England terminates.”

The Province of Pennsylvania (1681-1776)

William Penn (1644-1718) was born in London, educated at Oxford and was an early member of the Religious Society of Friends, familiarly referred to as the Quakers. He was an advocate of religious freedom and self-government. Like Calvert, Penn sought freedom from religious persecution.

In 1681, Penn received a royal charter from King Charles II to settle a debt that was owed by the Crown to Penn's father. Penn founded the proprietary colony to provide a place in which

the Quakers could practice their religion freely. King Charles II named the colony Pennsylvania, which translates to “Penn’s Woods” in the Latin language. Interestingly, the name was given by the king in honor of William Penn’s father and not in honor of the younger Penn.

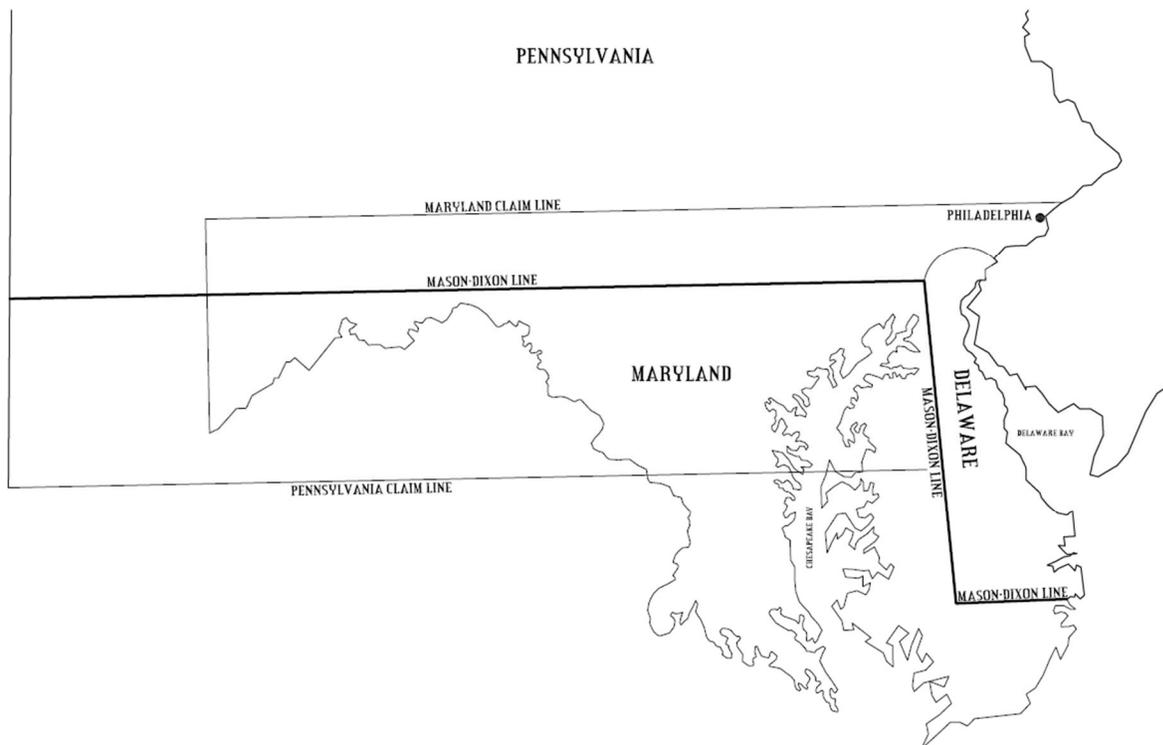
A portion of the description of the southern boundary of Penn’s lands contained within the March 4, 1681 charter reads as follows:

“A circle drawn at twelve miles distant from Newcastle northward, and westwards unto the beginning of the 40th degree of northern latitude.”

The uncertainties contained within this boundary line description are apparent to the land surveyor and may be expressed by the following questions:

1. “A circle drawn at twelve miles” may refer to a circle with a radius of twelve miles, a circle with a diameter of twelve miles, or a section of arc which is twelve miles in length.
2. “...distant from Newcastle” raises the obvious matter of where exactly in Newcastle shall the circle be centered.

The charter for the proprietary colony remained in the possession of the Penn family until the American Revolution, at which time the Commonwealth of Pennsylvania was formed and admitted as one of the original thirteen states.



The Penn-Calvert Boundary Dispute

The lengthy boundary dispute between William Penn and his heirs, and Charles Calvert (Third Baron Baltimore) and his heirs, was the source of the necessity of the Mason-Dixon Survey. The ambiguities and uncertainties within the land descriptions of the royal charters for both Maryland and Pennsylvania led to years of negotiations, surveys, and cases tried in the courts of England, none of which were enough to quiet the disputed boundary.

Following is background information on the attempts to colonize the area that is the subject of the Penn-Calvert dispute.

In the year 1631, agents of the Dutch West India Company purchased land at Cape Henlopen and formed a new colony called Zwaanendael in what is now Delaware. Constant conflict with the local Nanticoke Tribe, from whom the land was initially purchased, caused the new colony to fail in its first year. A subsequent effort at colonization was attempted the following year and likewise failed.

In 1632 Cecilius Calvert (Second Baron Baltimore) received a charter from King Charles I which included the Chesapeake Bay area. The charter was bounded on the north by the 40th parallel of latitude, and on the east by the Atlantic Ocean and the Delaware Bay. When the original colonists began to arrive and settle on the land, no survey was made to ascertain the location of the 40th parallel. Furthermore, the original immigrants did not settle the lands along the Delaware Bay.

Sweden established the Colony of New Sweden along the Delaware River (near what is now Wilmington, Delaware) in 1638 during the Thirty Years War when Sweden was at the height of its military power. Considering the establishment of this colony to be an incursion into Dutch lands, the Dutch established an outpost, Fort Casimir, in the location of present-day New Castle, Delaware in 1651. Three years later, the Swedish captured Fort Casimir, but the Dutch recaptured the fort the following year under the leadership of Peter Stuyvesant, Director General of New Netherland. Stuyvesant renamed the fort to Fort New Amstel.

The English protested the colonization by the Swedish and the Dutch in the lands which the King had granted to Lord Baltimore by Royal Charter. In 1659, Maryland sent a delegate to New Amstel to formally object to the Dutch presence in Maryland, but the English did not take action on this matter until 1664 when King Charles II granted James, the Duke of York (and the King's brother) all land situated between the Delaware River and the Connecticut River. The English took Fort Amsterdam in September of 1664, and Peter Stuyvesant was forced to surrender all the territories of New Netherland. The remaining Dutch outposts in the Delaware Bay region surrendered shortly after the fall of Fort Amsterdam. Further, New Amstel was given the English name of New Castle.

In the year 1681, William Penn received a Royal Charter from King Charles II for what would become Pennsylvania. Lord Baltimore (now Charles Calvert) stated no objection to the charter with the understanding that Penn's holdings would be entirely north of the 40th parallel. James, the Duke of York, was to retain New Castle and the surrounding area as circumscribed by

a 12-mile circle. William Penn leased this land from the Duke for the purpose of securing access to the sea for his colony. In 1682, the Duke of York conveyed to William Penn the 12-mile circle around New Castle as well as the lands to the south extending to Cape Henlopen.

In May of 1683, Penn visited the Colonies and met with Calvert at New Castle. The men disagreed on their understanding of how the land boundaries were to be determined. The points of contention were the location of the southern boundary of Pennsylvania and the location of the 12-mile circle around New Castle. This meeting signified the beginning of the famous boundary dispute.

Penn's desire for his colony to have access to the Chesapeake Bay was in direct conflict with Calvert's steadfast assertion that Pennsylvania was to be limited to only the lands north of the 40th parallel. Calvert further contended that the original royal charter to Maryland had intended to include the land along the Delaware Bay. The two men being at an impasse, Penn sought a legal remedy in the courts of England, to which both returned in order to try the case. James, the Duke of York had, by the time of the trial, risen by ascendancy to the English throne as King James II. Penn anticipated an advantage in the proceedings, given his alliance and past relationship with James II.

Penn put forth the position that the Maryland Charter had only included uncultivated lands and that the Dutch settlers had previously farmed the Delaware Bay area prior to the execution of the charter, thereby nullifying Calvert's claim on the land. The decision of the Committee for Trade and Plantations concurred with Penn's assertion that the Maryland Charter was to include uncultivated lands only and that the prior settlement by the Dutch fairly excluded the lands along the Delaware bay from the charter.

In 1685, King James II handed down a compromise decision ordering the division of the land lying between the Chesapeake Bay and the Delaware Bay by way of a line to be drawn west from Cape Henlopen to its intersection with a line to be drawn directly south from the 40th parallel. Also, the royal decree confirmed that the northern boundary of Maryland was to remain at the 40th parallel, however this boundary was not surveyed at the time allowing its physical location on the ground to remain uncertain. Three years later, King James II issued to Penn an updated charter which better defined the Delaware Bay region.

In 1701, the settlers in what is now Delaware, which at the time was referred to as the Lower Counties, petitioned William Penn with a request to establish their own legislature and public officials. Penn agreed to their petition and arranged for the survey of the 12-mile circle around New Castle with the goal of marking the border between the Lower Counties and Pennsylvania.

Surveyors Thomas Pierson of New Castle and Isaac Taylor of Pennsylvania were commissioned to survey what would be the first of many attempts to rightly survey the boundary arc.

In 1709, Calvert petitioned Queen Anne for the dismissal of the previous ruling which had granted to Penn the Delaware region, contending that Penn's lands must not extend south of

the 40th parallel. The queen denied Calvert's petition. Based upon the queen's edict, the assemblies of both Pennsylvania and Delaware agreed to accept the 12-mile boundary arc as surveyed by Pierson and Taylor. This agreement, however, did little to resolve the frequent boundary disputes between the settlers from Delaware and Maryland, which were exacerbated by the recurring cases of the Maryland government making land grants to Maryland residents which were within the borders of Delaware. In frustration, the Delaware assembly revoked its ratification of the 12-mile circle boundary.

The deaths of the original contestants to the dispute, Calvert in 1715 and Penn in 1718, led their heirs to carry on the controversy. Charles Calvert, the Fifth Lord Baltimore, and John, Thomas, and Richard Penn would continue in the dispute begun by their predecessors.

After a brief period of quiet, the dispute roared back to life owing mostly to two major discoveries. First among these was the fact that the 12-mile boundary arc around New Castle at no point actually intersected with the 40th parallel. The other issue was that the 40th parallel was found to lie north of Philadelphia, Pennsylvania's principal city, thereby placing it within the borders of Maryland. These disputes led each colony to conduct its own surveys of the borders, which only added to the confusion.

In 1730, a violent dispute that came to be known as Cresap's War began when ferry boat operator Thomas Cresap was almost drowned when his ferry boat was attacked by a pair of men from Pennsylvania. The attackers apprehended Cresap's hired man who was wanted in Lancaster County, Pennsylvania for delinquent debts. Cresap complained of the incident to the Pennsylvania magistrate, but received no satisfaction.

Continuing conflicts, sometimes escalating to the point of violence, coupled with uncertainty among the settlers as to which colony their taxes were owed compelled the leaders of Pennsylvania and Maryland to seek a final and equitable settlement.

Calvert petitioned King George II in 1731 to require the Penns to accept a final location of the disputed boundaries. The petition was sent to the Committee for Trade and Plantations. At the center of this latest round in the dispute was Calvert's claim that the 40th parallel should be held as the boundary (thereby placing Philadelphia within Maryland) and Penn's assertion that the boundary should be placed 20 miles south of Philadelphia.

In 1732 King George II and the Committee compelled the Calverts and the Penns to agree to a compromise, whereby they executed an agreement placing the southern boundary of Pennsylvania to the south of Philadelphia. The agreement also provided for the division of the peninsula by a line drawn west from Cape Henlopen to the central point of the peninsula. From said central point, a boundary line would be drawn north to the point of tangency with the 12-mile circle around New Castle. From this tangent point, the boundary would run along the arc of the circle until it was directly north of the point of tangency, and from that point would run north to its intersection with the latitudinal line positioned 15 miles south of Philadelphia. It should be noted that the map used in the agreement contained an error miscalling Fenwick Island as Cape Henlopen, which represented a 19-mile blunder.

The agreement also directed the establishment of a body to govern its implementation and to supervise the placement of boundary monuments. Maryland and Pennsylvania appointed seven members each to the Commission, which was headed jointly by each colony's governor.

Despite regular meetings, the Commission could reach no agreement on several particular points regarding the 12-mile circle boundary. The Commissioners from Maryland argued that the circle did not have a definitive central point. Also, the Maryland commissioners contended that the circle was intended to be 12 miles in circumference, as opposed having a radius of 12 miles as claimed by the Pennsylvania group. Calvert also raised the issue of the aforementioned mapping blunder regarding Fenwick Island and Cape Henlopen.

With no resolution achieved, the Commissioners drafted a statement acknowledging their failure to resolve the dispute. Lord Baltimore then petitioned the courts of England and William Penn filed a petition to counter. As a temporary solution, King George II decreed that no further grants of land were to be made within the disputed territory. Meanwhile, proxies for each side began the legal process of obtaining depositions from potential witnesses.

In 1750 at the Court of Chancery, Lord Chancellor Phillip Yorke, First Earl of Hardwicke reviewed the charters and the prior agreements made between the Calverts and the Penns, and received testimony from witnesses on both sides. The ruling handed down by Lord Hardwicke ordered that the Agreement of 1732 was to be binding, and that a new slate of Commissioners was to be appointed for the purpose of establishing the boundaries set forth therein. Addressing three of the main queries specifically, Lord Hardwicke decreed that the center point of the 12-mile circle was to be held at the center of New Castle. Also, Lord Hardwicke determined that the 12-mile circle was to have a radius of 12 miles. Lastly, he decreed that the previous mapping error was to be corrected and that Fenwick Island, instead of Cape Henlopen, would represent the southern boundary line.

The new Commission convened later the same year, with representatives from Maryland, Pennsylvania, and Delaware. Among the first decisions made was the agreement that the center of New Castle would be defined as the cupola sitting atop the Court House.

The Commissioners next retained surveyors John Riggs, Thomas Garnett, Archibald McClean, and John Lukens to establish what would become known as the Transpeninsular Line, which was the line dividing the southern half of the peninsula from the northern half. As directed by the Court of Chancery, this line was begun at Fenwick Island and run west. After completion of the survey, discord came to light again as the commissioners could not agree upon the location of the western terminus of the line. With the position of the line's midpoint being critical to the overall division of the peninsula, and with the midpoint being impossible to ascertain without knowledge of the western terminus of the line, the parties were once again at an impasse. Further complicating matters was the question of whether the radius of the 12-mile circle should be measured along the contour of the ground or if it should be measured on a level line, neglecting the relief of the land. The method chosen would have a considerable effect on the size of the circle.

The Commissioners appealed to Lord Hardwicke, who ruled that the Chesapeake Bay was to be the western terminus of the line and that the radius of the 12-mile circle should be measured on a level line. Lord Hardwicke also accepted the Commission's decision to hold the New Castle Court House as the center point of the circle.

Upon the death of Charles Calvert, his son Frederick (6th Baron Baltimore) who had opposed his father's agreements, succeeded him. For nine years, the surveying of the agreed upon boundary lines ceased. Eventually, however, Calvert entered into an agreement concurring with the Agreement of 1732 and with the Decree of 1750. In 1760, the Commissioners ratified the results of the survey of the Transpeninsular Line, and set the Middle Point Marker, which can be found today between Delmar and Mardela Springs, Maryland. The eastern Transpeninsular Line monument is found near the Fenwick Island Lighthouse.

Over the course of three years, local surveyors* attempted to lay out the 12-mile circle in 1761 and again in 1763 but the progress made was disappointing. The Commissioners then agreed to hire experts from England to correctly complete the survey. Charles Mason and Jeremiah Dixon had gained renown within the scientific community for their excellent work in the observation of the transit of Venus plus further astronomical observations made during their time in South Africa. Furthermore, Dixon was widely regarded as a top land surveyor. With the determination of a latitudinal line being critical to the disputed boundaries, both astronomical navigation and conventional land surveying methods would be called upon.

In the Summer of 1763, the Penns and the Calverts being both in London, retained Charles Mason and Jeremiah Dixon to:

“mark, run out, settle, fix and determine all such parts of the circle, marks, lines, and boundaries, as were mentioned in the several articles or commissions, and were not yet completed.”

Mason and Dixon left England in mid-September aboard the *Hanover Packet* and landed at Marky's Point, about 20 miles from Philadelphia on November 15, 1763 to begin their monumental work.

**Note: The local surveyors from the 1761-1763 surveys were John F.A. Priggs, John Lukens, Archibald McClean, Archibald Emory, Jonathan Hall, John Watson, John Stapler, Thomas Garnett, and William Shankland.*

SECTION 2: SURVEYING THE LINES (1763-1767)

Scope of the Survey

Shortly after arriving in Philadelphia, Mason and Dixon met with the commissioners from Pennsylvania first and then the commissioners from Maryland joined about two weeks later. A series of daily meetings was held to discuss the specific tasks required of Mason and Dixon.

The first major task was the establishment of the “West Line” of the boundary, which was decreed by the Court of Chancery to lie 15 miles south of the southernmost point of the City of Philadelphia. Prior to the commencement of Mason and Dixon’s survey, the City Commissioners of Philadelphia had sought to determine the southernmost point of the city for the purpose of establishing the initial basis by which to establish the boundary between the lands governed by the descendants of Lord Baltimore (Maryland) and by the descendants of William Penn (Pennsylvania). The officials walked the south border of the city and agreed that the north wall of the house owned by Thomas Plumsted and Joseph Huddle was the satisfactory location of the southernmost point of Philadelphia. The front wall of this house adjoined the street which represented at that time the southern border of the city. The Plumsted-Huddle house was in Southwark, which in the colonial period was a municipality in Philadelphia County, and which today is a neighborhood in South Philadelphia. Today, no trace of the original Plumsted-Huddle house remains.

The other major task was the establishment of the “Tangent Line,” or the boundary between Maryland and Pennsylvania’s three lower counties (present-day Delaware). This line would require the establishment of a line running from the midpoint of the Transpeninsular line to the tangent point with the 12-mile circle and from there a meridional line to a point 15 miles south of the southernmost point of Philadelphia.

In the course of the daily meetings, the commissioners disagreed as to which of the lines should be surveyed first. Maryland’s contingent was in favor of surveying the West Line first, proposing that the team survey westward to South Mountain. The Pennsylvania representatives favored surveying the Tangent Line first, suggesting that the terrain would only be traversable in the summer months.

The commissioners did agree that the task of first importance was the determination of the latitude of the southernmost point in Philadelphia, which point had been previously agreed upon. From there, the surveyors could reckon the latitude at a point 15 miles south as required, which would then be held as the latitude for the West Line.

The surveyors requested the construction of an observatory in order to make the necessary celestial observations. This was agreed to upon the condition that the surveyors pledged an oath to perform to the best of their knowledge and ability and to remain impartial in their work, taking care to not favor one side over the other. Also, the commissioners provided the surveyors with detailed instructions compiled from the decisions made during the series of meetings.

Celestial Observation and a Commencing Point

With their observatory built, the surveyors began the process of setting up their equipment, which included a 6-foot Zenith Sector: a vertically mounted telescope used to establish latitude by measuring the positions of stars. With this instrument, the observer could measure the zenith angle of a star (the angle created between the zenith, the observer, and the star’s location on the celestial sphere), and thereby could compute the zenith distance and declination. Using this data along with the Royal Society’s star table, the latitude of the observer

could be calculated. The stated accuracy of the Zenith Sector by its manufacturer was two arc seconds. Additionally, the team set up a Telescope and Hanging Level configured as a tripod-mounted transit and equal altitude instrument.

These instruments were manufactured by John Bird of London, who was at the time considered to be the top maker of mathematical instruments in England. John Bird (1709-1776) worked in his youth as an apprentice to Jonathan Sisson (inventor of the theodolite) and had also worked alongside well-known instrument maker George Graham. By the time of Mason and Dixon's survey, Bird had invented the slow-motion tangent screw which allowed for the reading of fractions of seconds of angle.

The Zenith Sector consisted of a base and stand to which a telescope was mounted vertically. The telescope was positioned to aim straight up, or to the zenith angle. The telescope was mounted upon a pivoting device so the observer could move the scope along the vertical circle. A curved scale, which was called the sector, was affixed to the base of the instrument. The sector consisted of an ivory scale in the form of a segment of an arc of 6-foot radius, upon which was inscribed markings identifying the increments of degrees of angle. When observing the location of a star on the celestial sphere, the indicator on the sector would inform the observer of the angular measurement between the zenith and the observed object. The micrometer attached to the Zenith Sector enabled the user to make angular measurements of one-hundredth of a second of arc.

Interestingly, the configuration of the Zenith Sector with the eyepiece near the floor required the user to lie in the supine position. Further, with stellar observations necessarily being taken at night, an assistant to the observer was needed to illuminate the crosshairs of the telescope via candlelight shone through an aperture in the instrument's eyepiece.

The process of using the Zenith Sector first involved aligning the instrument with the meridian, which is the north-south line directly above the instrument's position. Mason achieved this by selecting a star to observe through the telescope. Due to the rotation of the Earth, a star observed through a stationary telescope will seem to travel in the path of an arc across the telescope's field of view, parallel with the celestial equator. By positioning the telescope in such a way that the star would appear to cross the horizontal crosshair twice. Mason would record the precise times that the star crossed the horizontal crosshair, and by determining the midpoint of the arc traced by the star relative to the crosshairs, it could be ascertained when the observed star was on the meridian. This process would be repeated on several different stars on a single night and by computing the positions of each star and at what time they were on the meridian, Mason could calibrate his instrument to the meridian.

Once the Zenith Sector was correctly oriented to the meridian, Mason and Dixon began the process of precisely computing the latitude of the agreed-upon southernmost point of Philadelphia, fifteen miles south of which the West line of their survey was to be run. A group of stars was selected for observation and according to their notes, zenith angles and right ascensions were recorded on these stars from December 19, 1763 to January 4, 1764. Upon completion of 17 nights of stellar observations and after two straight days of mathematical

calculations, Mason was able to report to the commissioners his result, which was that the southernmost point of Philadelphia was at a north latitude of 39 degrees 56 minutes 29.1 seconds.

The Point of Beginning

With the latitude of the southernmost point of Philadelphia established, Mason and Dixon set about the task of determining the position of a beginning point fifteen miles to the south, which would control the latitude of the West Line. It was impractical for the team to attempt to survey directly south from Philadelphia and then to the west, as two crossings of the Delaware River would have been necessary. The more expedient alternative of first travelling west from Philadelphia for 30 miles and then surveying southward was chosen. This route allowed the team to avoid the two unnecessary river crossings.

John Harlan was a landowner near the forks of Brandywine Creek in the area of present-day Embreeville, Pennsylvania. Mr. Harlan agreed to provide lodging for the surveyors and further permitted them to construct an observatory on his land. Over the years in which the survey was conducted, the Harlan home served as a home base for Mason and Dixon.

Mason and Dixon returned to Philadelphia in order to gather their belongings and prepare for the westward journey. They arranged to have their observatory dismantled by a team of carpenters and carried by wagon along with their instruments to the Harlan residence. Once back at the Harlan residence, Mason and Dixon set up a temporary observatory for the Zenith Sector in a tent. Mason made celestial observations in order to determine their latitude and realizing that their present position was conveniently near to the latitude of the southernmost point of Philadelphia, instructed the team of carpenters to erect their observatory upon the site. After the completion of their observatory and upon additional observations and calculations, Mason and Dixon concluded that the observatory was located at 39 degrees 56 minutes 18.9 seconds north latitude, a mere 10.2 seconds south of the latitude of the southernmost point of Philadelphia.

The next objective was to survey southward to the latitudinal line 15 miles south of the latitude of the southernmost point of Philadelphia. One of the first steps taken was to mark the meridian on the ground, which would provide the surveyors with positional control in the daytime. A large stone monument was placed (and then replaced after a more accurate position was established) about 700 feet north of the Harlan house. This stone came to be known locally as the Star Gazers' Stone and still exists today. The Harlan farm, house, and Star Gazers' Stone were placed on the National Register of Historic Places in 1985.

For the procession southward, laborers and experienced survey crew members joined Mason and Dixon. Their method was a line-of-sight technique setting out from the Harlan property. Dixon aligned his circumferentor (an instrument used for the measurement of horizontal angles) with the meridian line, sighted a line to the south and positioned a crewmember upon the meridian line to the south to set the first stake. The chainmen would then measure directly from the setup point to the stake which had been set and Dixon would move forward to the new stake to set up. Aligning the circumferentor with the setup stake and the back

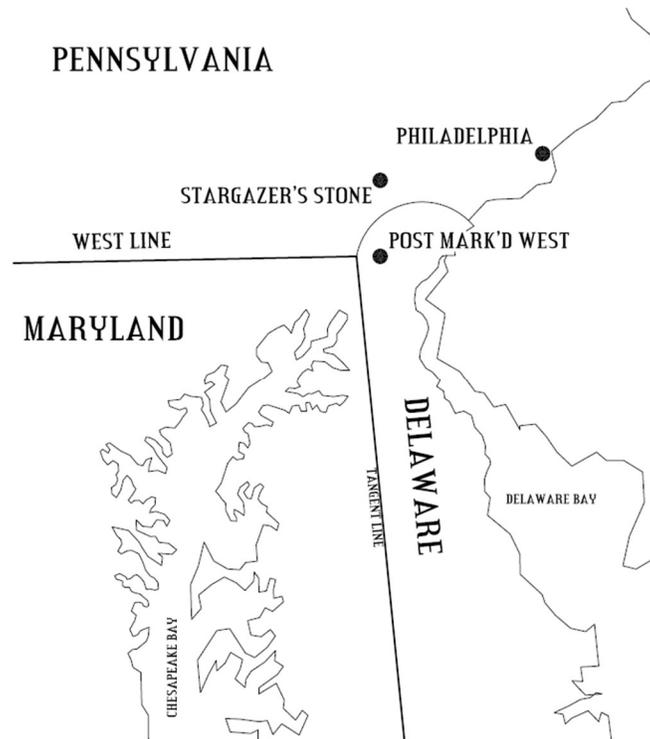
sight stake, Dixon would sight a line to the south again and the process would be repeated again and again while keeping a running total of the distances measured by the chainmen.

When crossing ordinary terrain, distances were measured using a Gunter's chain which was 66 feet in length. Rough terrain was often measured with a 22-foot or 16 ½-foot long rod called a level. This permitted the survey crew to maintain a level line of measurement, rather than measuring along the ground going up and down hills.

By April 12, 1764, the men had traversed their way southward approximately 15 miles. By Dixon's computations, the correct distance from their commencing point at Harlan's farm was calculated to be 15 miles, 2 chains, and 93 links, which placed them on the land of Alexander Bryan. At the southern terminus of the 15-mile line, the surveyors set a large wooden post which would come to be referred to as the "Post Mark'd West" owing to the fact that the men had carved the word "WEST" into the west-facing side of the post. The survey party then returned to Harlan's farm to collect their belongings.

The observatory was disassembled and placed into wagons along with the Zenith Sector. The hired laborers returned to the south terminus of the 15-mile line to reconstruct the observatory while Mason and Dixon traveled back to Philadelphia to meet with the commissioners to give report on their progress.

Upon returning to the field and making careful observations, the surveyors determined that the south point of terminus of the 15-mile line, where the Post Mark'd West had been placed, was at a north latitude of 39 degrees 43 minutes 18.2 seconds. With the first step of the process complete, Mason and Dixon shifted their efforts to the establishment of the Tangent Line, which had confounded earlier surveyors for years.



The Tangent Line

In June of 1764, Mason and Dixon began to make preparations for the surveying of the Tangent Line. This line of approximately 80 miles was to run from the middle point of the previously surveyed Transpeninsular Line to the tangent point with the 12-mile arc around New Castle. In preparation for this survey, the surveyors brought on additional hired hands and purchased a stock of medical supplies.

Mason and Dixon also hired Moses McClean to work as their steward. McClean was responsible for the logistical aspects of maintaining a large survey crew in the field for an extended time. His duties included the procurement of provisions, supplies, and horses, as well as handling the money and tending to the equipment.

The crew, which had by this time grown to 39 men, traveled south down the peninsula toward the midpoint of the Transpeninsular Line to begin the survey northward to the tangent point. Previous surveyors had attempted, and failed, to run a line directly from the midpoint to the tangent point. Mason's plan was to run a straight line north to a point slightly west of the tangent point and then calculate an adjustment to the line to bring it to the tangent point. This adjusted line could then be established and monumented.

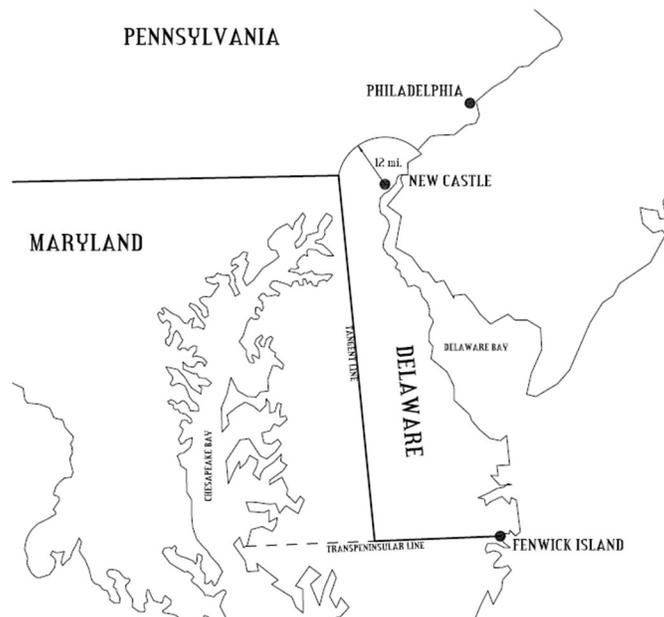
To correctly survey a straight line running north, Mason elected to use astronomical north. Interestingly, Mason did not use Polaris (the North Star) as his basis. Rather he chose to set his course upon the adjacent star in the constellation Ursa Minor, which is known as Delta Ursae Minoris. Mason's rationale was that Polaris appears to move on a very small arc during the course of a night, while Delta Ursae Minoris appears to move along a slightly larger arc, making the apparent movement much easier to observe. By night, the transit's position was fixed based on the stellar observations and by day the transit was used to sight the line running north, which was measured as before by chainmen, measuring ahead to each new line stake. The crew set a wood post at each mile interval. At every fifth mile, the chainmen took an offset measurement from their line to the line established by John Lukens, who attempted unsuccessfully to survey the tangent line in 1763. On August 25, the eighty-first milepost was set, which was determined to be north of the tangent point, thereby making the line long enough for the surveyors to compute the necessary adjustment.

The next task in this phase of the project was to locate the exact position of the tangent point. Hiking their way eastward toward the 12-mile circle, the surveyors eventually recovered posts that had been placed during the 1760-1763 survey, including the post marking the tangent point. Extending the radius of the 12-mile circle to its point of intersection with the newly surveyed north-south line, a distance of 22 chains and 51 links was measured. This distance would be the basis of the eastward adjustment of the north end of the line, as each milepost going south which was previously set could now be moved to the east by a prorated distance. This adjustment would successfully mark a line from the midpoint of the Transpeninsular Line to the Tangent Point.

The crew started back to the south, relocating each milepost along the way by the correct distance to place it correctly on the tangent line. Arriving at the midpoint, the crew discovered

that the south end of the calculated tangent line was a mere 26 inches west of the midpoint. The crew then began working their way back north, taking additional measurements and making necessary corrections to the line's position and the locations of the mileposts. On November 10, Mason and Dixon arrived back at the north end of their line. They found that their line as surveyed was 16 feet and 9 inches east of the tangent point. Mason divided the discrepancy on a proportionate basis across the entirety of the line to learn if any of the mileposts were far enough offline to merit resetting them. However, the results were found to be satisfactory.

Just one day shy of completing their first full year in America, Mason and Dixon had established the latitude of what would become the east-west dividing line between Maryland and Pennsylvania, and had successfully surveyed the Tangent Line, the position of which had eluded all previous surveyors. Mason and Dixon spent the winter of 1764-1765 as the guests of the Harlans.



The West Line and the North Line

In the spring of 1765, after wintering at the Harlan Residence, Mason and Dixon set about the difficult task of surveying the West Line. Surveying a latitudinal line is far more complex than surveying a meridional line: a meridional line may be surveyed by making nighttime observations of a singular star for the purpose of finding the true astronomical north, while surveying along a specific line of latitude requires frequent repositioning of alignment based upon the repeated observations of a group of stars. It is much more difficult to determine one's longitude by celestial observation than is to follow the center of the arc traced by Polaris, or in the case of Mason and Dixon, Delta Ursae Minoris.

For the purpose of surveying the West Line, Mason selected five stars to observe: Vega, Deneb, Sadr, Delta Cygni, and Capella, which are located in the constellations familiarly known as Lyra, Cygnus, and Auriga.

On March 19, 1765, the crew began their arduous assignment only to be hindered by immoderate weather, first in the form of heavy rain and then in the form of a snowfall of more than two feet. Being delayed severely by the conditions, the westward survey got successfully underway on April 5. The complexity of surveying along a latitudinal line was evidenced by the fact that the surveyors could correctly plot their course westward only about ten miles at a time, placing mileposts at the completion of each mile chained. At the completion of that distance, it was necessary for Mason to make celestial observations to determine their position and their departure from the target of 39 degrees 43 minutes 18.2 seconds north latitude. Once their position was determined and the course adjusted if necessary, Dixon and his crew could continue chaining westward for another ten miles.

Mason and Dixon's team reached the Susquehanna River on May 11, which point was recorded in their field notes as being at 26 miles, 3 chains, and 93 links. At this point, the survey was on schedule. The crew then made their way back east to the Post Mark'd West, while along the way verifying the positions of the mileposts that had been set on their survey west. From there, the crew turned southward toward the Tangent Point for the purpose of establishing a line running north from the Tangent Point to the intersection with the West Line, thereby completing the boundary running from the midpoint of the Transpeninsular Line to the line of 39 degrees 43 minutes 18.2 seconds north latitude. This would come to be called the North Line and was only 5 miles, 1 chain, and 50 links in length. Its northern point of terminus was reached by the surveyors on June 6, 1765 at a field owned by Captain John Singleton. This point marked the common corner of Maryland, Pennsylvania, and the Lower Counties (now Delaware). It was monumented with a wooden post carved with a "W" on its west face and an "N" carved on its north face. In 1849, the wooden post was replaced with a stone marker and the point is contemporarily known as the Tri-State Point.

Satisfied with the present results of the survey, the commissioners agreed to have the surveyors set permanent boundary stones, quarried from the Isle of Portland in England, at the critical points of the survey that had been established, including at the Tangent Point and at the intersection of the West Line and the North Line.

The commissioners then instructed Mason and Dixon to resume their survey of the West Line from the Susquehanna River to as far west as the country was inhabited. The crew surveyed their way westward in the same method as they had east of the Susquehanna; however, the terrain was becoming much more disagreeable as they traversed into the foothills of the Allegheny Mountains, part of the vast Appalachian Mountain Chain. In October of 1765, the survey had reached North Mountain and had set a post at mile 117. With winter approaching, this point was declared to be the end of the survey for the 1765 season; however, they remained for three weeks to make astronomical observations and to verify the accuracy of the West Line up to that point.

The instructions received by the surveyors indicated that the boundary line was not to cross the Potomac River, which in this area runs generally from west to east and meanders significantly. The surveyors enlisted the aid of Captain Evan Shelby, a local resident, who traveled with them to the top of North Mountain and showed them the path of the river as it flowed from the west. This view informed Mason and Dixon that their West Line would not cross the Potomac River. The surveyors next packed up their instruments and left them to the care of Captain Shelby for the winter. The crew traveled back east, checking their mileposts along the way, toward the Susquehanna River, where the present phase of the survey had recommenced. On November 8, the crew arrived at Peach Bottom, where a ferry across the Susquehanna operated, and the hired men were released for the winter.

Mason and Dixon then traveled to York, Pennsylvania for a meeting with the commissioners at which they received the instruction to oversee the placement of fifty boundary stones beginning at the midpoint of the Transpeninsular Line, or the south end of the Tangent Line. At the completion of the setting of these boundary stones, Mason and Dixon returned once again to the Harlan property to spend the winter, this being the winter of 1765-1766.

In March of 1766, Mason, Dixon, and their hired men reassembled at the residence of Captain Shelby, which was in the vicinity of milepost 117 at North Mountain where the survey had stopped in the fall of 1765. Mason began by making the necessary astronomical observations needed to set the course of the survey line going west. Mountainous terrain, dense forests, and bad weather made for slow progress in the spring of the year; however, the team forged ahead, going over the very steep Sideling Hill at Mile 134, and continuing through the summer months to Mile 165 which traversed across numerous hills and mountains, finally conquering Little Allegheny Mountain. On June 9, 1766, Mason and Dixon once again set up the Zenith Sector to make astronomical observations.

On June 14, Mason summited Savage Mountain, which was part of the mountain chain that separated colonial settlement from the lands inhabited by the native people. By King George III's Proclamation of 1763, this signified the boundary of Indian Territory, and further settlement by the colonists was prohibited.

The Proclamation of 1763

After the French and Indian War, the British Empire began to exercise more strict control over the colonies in America. In reply to a Native American rebellion led by Chief Pontiac of the Ottawa, King George III decreed the Appalachian Divide to be the limit of western settlement by the colonists.

The Proclamation of 1763 issued by King George III of Great Britain at the conclusion of the French and Indian War proposed to placate the Native American people by restricting the incursion of the European settlers onto their lands. Also, colonists previously settled west of Appalachia were required to move back east.

The boundary created by this edict became known as the "Proclamation Line" and served as the division line between the British Colonies and the Native American

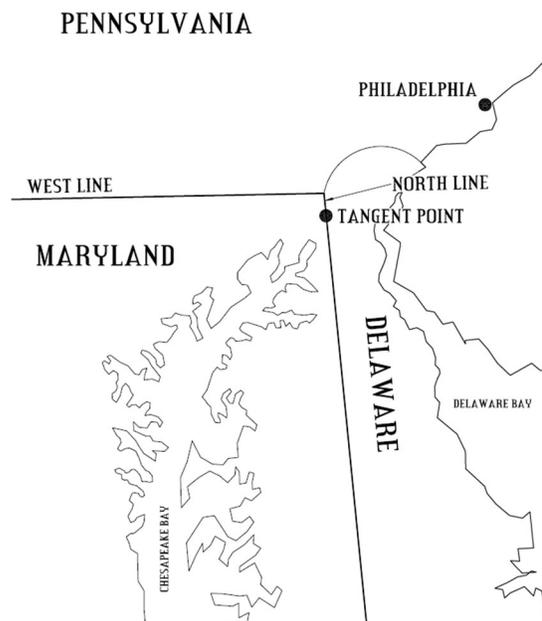
territory lying west of the Appalachian mountain range, thereby ending further western settlement by the colonists. Further, this measure prohibited any private citizen or colonial government from purchasing land or making any agreements with Native people to the west of Appalachia.

The Proclamation was largely flouted by the colonists and was loosely enforced by the British forces in North America, but it did become the source of considerable contempt for the British by the colonists and was one of many factors that contributed to the frustration that eventually set the American Revolution in motion.

With the limit of colonial settlement being reached, and therefore the requirements of the survey of the West line being satisfied, Mason, Dixon, and their hired men started back east, with the axmen cutting an 8-foot wide swath through the forests along the way. This chore consumed the remainder of the summer and on September 30, when the North Line had been reached, Mason and Dixon released all their hired men.

The surveyors had a month to spend before their next scheduled meeting with the commissioners, so with the permission of officials from both colonies they took on an unrelated scientific task for the Royal Society. As part of the scientific goal of determining the precise shape of the Earth, Mason and Dixon endeavored to precisely measure the length of a degree of latitude in America, so that the length could be compared with a degree of latitude as measured in Europe.

Upon the completion of their work on the Royal Society's project, Mason and Dixon received the instruction to set a stone at each milepost of the West Line, which was accomplished for 65 miles, excepting at Mile 64 where conditions made it impossible to set a stone.



Extending the West Line

Mason and Dixon had satisfactorily completed the tasks set forth in their original instructions; however, the commissioners desired to retain the team in order to perform additional surveys before they departed for their homes in England. First among these tasks was the running of a line from the Post Mark'd West, east to the Delaware River, which was important to know since the Royal Charter issued to William Penn provided that the western limit of Pennsylvania was to be five degrees of longitude west of the Delaware River. By obtaining a good position for the Delaware River upon the extension of the West Line, a correct length for the south boundary of Pennsylvania could be derived. This task was accomplished quickly and led to a second, related task.

The commissioners desired for Mason and Dixon to extend the West Line westward to a point exactly 5 degrees of longitude west of the Delaware River. This would require the crew to survey into Indian Territory, which was under the jurisdiction of the Six Nations, and where white settlement was expressly forbidden according to the Proclamation of 1763. Governor Penn of Pennsylvania and Governor Sharpe of Maryland each wrote to William Johnson, who was an Indian agent, to request his intercession on their behalf in requesting the consent of the Six Nations to allow the survey to proceed westward into their territory.

While awaiting word on consent from the leaders of the Six Nations, Mason and Dixon traveled once again to the Harlan residence to prepare for the next phase of their work. While there, the surveyors performed experiments relating to gravitation for the Royal Society in part of an effort to understand the effect, if any, on the earth's gravity imparted by the observer's latitude. The team spent most of January and February of 1767 conducting their experimental observations, the results of which were shipped back to England.

After lengthy negotiations with the leaders of the Six Nations, William Johnson was able to secure consent for Mason and Dixon to resume their survey of the West Line. As part of the consent agreement, a contingent from the Six Nations would join the survey party in their journey westward. In June of 1767, the group of 65 men made their way west to the where they had halted their survey the previous year. Moving ever westward and hiring willing workers along the way, the group ballooned to 110 men by September.

Disaster struck on September 17 at 221 miles west of the Post Marked West, when horse drivers John Carpenter and William Baker were struck by a falling tree and killed.

Twelve days later, doubtlessly distressed by the earlier tragedy, 26 members of the crew approached Mason and Dixon concerned that continuing westward across the Monongahela River into the lands of the Lenni-Lanape and the Shawnee would place them in serious jeopardy. Unable to be persuaded, the 26 men resigned their positions, were paid up, and were dismissed. Messages were sent to Fort Cumberland and Fort Redstone requesting men to replace those who had resigned. A group of willing men from Fort Cumberland arrived in early October.

Also, in early October, a party of eight members of the Seneca tribe arrived, which was welcome as the Senecas were part of the Six Nations and as such were friendly to Mason and

Dixon's native escorts. The Senecas were heading south to battle the Cherokee but remained with the survey party for two days before resuming their mission.

At a position of 231 miles and 20 chains, the surveyors reached an Indian warpath. The leader of the Mohawk escort asked for a meeting with Mason and Dixon. Following is an excerpt from the notes of the meeting:

"This day the Chief of the Indians which joined us on the 16th of July informed us that the above mentioned War Path was the extent of his commission from the Chiefs of the Six Nations that he should go with us, with the Line; and that he would not proceed one step farther Westward."

Despite the urging of Mason and Dixon, the Indian escorts remained resolute in their unwavering refusal to travel any farther and the surveyors were forced to accept their conclusion and decided to end the West Line short of the true western boundary of Pennsylvania, (five degrees of longitude west of the Delaware River) rather than risk traversing into hostile territory without the aid of the escorts.

At Brown's Hill, Mason and Dixon spent the second week of October recording celestial observations to make a final determination of position and at a distance of 233 miles, 17 chains, and 48 links from the Post Marked West, the surveyors set a post with a "W" carved on the west-facing side atop a cairn of stones.

At this point, Mason and Dixon had accomplished the tracing of a parallel of latitude upon the ground by means of astronomical navigation and terrestrial surveying methods, a feat which had not been achieved at any prior time in recorded human history.

Having reached the western end of their line, the crew turned back east and started the job of clearing a vista back to Milepost 199 where the previous clearing had left off. Along the way, one of the Indian escorts died of a cause that was not entered in the record. His remains were placed in a coffin and carried back east for proper burial and his wages were sent to his widow.

In the first week of November, the escorts and most of the hired men were given their final payments and made their way back to their homes. Placing the permanent boundary stones along the West Line was all that remained to do. The boundary stones had been delivered and were located near Milepost 134. Mason and Dixon had received a quote to have the stones distributed along the line from Milepost 134 to Milepost 199, however finding the quote of 12 pounds to be much too high, they declined to accept the stones. Instead of placing the boundary stones, the surveyors erected cairns of stone on the ridgetops along the West line.

Battling the onset of winter as they made their trek back east, the surveyors encountered Robert Farlow at Town Hill. Farlow had been an instrument bearer on their crew for the past three years and had earlier been sent east to place the boundary stones on the east portion of the line. Farlow offered the good news that the boundary stones had been set from Milepost 135 going east to the Post Marked West, with the exceptions of Milepost 77 and Milepost 117 which had been placed at offsets due to topographical conditions.

On December 12, Mason and Dixon sent a message to notify the commissioners that they expected to arrive back in Philadelphia on December 15.

The commissioners requested two final tasks of Mason and Dixon. First, they asked that Dixon draft a map of the boundary as surveyed. Secondly, the commission asked that the length of a degree of longitude along the latitude of the West Line be calculated. The men returned to the Harlan house to undertake these final chores.

Mason and Dixon arrived at a length of 53.5549 miles per degree of longitude along the West Line, however this solution was paired with a disclaimer stating in brief:

“But the Earth is not known to be exactly a spheroid... We do not give in this as accurate.”

Dixon submitted his completed map on January 29. With their work for the colonial proprietors concluded, the men decided to stay in the colonies long enough to finish their computation of the length of a degree of latitude for the benefit of the Royal Society.

Eschewing the Gunter’s chain for a set of brass-tipped wooden rods, the surveyors meticulously measured their way south from the Stargazer’s Stone to the Middle Point, a project which ran from February 23 to June 4. Their finding that a distance subtended by a degree of latitude in their location was 0.69 miles longer than a degree of latitude in England was an important contribution in the scientific understanding of the shape of the Earth; specifically the understanding that the Earth is not a perfect sphere but rather an oblate spheroid.

With all their work in the colonies completed, Mason and Dixon informed the commissioners of their intention to return home to England. The commissioners requested that the men remain until Dixon’s map could be engraved and printed. Robert Kennedy of Philadelphia printed the engraving and furnished the surveyors with 200 copies on August 16.

The next three weeks were spent settling accounts, tending to outstanding matters, and meeting with the commissioners for a final time before heading to New York.

On September 11, 1768 Charles Mason and Jeremiah Dixon set sail for England aboard the *Halifax Packet*, bringing to a close, after nearly 5 years, a remarkably complex and incomparably important set of land surveys, the ramifications of which would be unknown to the responsible surveyors within the spans of their lifetimes.

SECTION 3: LASTING EFFECTS OF THE SURVEY

The Delaware Wedge

The Delaware Wedge is a 684-acre tract of land lying along the state borders of Maryland, Pennsylvania, and Delaware. The creation of the tract may be attributed to the limitations of the surveying methods at the time when the state boundaries were established. The Delaware Wedge is bounded on the north by the extended east-west portion of Mason and

Dixon's line (The West Line), on the west by the north-south portion of Mason and Dixon's line (The North Line), and on the southeast by the Twelve Mile Circle around New Castle.

The Delaware Wedge came into existence because Mason and Dixon's North line from the Tangent Point of the Twelve Mile Circle left a small residual tract between the North line and the Twelve Mile Circle. At the time of the discovery of this wedge, the Penn family held claim to both Pennsylvania and Delaware, so there was no immediate need to resolve the issue. However, when Pennsylvania and Delaware separated into two different states, a dispute arose.

Pennsylvania officials claimed that the Wedge was outside of the Twelve Mile Circle so it could not be a part of Delaware, and it was east of the Mason-Dixon Line and could therefore not be a part of Maryland.

Delaware held the position that Pennsylvania was not to extend to any lands south of the northern border of Maryland. They further asserted that the North Line represented the logical extension of the Tangent Line and should form the border between Maryland and Delaware, regardless of the fact that the Wedge was situated entirely outside of the Twelve Mile Circle.

In 1849, Lt. Col. J.D. Graham of the United States Army Corps of Topographical Engineers surveyed the northeast corner of Maryland and the Twelve Mile Circle. This survey reignited interest in the dispute and prompted Pennsylvania to claim the Wedge as its own, a claim which was not honored by Delaware officials.

In 1892, W.C. Hodgkins of the Office of the United States Coast and Geodetic Survey placed monuments upon the east extension of the Pennsylvania-Maryland border, marking what became known as the "Top of the Wedge Line". Finally, in 1921, officials from Pennsylvania and Delaware settled upon the location of the boundary and agreed that the Delaware Wedge would be part of the State of Delaware.

Today, the small community of Mechanicsville, Delaware is located within the Delaware Wedge.

Cultural Implications

Mason and Dixon's survey was a tremendous technical achievement. They accomplished the complicated task of placing abstract lines upon the ground - lines which would become the permanent borders between colonies (and later, states). What they almost certainly did not realize at the time were the profound cultural and political effects that the newly surveyed boundaries would have on the development of a fledgling nation.

In the second half of the eighteenth century, the issue of slavery had become severely divisive within the colonies. Generally speaking, slavery was practiced in the southern colonies and not practiced in the northern colonies. In 1780, the newly formed State of Pennsylvania abolished slavery by way of gradual emancipation, which placed the state in union with the State of Massachusetts which had abolished slavery earlier in the year. By this time, other northern states had either abolished slavery or were working toward abolition. All of the abolitionist states were located north of the Mason-Dixon Line.

South of the Mason-Dixon Line were a tier of states that did not accept the abolitionist attitudes prevalent in the north. In these southern states, the agricultural economy was dependent on a large labor force and as such, the exploitation of slave labor was deemed not only a necessity but a fundamental aspect of southern culture.

Because of this ideological rift between the states, the Mason-Dixon Line came to be recognized as the practical boundary between the abolitionist North and the slaveholding South.

The newly created United States of America had declared its independence from England in 1776 and had finally secured its independence in 1783 after several years of war. However, the nation's domestic problems regarding slavery carried over from the colonial period. As the new nation began to develop, the leaders of the young republic were faced with defining questions: Would the United States be a free nation or a slave nation?

Slavery was permitted on a state-by-state basis, with the southern states permitting slavery and the northern states barring it, with the Mason-Dixon Line cited as the dividing line. As the nation began to grow physically, owing to the large tracts of land acquired from England expanding westward to the Mississippi River, organization of the new territories became necessary. In the division of these newly acquired territories, the federal government sought to maintain political balance between the advocates of freedom and slavery, taking care not to give one side or the other a legislative advantage.

In 1787 the Confederation Congress (which was the predecessor to the Congress which was established by the United States Constitution) crafted the Northwest Ordinance, organizing the lands that now comprise the states of Ohio, Indiana, Illinois, Minnesota, Wisconsin, and Michigan. The ordinance provided for territorial administrations which could petition the federal government for statehood once their territory reached a population of 60,000 residents. Of crucial importance was the Northwest Ordinance's prohibition of slavery throughout the territories. This ensured that the several future states which were certain to arise would be free states. The Ohio River was selected as the natural southern boundary of the territory and as a compromise to the southern states, all lands south of the Ohio River were not subject to the prohibition of slavery.

This decision had the effect of identifying a second symbolic dividing line between free territory and slave territory, effectively extending the concept first associated with the Mason-Dixon Line all the way to the Mississippi River. Both Mason and Dixon were deceased by this time but could have scarcely imagined that the ideals attributed to their remarkable technical achievement would come to represent the great line of demarcation across a nation and an ideological watershed by which a nation was nearly split asunder.

In the ensuing decades, the United States experienced rapid growth which led to the admission of new states. At the federal level, compromise between northern and southern interests was critical, as each side relied upon the other economically and it worked best for the North and South to coexist while downplaying the divisive issue of slavery. To ensure the balance of influence and representation in Washington D.C., it was necessary to maintain an

equal number of free states and slave states. For this reason, new states were admitted into the Union in pairs, one free state and one slave state.

A political crisis arose in 1820 when Missouri reached the population threshold to qualify for statehood. Missouri had been mostly settled by slaveholders who had brought slaves with them into the territory. This fact paired with the physical location of the would-be state made it logical that Missouri would enter the Union as a slave state. However, its admission would upset the balance of free states and slave states.

With a political showdown looming and congress at an impasse that threatened to tear the new nation apart, Speaker of the House Henry Clay of Kentucky remarked that “the words civil war and disunion are uttered almost without emotion.” Clay, working with other congressmen, developed a compromise based on the concept that had by this time been attached to the Mason-Dixon line, namely, a clear line of demarcation dividing the north from the south. In cooperation with other members of the House and Senate, Clay drafted a plan which would become the Missouri Compromise. In this compromise, Missouri would be admitted to the Union as a slave state while Maine would be simultaneously admitted to the Union as a free state, thereby maintaining the political balance.

At the heart of the Missouri Compromise was the establishment of a transcontinental line of demarcation between North and South. The line was to begin at the western terminus of the Mason-Dixon Line, follow the Ohio River southwest to a point on the Mississippi River at a latitude of 36 degrees 30 seconds, then West to the west edge of the Louisiana Territory (extending theoretically West to the Pacific coastline). With the exception of the State of Missouri which had been admitted to the union in 1821, any newly admitted state lying north of this line would be admitted as a free state and any newly admitted state lying south of this line would be admitted as a slave state. The lasting effect of the Missouri Compromise Line is evident by an examination of the American states, as the line forms the border between Missouri and Arkansas, and the border between north Texas and the panhandle of Oklahoma. While geographically quite distant from the actual Mason-Dixon Line, the Missouri Compromise Line stands as the ideological extension of a concept attached to the Mason-Dixon Line.

In 1846, the United States went to war with Mexico in an effort to gain control of the western portion of North America, including California and its natural harbor, San Francisco. The United States government was motivated by the concept of “Manifest Destiny,” that is to say, a belief that the United States possessed a right to take control of the continent all the way to the Pacific Ocean. Manifest Destiny was pursued with the presumption that any lands acquired would be settled according to the conditions of the Missouri Compromise and the latitudinal line defined therein.

The United States defeated Mexico and took control of California in 1848. Shortly thereafter, gold was discovered in the foothills of the Sierra Nevada mountains. The famous gold rush ensued and within a year, California’s population had grown sufficiently to permit a petition for statehood. California possessed a wealth of gold, the finest port on the Pacific coast, and vast expanses of arable land in its inland valley. With its remarkable resources, it was

apparent that the new state of California was going to be an economic powerhouse, so the question of whether California would be admitted as a free state or a slave state was a question of national importance. Dividing California into two states, north and south, was not practical as the bulk of the economic resources (San Francisco and the gold mines) were located in the northern half and a split would have been deemed unfair to the South. A stalemate was the result.

Henry Clay proposed a new compromise in 1850 which allowed for the admission of California as a free state and granted the South the passage of the Fugitive Slave Law, which permitted slave owners to reclaim their escaped slaves who had fled to free states. Further, the law gave slave owners and their agents the authority to compel local officials to cooperate in the returning of escaped slaves. This compromise came to be known as the Compromise of 1850.

The result of the Compromise of 1850 was a heightening of tensions between the North and the South, as anti-slavery northerners were forced to allow slaveholders to enter free states to recover their escaped slaves, and worse, some anti-slavery northerners were forced to assist the slaveholders in the process. Against their will, many northerners who considered slavery to be a moral abomination became unwilling accomplices to its continuation. In the South, the admission of California as a free state was seen as an unfair attempt to unbalance the nation's economy to the advantage of the North. Southerners also worried that, by the prevention of the expansion of slavery in the West, the North would gain momentum toward nationwide abolition.

On the other side of the country, the tension turned to violence and once again the Mason-Dixon Line was involved. On September 11, 1851 in Christiana, Pennsylvania, a Maryland slave owner, invoking the Fugitive Slave Law, crossed the Mason-Dixon Line into Pennsylvania to recover a group of slaves who had escaped. Christiana's free black population and the white residents of the town joined together to defend the fugitives. Armed men on both sides commenced fighting and the Maryland slave owner was killed. The remaining Marylanders retreated. In the North, the battle was hailed as a victory for liberty, while in the South it was condemned as an act of aggression contrary to federal law. Some historians consider this skirmish to represent the first spark that eventually drew the nation into civil war, and the battle lines had unwittingly been drawn decades before by two long gone English gentlemen, Charles Mason and Jeremiah Dixon.

The Mason-Dixon Line and the Civil War

Throughout the 1850s, the lines drawn across the nation in a spirit of compromise and balance had become largely obsolete owing to the concept of popular sovereignty, by which the voters of a state could determine their own status as a slave state or free state. This concept underscored the idea that had become self-evident: the North and the South had grown into two separate and hostile nations and that a tangible border between them was effective and necessary. Without a real barrier between the two nations, incursions and conflicts were inevitable.

In November of 1860, the anti-slavery presidential candidate from Illinois, Abraham Lincoln, was elected and in December of the same year, South Carolina seceded from the United States, proclaiming itself an independent state. The states of Mississippi, Florida, Louisiana, Alabama, and Georgia, in agreement with South Carolina's stated goal of preserving slavery, seceded from the Union in January of 1861, with Texas seceding in February. Officials from the seceding states convened in Montgomery, Alabama in February of 1861 and formed the Confederate States of America.

Slave states situated along the Mason-Dixon Line and the Missouri Compromise Line (Kentucky, Delaware, Maryland, West Virginia, and Missouri) that did not secede became known as "border states."

In the pre-dawn hours of April 12, 1861, a cannon was fired from the shore of Charleston Harbor, striking Fort Sumter, a United States Army fort located on an offshore island. This attack by South Carolina against a federal garrison signified the opening moment of the deadliest war in American history. With war now beginning, the uncommitted southern states of Tennessee, Arkansas, Virginia, and North Carolina joined the Confederacy.

The Mason-Dixon line quickly became a strategic point in the war. Maryland was a border state but had allegiance to the South. It was therefore critical to the North that Maryland did not fall into the control of the South, as it would place Philadelphia in severe jeopardy of being taken. Ironically, the Mason-Dixon Line represented the division between the North and the South, but in the time of war it was strategically crucial that the Mason-Dixon Line did not become the southern border of the Union. To keep the Confederates out of Maryland was to keep them at an arms-length from Pennsylvania.

From the Confederate point of view, the Mason-Dixon Line was viewed as a goal line to be crossed. To cross the line and attack into Pennsylvania would be considered a major blow to the Union cause and a demonstration of the strength of the Confederate forces. However, any incursion into the north would be fraught with risks. President Davis was well aware his army's vulnerabilities, having fewer men and less equipment, as well as the fact the Confederacy was lacking a naval force which made them susceptible to blockade of the coastline by the Union Navy. Davis employed a defensive strategy until a favorable opportunity to invade the North presented itself.

In the summer of 1864, General Robert E. Lee had captured some momentum, having recently turned back a major Union offensive on Richmond. General Lee approached President Davis with his idea to invade Maryland, which he thought would pose a direct threat to Washington D.C., thereby diverting the Lincoln administration's attention and resources toward the protection of the city. In a letter to President Davis, General Lee wrote that a victory in Pennsylvania would enable the people of the United States to determine whether they support politicians who favor continuing the war or those who wish to bring it to a termination. President Lincoln, perceiving the imminent threat, ordered his generals to destroy the Confederate army before it got near Pennsylvania.

General Lee led his army into Maryland heading toward the Mason-Dixon Line, positioning himself as a liberator of the people of the state. In a famous address to the people of Maryland, Lee stated that he intended to *“right the wrongs that have been inflicted upon the citizens of a commonwealth allied to the States of the South by the strongest social, political, and commercial ties.”*

Eventually, in September 1862, the Union and Confederate armies clashed in Maryland at Antietam Creek, the location of which Mason and Dixon had recorded a century prior. General George McClellan and his Army of the Potomac battled Lee’s army to a standstill in what still remains as the bloodiest one-day battle in American military history with approximately 23,000 casualties. There was no decisive outcome to the Battle of Antietam, but the North did claim victory since Lee’s army left Maryland and fell back to Virginia.

Even in defeat, Lee remained focused upon the strategic value of crossing the Mason-Dixon Line. Likewise, the Union strategy was fixed on defending Pennsylvania and keeping Maryland attached to the Union. From the Union’s perspective, the Mason-Dixon line had to be held as the dividing line between the North and South. Any advance by the rebels past the line would have the effect of conferring legitimacy to the Confederacy as a nation of its own.

By the summer of 1863, Lee had earned victories at Fredericksburg and Chancellorsville. In an attempt to capitalize on this success, Lee marched the Army of Northern Virginia again into Maryland and then crossed over into Pennsylvania with the plan of executing raids and causing disruption of Union communication and supply lines. General Lee’s ultimate plan was to achieve decisive victory in a major battle, which would demonstrate to the people of the North that the Confederacy was a legitimate nation that could not be oppressed by the United States. Lee’s plan came to a head just a few miles north of the Mason-Dixon Line, near the small community of Gettysburg, Pennsylvania, which interestingly did not yet exist at the time of the Mason-Dixon survey but now is known to Americans as the site of a pivotal point in the history of our nation.

The Battle of Gettysburg began when men from Lee’s army and the Army of the Potomac, now led by General George Meade, encountered one another unexpectedly. What began as a skirmish broke out into three days of intense fighting. The rebel army had the upper hand in the early going, forcing Meade into a defensive tactic which had good effect. On the third day of fighting and frustrated by Meade’s defensive strategy, Lee ordered an attack at the center of the Union line, which proved to be futile. Next, Lee commanded General George Pickett to lead an uphill charge at Cemetery Ridge, directly into the face of heavy Union cannon and musket fire. At the end of this fateful day, two-thirds of Pickett’s men lay dead on the battlefield and the Union army had gained control of Gettysburg. Lee and what was left of his army crossed the Mason-Dixon line for the final time and fell back to Virginia, having lost nearly 30,000 men.

While Lee’s army was in retreat, the unwelcome news arrived that Vicksburg, which had long been under siege by Union forces, had fallen, thereby cutting the Confederacy into two parts, and ensuring certain victory to the Union.

Mason and Dixon could have scarcely imagined what their survey line would come to represent and the effect it would have on a young United States.

Abraham Lincoln's brief but exquisite Gettysburg Address given in dedication of the battlefield cemetery follows:

Four score and seven years ago our fathers brought forth on this continent, a new nation, conceived in Liberty, and dedicated to the proposition that all men are created equal.

Now we are engaged in a great civil war, testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great battle-field of that war. We have come to dedicate a portion of that field, as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this.

But, in a larger sense, we can not dedicate—we can not consecrate—we can not hallow—this ground. The brave men, living and dead, who struggled here, have consecrated it, far above our poor power to add or detract. The world will little note, nor long remember what we say here, but it can never forget what they did here. It is for us the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us—that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain—that this nation, under God, shall have a new birth of freedom—and that government of the people, by the people, for the people, shall not perish from the earth.

—Abraham Lincoln

In the time since the end of the Civil War, the Mason-Dixon line has retained its cultural and political significance as the dividing line between the northern and southern United States, two distinct cultures within the same nation.

SECTION 4: MONUMENTS OF THE SURVEY

Overview

The original milestone monuments created for use on Mason and Dixon's survey were made of oolitic limestone, quarried at Isle of Portland in England. The stone monuments were 4.5 feet long and 12 inches square with pyramidal tops and with all four sides featuring vertical fluting. Each of the nearly 400-pound monuments were prepared with an ornate capital letter "P" carved into one face to represent the Pennsylvania side and a similarly styled capital letter "M" carved into the opposite face to represent the Maryland side.

The Star Gazer's Stone

The Star Gazer's Stone is located near Embreeville, Pennsylvania and Marks the location of the temporary observatory created by Charles Mason and Jeremiah Dixon in January 1764. From this location, Mason and Dixon took critical early celestial observations with which to begin their survey work. The stone was set about 700 feet to the north of the Harlan House, which served as a home base for Mason and Dixon throughout their survey lasting over four years.

The stone's placement was approximately 31 miles west of what had previously been determined to be the southernmost point of Philadelphia. From the observatory at this site, Mason and Dixon were able to compute their latitude precisely. With the knowledge of this latitude, they computed the necessary distance to survey southward in order to arrive at the parallel of latitude situated 15 miles south of the southernmost point of Philadelphia, at which latitude would be established the east-west border line dividing Maryland and Pennsylvania.

The Star Gazer's Stone is found at a latitude of 39 degrees 56 minutes 21 seconds North and a longitude of 75 degrees 43 minutes 57 seconds West.

The Harlan House and the Star Gazer's Stone were listed on the National Register of Historic Places on May 9, 1985.

The Post Mark'd West

The Post Mark'd West was set by Mason and Dixon on June 12, 1764 and marked the initial point of their survey. It was placed on the land of Alexander Bryan which today is located within White Clay Creek State Park in New Castle County, Delaware.

According to Mason's notes, "*...the point 15 miles south of the southernmost point of the City of Philadelphia is situated in Mill Creek Hundred in the County of Newcastle, in a plantation belonging to Mr. Alexander Bryan.*"

By Dixon's computations, the correct distance from their commencing point at Harlan's farm to the southern terminus of the line was calculated to be 15 miles, 2 chains, and 93 links.

The original monument set by Mason and Dixon was a post with the word "WEST" carved into the west-facing side of the post.

In 1952, S. Hallock du Pont donated a modern monument which presently marks the spot of the Post Mark'd West.

The Terminal Point

The Mason and Dixon Survey Terminal Point is a marker situated near the community of Pentress, West Virginia. It lies on the border between Greene County, Pennsylvania and Monongalia County, West Virginia. It marks the westernmost point of Mason and Dixon's survey reached on October 19, 1767 at Brown's Hill.

This monument is found at a latitude of 39 degrees 43 minutes 16 seconds North and a longitude of 80 degrees 07 minutes 07 seconds West and was listed on the National Register of Historic Places in 1973.

The Middle Point

The decree handed down by the Court of Chancery, Lord Chancellor Phillip Yorke, First Earl of Hardwicke had stated that the southern border of Delaware was to be a line across the Delmarva Peninsula, beginning at Fenwick Island and terminating at Taylor's Island. Furthermore, the west line of Delaware was to be a line running from the midpoint of this transpeninsular line to the point of tangency with the twelve-mile circle around New Castle.

The midpoint of the Transpeninsular Line had been marked with an oak post in 1760 by colonial surveyors prior to Mason and Dixon's arrival to the region.

Four stone monuments are found at the side of the Middle Point. The first monument set in 1760 is made of stone and has the coats-of-arms of both the Calverts and the Penns carved into it. Strangely, this monument was set 32 inches away from the calculated midpoint after the sons of William Penn and Lord Baltimore agreed that the corner would be "69 miles, 289 perches" west of the stone at Fenwick Island Marking the East end of the Transpeninsular Line.

In 1768, Mason and Dixon placed a "Double Crown" stone at the midpoint according to their measurements. This stone bears the Penn coat-of-arms on the north and east sides, and the Calvert coat-of-arms on the south and west sides.

Another marker on the site is the stone that had previously marked Mile #25 on the Transpeninsular Line. It was moved to this location due to being displaced by a road construction project.

There is a fourth stone monument at the site, the origin and purpose of which remains a mystery. A common belief is that it was placed there by a nearby landowner who found the stone and thought it looked like a mile marker stone and placed it next to the other stones.

Today, the stone monuments at the Middle Point are found under a pavilion that was erected on a parcel of donated land in 1961.

The Tangent Stone

The Tangent Stone is located at the intersection of the Tangent Line and Arc Line segments of the border dividing Maryland and Delaware. Mason and Dixon set a granitic gneiss stone at this position in June of 1765 and it was later replaced with a 12-inch by 18-inch granite stone marker set by Lt. Col. J.D. Graham of the United States Corps of Topographical Engineers (USCTE) in 1849. The monument has an "M" carved into the Maryland side and a "D" carved into the Delaware side.

Mason and Dixon had established this position in August of 1764 and confirmed the position in November of the same year.

The Tangent Stone is situated at a latitude of 39 degrees 23 minutes 22 seconds North and a longitude of 47 degrees 28 minutes 24 seconds West.

The Tri-State Point

The Delaware-Maryland-Pennsylvania Tri-State Point is the common point of the northwest corner of Delaware, the northeast corner of Maryland, and the south border of Pennsylvania. Mason and Dixon marked this point with a wood post in 1765, which was replaced by a stone monument in 1849. This monument disappeared and was finally reset by W.C. Hodgkins of the United States Corps of Topographical Engineers (USCTE) in 1892.

This stone is marked with “M” and “P” denoting the initial of the colony on each side. At the time of Mason and Dixon’s survey, Delaware was not yet a separate entity and therefore was not noted on the monument.

The Tri-State Point is found at 39 degrees 43 minutes 20 seconds North latitude and 75 degrees 47 minutes 19 seconds West longitude.

The Fenwick Island Monument

On Fenwick Island at the eastern end of the Transpeninsular Line lies a stone monument bearing on its north face the coat-of-arms of the Penn family and on its south face the coat-of-arms of the Calvert family. The position of this border point was accepted in 1760 and was ratified by King George III in 1769.

This stone marker stands just south of the well-known Fenwick Island Lighthouse. While not actually part of the Mason-Dixon survey, this marker still represents a point of interest and importance relative to the borders which they were employed to survey.

SECTION 5: Methods and Techniques

Astronomy and Surveying

In all the generations in which surveyors have made measurements upon the earth, excepting of course the present generation, the celestial bodies have been used to compute position and direction. Specialized knowledge, painstaking observation, and advanced mathematical skills were all necessary for the surveyors of the past to determine direction and to ascertain positions in terms of latitude and longitude. While modern technology, particularly advent of satellite-based navigation systems, has largely rendered skill in astronomical observation unnecessary to today’s surveyor, it is still worthwhile to at least make a cursory review of the terms and procedures relating to the subject of astronomy as it relates to the surveying field.

As we look to the night sky, millions of stars are visible to us. It is not possible with the naked eye to determine the varying distances that each star is from the earth. While two stars may appear in proximity in the sky, in reality they are likely light years distant from one another. For the sake of celestial observation, it is necessary to consider the stars as they appear on an

imaginary spherical sky. This imaginary sphere upon which the stars appear to lie is referred to as the celestial sphere. The center of the earth is considered to be the center of the celestial sphere.

The point on the celestial sphere created by imagining a plumb line directly above the observer is known as the zenith. Likewise, the point on the celestial sphere created by imagining a plumb line directly below the observer is called the nadir. The zenith-nadir line is defined by two points: the center of the earth and the position of the observer.

The celestial horizon (also called the true horizon, the rational horizon, or the geocentric horizon) is defined by the great circle traced upon the celestial sphere by a plane which is perpendicular to the zenith-nadir line, which by definition passes through the center of the earth.

The two points at which the earth's rotational axis intersects the celestial sphere are called the celestial poles. The celestial equator is the great circle of the celestial sphere, the plane of which is perpendicular to the earth's rotational axis. The two celestial poles are considered equidistant from the celestial equator.

The sensible horizon is defined by a circle on the celestial sphere, the plane of which is tangential to the earth at the point of observation and the orientation of which is perpendicular to the earth's axis of rotation.

A vertical circle of the celestial sphere is a great circle passing through both the zenith and the nadir. By definition, it crosses the sensible horizon at right angles. The meridian, or the observer's meridian, of any point is established by the circle passing through the zenith and nadir of the point as well as through both of the terrestrial poles. The prime vertical is the vertical circle which lies at right angles to the meridian and passes through the east and west points of the celestial horizon.

Latitude is defined as the angular distance of any position on the surface of the earth relative to the equator and is measured on the meridian. A position of latitude is noted in terms of degrees and is further identified as being north or south of the equator. Latitude is also defined as the angle between the zenith and the celestial equator. The seldom used co-latitude of a point is defined as the angle between the zenith and the pole and is by definition the angular complement of the latitude.

Longitude is defined by the angle between a point and the Prime Meridian in Greenwich, England. The Prime Meridian was established arbitrarily but has been adopted universally. The longitude of a point is expressed in terms of degrees (0-180) east or west of the Prime Meridian.

The altitude of a celestial body is expressed as the angle between its position and the horizon, as measured on a vertical circle passing through the body. The co-altitude of a body is the angle between the zenith and the body and is by definition the angular complement of the altitude. A related term, the azimuth of a body is defined by the angle between the observer's meridian and a vertical circle passing through the body.

The declination of a star is the angle from the equatorial plane, measured along the star's meridian. Declination values range from 0 to 90 degrees and are noted "+" for bodies north of the celestial equator and "-" for bodies south of the celestial equator. Polar distance is the angle between the celestial body, and the nearest celestial pole and is by definition the angular complement of the declination angle.

The hour circles are the great circles passing through both celestial poles. The hour angle of a celestial body is the angle between the observer's meridian and the declination circle which passes through the body. By convention, the hour angle is always measured westward.

The angular measurement of a point as measured eastward along the celestial equator from the Sun at the March equinox to the hour circle of the point above the earth is known as the right ascension.

Establishing Azimuth by Astronomical Observation

Prior to the advent of GPS, surveyors of ordinary parcels based their bearings upon section monuments, adjoining boundary lines, magnetic north, astronomical observations, a local basis, or an assumed basis. With GPS now readily available, it has become common to use public coordinate systems as a basis of bearing.

There are many ways to define "North" and the professional land surveyor is tasked with selecting the best method for the job at hand.

Magnetic North is defined by the forces of the earth's magnetic field. The locations of the north and south magnetic poles are constantly shifting and therefore the direction of Magnetic North shifts likewise. The compass user must be constantly mindful of the magnetic declination in his or her area as it may affect the needle by several degrees. The reliability of compass readings may be affected by mineral deposits and electromagnetic interference. Ease of use makes magnetic navigation useful in cases where accuracy and repeatability are not of first importance, but for the purposes land surveying magnetic directions are not especially useful.

Assumed North is based upon monumented positions between which a line is constructed and defined as "North" with an azimuth of 0 degrees. This method is convenient for independent surveys, however the monuments defining the bearing may be lost, thereby complicating the work of the future surveyor.

Geodetic North or Geographic North is defined by the average location of the earth's rotational axis. The earth's axis is not perfectly fixed and traces a narrow cone both above and below the equator. While Geodetic North is a precise direction, it is not able to be directly measured and is therefore impractical for use by the surveyor, except in the sense that many reference monuments are tied into the Geodetic basis.

Grid North is based upon any one of many map projection systems and like Geodetic North is not able to be measured directly.

Astronomical North or Celestial North will be the subject of the remainder of this Section. It is based upon the projection of the earth's axis onto the celestial sphere. A true North

meridian can be established in the field with conventional equipment, with minor corrections made based on the location of the observer. For the purpose of large surveys, like the Mason-Dixon survey, the use of Astronomical North is the logical method with which to determine direction, as it can be determined from any location where the star Polaris is visible. Also, it is a permanent and consistent system which allows the retracing surveyor to “follow in the footsteps of the original surveyor.” Long after the artificial monuments of a survey are lost to history, their original positions will remain in the same relationships to the celestial bodies as they were on the day they were placed.

The people of ancient civilizations had clever geometric methods by which to determine direction that required no modern technical equipment and no advanced knowledge of mathematics.

One method, known by historians as the “Shadow Method,” involves setting a vertical rod into an area of flat ground. Throughout the day at timed intervals, the position of the endpoint of the rod’s shadow would be marked on the ground. After marking the procession of the shadow for the day, a rope would be pulled from the center of the rod to the arc of the shadow and used to trace an arc intersecting the shadow’s path in two places. A chord would be constructed between the two points of intersection and a line would be drawn from the rod to the midpoint of the chord, thus defining the astronomical meridian. When done with extreme care, this method is considered to be accurate to within about a half of a degree of angle.

Another more complex method is known as the “Equal Altitude Method,” in which the vertical angle to the sun is measured in mid-morning and then the position of the sun in the mid-afternoon is observed when it is at the same altitude. The bisecting line of the horizontal angle created by these points of equal altitude represents the astronomical meridian through the observer’s location. Like the Shadow Method, the Equal Altitude Method, when painstakingly exercised, may yield an accuracy of about a half of a degree of angle.

Due to the rotation of the earth, the stars at night appear to rotate counterclockwise about the North Pole. This apparent motion of the stars causes their horizontal angle relative to the meridian to change throughout the night. Some definitions are necessary to aid in the explanation of the astronomical determination of azimuth.

Upper Culmination is the highest point of a star on its circle of rotation.

Lower Culmination is the lowest point on a star on its circle of rotation.

Eastern Elongation is the easternmost point of a star on its circle of rotation.

Western Elongation is the westernmost point of a star on its circle of rotation.

Polaris (the North Star) is the most common star used for celestial observation in the northern hemisphere. Polaris is easily located in the night sky and its path traces the smallest

circle about the celestial pole of all the visible stars. A star map or a planisphere may be useful for locating stars. Other stars besides Polaris may be used, as was the case for Mason and Dixon who selected nearby Delta Ursae Minoris in the Ursa Minor constellation, because of its larger arc about the pole.

Simply explained, a determination of the meridian line can be achieved by sighting Polaris (or another nearby star) with an angle-reading instrument and making frequent observations of its circular path throughout the night and recording the reading of the horizontal and vertical circle at each time interval. Depending on the season of the year and the latitude of the observer, the period of nocturnal darkness varies dramatically. With the multiple observations, it is possible to then construct the arc traced by the star in the night sky and to determine the eastern elongation and the western elongation thereof. The horizontal circle reading at each elongation is used to determine the horizontal angle between the elongations and the bisecting line beginning at the observation station represents the meridian line, which may be marked on the ground and used as a reference bearing.

As meridian lines converge toward the poles and diverge toward the equator, a meridian line established at a particular observation station becomes inaccurate as the observer sets up either east or west from the original station. On ordinary surveys, this variance would be small to the point of insignificance but on large scale surveys, such as the survey of the West Line, frequent recalibration was necessary.

A working knowledge of basic astronomy was necessary for the surveyors of the past but as with many other things, technology has relegated surveying astronomy to little more than a matter of historical curiosity with little or no practical use. Still, as modern retracement surveyors must review and understand the surveys of old, it is important to at least understand how the surveyors of the past conducted their work.

SECTION 6 – Resurveys of the Mason-Dixon Line

In the lengthy span of time since Mason and Dixon's original survey, many resurveys of portions of the line have been conducted for a variety of purposes. Following is a brief overview of some of the important resurveys.

Lieutenant Colonel James D. Graham of the United State Army Corps of Topographical Engineers conducted a survey from the Tangent Point to the North Line to the northeast corner of the State of Maryland. This survey was conducted in the years 1849 and 1850 and brought renewed attention to the dispute over the Delaware Wedge, culminating with the State of Pennsylvania claiming the Wedge as its own. The Wedge would not officially become part of Delaware until 1921.

In the year 1885, United States Coast and Geodetic Survey surveyor C.H. Sinclair and his assistant C.H. Van Orden set out to resurvey the western extension of the Mason-Dixon line, with the instruction to rerun the line as previously established and to replace any monuments

found to be missing. This survey ran from the southwest corner of Pennsylvania to the northwest corner of Maryland.

From 1900 to 1903, an ambitious resurvey of Maryland's northern border with Pennsylvania was led by W.C. Hodgkins of the Office of the United States Coast and Geodetic Survey. This survey was not intended as a correction or relocation of the Mason-Dixon Line, but rather was for the purposes replacing missing monuments, repairing broken monuments, and improving the stability of leaning and sinking monuments. Interestingly, the unused original stone monuments which had been left at Fort Frederick at the end of the original survey were used as replacement monuments for this resurvey. The scope of this resurvey also included the acquisition of topography and the preparation of a topographic map in the vicinity of the boundary line.

SECTION 7 – The Popular Legacy of the Mason-Dixon Line

A quarter of a millennium hence, the Mason-Dixon Line remains prominent in the collective American cultural consciousness. Following is a partial listing of references to the Mason-Dixon Line in American popular culture:

In the 2006 film *Rocky Balboa*, the antagonist is the fictional World Heavyweight Champion boxer, Mason “The Line” Dixon, played by Antonio Tarver. This was the sixth film in the successful *Rocky* franchise.

In 1978's cult-classic *Attack of the Killer Tomatoes*, Mason Dixon heads a federal task force attempting to resolve the titular crisis.

In Jeff Greenfield's novel, *People's Choice*, W. Dixon Mason is a preacher who has a hand in determining the next President of the United States when the president-elect dies after the election but before the formal vote of the Electoral College.

Mason & Dixon is a postmodernist novel by Thomas Pynchon presenting a highly fictionalized account of Mason and Dixon's exploits.

Johnny Cash's 1955 song, “Hey, Porter” contains the lyric, “*How much longer will it be until we cross that Mason-Dixon Line?*”

The 2000 song “Sailing to Philadelphia” by singer/songwriter/guitarist of Dire Straits fame, Mark Knopfler, tells the story of Mason and Dixon travelling to America to conduct their survey.

Singer and satirist Tom Lehrer mentioned the Mason-Dixon line in his song “*I Wanna Go Back to Dixie*”.

Country music's Lady Antebellum penned the lyric “*It's just south of the Mason-Dixon Line*” for their song, “*Home Is Where the Heart Is.*”

CHRONOLOGY OF EVENTS RELATING TO THE MASON-DIXON LINE SURVEY

Following is a chronological listing of the significant events of importance to the Mason-Dixon Line Survey. Italicized beneath each event are other major events that occurred in the same year to provide a historical context.

1632

Cecilius Calvert, known formally as Second Lord Baltimore, received a Royal Charter from King Charles I of England for what would become the colony of Maryland.

The Treaty of Saint-Germain-en-Laye was executed, restoring control of Quebec, which had been captured by the English in 1629, to the French.

Galileo Galilei published his famous work, Dialogue Concerning the Two Chief World Systems, which compared the heliocentric Copernican System to the traditional geocentric Ptolemaic System.

1681

William Penn received a Royal Charter from King Charles II of England for what would become the colony of Pennsylvania.

The last known dodo bird in the world was killed.

1728

Charles Mason was born in Gloucestershire, England.

Astronomer Royal James Bradley calculated the speed of light using stellar aberration.

The Copenhagen Fire of 1728 destroyed nearly a third of the Danish capital city.

1733

Jeremiah Dixon was born in Cockfield, County Durham, England.

The Battle of Kirkuk took place as part of the Ottoman-Persian War and marked a crushing victory for the Persians, inflicting 20,000 casualties upon the Ottoman army.

The Molasses Act was passed by the Parliament of Great Britain, which was unpopular with the American colonists.

1763

Mason and Dixon arrived in Philadelphia to begin their survey of the border separating the lands of the Penns and the Calverts

The Treaty of Paris was signed by Great Britain, France, and Spain, formally bringing a close to the Seven Years War, which was, and still is known as the French and Indian War in the American Theatre. As part of the treaty, France ceded Canada to Great Britain.

The Proclamation of 1763 was issued by King George III of England, prohibiting English settlement in North America west of the Appalachian Mountain range.

1765

Mason and Dixon, having finished their surveys of the twelve-mile arc around New Castle and the Tangent Line, resumed their work on the West Line of the border.

Great Britain passed the Duties in American Colonies Act of 1765, more commonly referred to as the "Stamp Act." This act required the purchase of a stamp to validate legal documents, newspapers, and playing cards. It was the first direct tax levied by the Crown on the American colonies and the revenue was used to defray the expenses of British military activity in North America, particularly the cost of the French and Indian War.

Great Britain caused further dissent in the Colonies with the passage of the Quartering Act, compelling private households to lodge British soldiers whenever necessary.

1768

Mason and Dixon presented their work to the officials of Maryland and Pennsylvania. Their line was accepted and became the recognized border between the two colonies.

The first modern circus was opened in London by Phillip Astley.

The first issue of the Encyclopedia Britannica was published in Edinburgh.

1779

Jeremiah Dixon died in County Durham, England.

The American Revolution was in full swing.

The world's first entirely iron bridge was constructed across the River Severn in Shropshire, England.

A joint Portuguese-Spanish survey of the Amazon basin was begun and would take 16 years to complete.

1786

Charles Mason died in Philadelphia, Pennsylvania.

Columbia College, now Columbia University, held its first commencement exercises with eight students graduating.

Mozart's famous opera, The Marriage of Figaro, premiered in Vienna.

The Confederation Congress established the United States Mint to produce a national currency and coinage to replace coins being produced by individual states.

Scottish poet Robert Burns' Address to a Haggis was published in Edinburgh.

1787

The Confederation Congress passed the Northwest Ordinance which prohibited slavery in the lands north of the Ohio River which had been acquired from Great Britain at the conclusion of the Revolutionary War.

The Constitution of the United States was signed in Philadelphia at the Pennsylvania Statehouse, now known as Independence Hall.

Astronomer William Herschel discovered two moons of Uranus: Titania and Oberon.

Delaware ratified the Constitution, becoming the first state of the new nation.

Pennsylvania and New Jersey followed shortly thereafter.

Captain William Bligh set sail from England for Tahiti aboard the HMS Bounty on an ill-fated voyage that would become the subject of a popular book and film.

1821

Missouri was admitted to the Union as a slave state. The agreement which came to be known as the Missouri Compromise prohibited slavery north of the line of 36 degrees 30 minutes north latitude, and thereby extended the concept of the Mason-Dixon line as a division between the North and the South through the Louisiana Territory.

Russian explorer Fabian Gottlieb Thaddeus van Bellingshousen led an expedition that discovered the continent of Antarctica.

French Emperor Napoleon Bonaparte died in exile on the Island of Saint Helena.

Under the leadership of Simon Bolivar, Venezuela won its independence from Spain.

1850

Senator Henry Clay proposed a plan by which California would be admitted to the Union as a free state, with the inclusion of the Fugitive Slave Law added as a compromise.

Nathaniel Hawthorne's classic novel, The Scarlet Letter, was published in Boston.

American Express was founded by Henry Wells and William Fargo.

Pope Pius IX ended his exile and returned to Rome.

Los Angeles and San Francisco were incorporated as cities in the State of California and Kansas City was incorporated as a city in the State of Missouri.

The Great Famine, also known as the Irish Potato Famine, subsided after five years of devastation.

1854

The Kansas-Nebraska Act introduced the concept of popular sovereignty and eliminated the line of 36 degrees 30 minutes north latitude as the effective line dividing free states and slave states.

English author Sir Arthur Conan Doyle first created his fictional detective Sherlock Holmes.

The Republican Party was founded in Wisconsin.

The United States Naval Academy in Annapolis, Maryland graduated its first class.

1858

The Dred Scott decision declared that Congress had no authority to prohibit slavery in any state and had the effect of nullifying the Missouri Compromise.

Felix Mendelssohn's Wedding March established its place as a popular wedding recessional after it is played at the wedding of Queen Victoria's daughter.

The first pencil with an attached eraser was patented in the United States by Hymen Lipman.

Abraham Lincoln accepted the Republican Party nomination for a seat in the United States Senate representing Illinois.

Charles Darwin presented his findings announcing a theory of evolution by means of natural selection in London.

The first aerial photograph was made from a moored hot air balloon in France.

Macy's department store opened in New York City.

1860

Upon the election of anti-slavery President Abraham Lincoln, South Carolina announced its intent to secede from the United States of America. Ten other southern states followed South Carolina in secession and the separated states formed the Confederate States of America.

The Pony Express made its first run from St. Joseph, Missouri to Sacramento, California.

Abraham Lincoln defeated Stephen A. Douglas to become the 16th President of the United States.

The first British Open was played at Prestwick Golf Club in Ayrshire, Scotland.

Charles Dickens published the first installment of Great Expectations.

1861

The Civil War began with the attack on Fort Sumter off the coast of South Carolina.

President-elect Abraham Lincoln avoided an assassination attempt in Baltimore.

Martin Doyle was executed in Great Britain in what would be the last execution carried out in that country.

The Pony Express made its final run.

1862

Confederate General Robert E. Lee invaded Maryland and suffered a costly defeat at the Battle of Antietam.

Julia Ward Howe's Battle Hymn of the Republic was published in the Atlantic Monthly.

Victor Hugo's novel Les Misérables was published.

The Homestead Act is signed into law by President Lincoln.

The Bureau of Internal Revenue, which would evolve into the Internal Revenue Service was established.

1863

General Lee crossed the Mason-Dixon Line into Pennsylvania and was defeated by Union forces at the pivotal Battle of Gettysburg. This battle turned the momentum of the war to the favor of the Union.

President Lincoln signed the Emancipation Proclamation, confirming the abolition of slavery in Confederate states to be an official goal of the war effort.

Ground was broken in Sacramento for the construction of the first Transcontinental Railroad in the United States.

The first fire extinguisher was patented by Alanson Crane of Virginia.

President Lincoln proclaimed a national Thanksgiving Day to be celebrated on the final Thursday in November.

Linoleum was patented in the United Kingdom.

1865

The Civil War ended as General Lee surrendered to Union General Ulysses S. Grant at Appomattox Courthouse in Virginia, thus closing what still remains the deadliest war in American history. On April 16, 1865, President Lincoln was assassinated by John Wilkes Booth.

The New York Stock Exchange opened its first permanent headquarters in Manhattan.

Scientist Gregor Mendel presented his groundbreaking paper, Experiments on Plant Hybridization, at the meeting of the Natural History Society in Moravia.

John Deere received a patent for his revolutionary plow design.

Electric equipment brand Nokia was founded in Tampere, Finland.