



#### FDM 9-80-1 Glossary

October 25, 2002

**Abutment.** That part of a bridge substructure (that directly receives thrust or pressure) which supports the end of the superstructure and retains the approach fill.

**Adjustment.** The determination and application of corrections to observations, for the purpose of reducing errors or removing internal inconsistencies in derived results.

**Accuracy.** The conformity of a measurement to the "true" value or to a standard.

**Accuracy ratio.** The error in a measurement divided by the overall value of the measurement, expressed as a fraction with a numerator of 1 and a denominator rounded to the closest 100 units; e.g., an error of 1 m in 3000 m would result in an accuracy ratio of 1:3000.

**Aerial cross section.** A profile of the ground taken perpendicular to a reference line as determined from vertical aerial photographs using a stereoplotting instrument.

**Aerial imagery.** The product or the process of acquiring imagery from an aircraft or spacecraft.

**Aerial mosaic.** An assemblage of two or more aerial photographs that overlap to form a single continuous image.

**Aerial photography.** (1) The art or process of taking photographs from an aircraft. (2) Photographs taken from an airplane using an aerial camera system or a hand-held medium-format camera.

**Alignment.** The location of the horizontal reference line of a survey or a facility. The location of points with reference to a straight line or to a system of straight lines.

**Analytical control.** Photo control produced by analytical aerotriangulation methods which result in substantial reduction of field survey time and costs.

**Annotate.** A marking placed on imagery or drawings for explanatory purposes.

**Automated survey.** The use of electronic surveying instruments or electronic data collectors to gather surveying data with a minimum of manual input, and with the ability to electronically transfer the data to a computer for further processing.

**Astronomic azimuth.** The angle measured to the right from the vertical plane through the celestial pole and the observer to the vertical plane through observer and the observed object.

**Automatic level.** A surveyor's level which has the line of sight automatically maintained in the horizontal plane once the instrument is coarsely leveled.

**Azimuth.** The horizontal angle to a line of sight, measured clockwise from a north meridian.

**Backsight.** (1) In leveling, a sight taken to a point of known elevation, thus permitting the surveyor to compute the elevation of the instrument. (2) In traverse work, a sight taken to a previously located point to establish a reference for angular measurement.

**Baseline.** A line of reference for surveying work.

**Bearing.** Direction of a line given by the acute angle from a meridian and accompanied by a cardinal compass direction.

**Bench mark** A fixed, solid reference point with a precisely determined, published elevation.

**Benchmark** Something that serves as a standard by which other things may be measured or judged.

**Blunder.** Incorrectly measured or recorded data by an observer or recorder resulting from carelessness or confusion. A mistake.

**Cadastral map.** A map showing the boundaries of subdivisions of land.

**Cadastral survey.** A survey relating to land boundaries and subdivisions of land.

**Calibration.** The act or process of determining certain specific measurements in a device by comparison with a standard, for use in correcting or compensating for errors. Determining the systematic errors in a measuring

device by comparing its measurements with the measurements of a device that is considered correct.

Cap. See survey cap.

Cartesian coordinates. A coordinate system in which locations of points in space are expressed by reference to three mutually perpendicular planes.

Central meridian. A reference meridian in the center of the zone covered by the plane coordinate grid.

Chi-square test. A statistical test on the standard error of unit weight.

Chord. A straight line joining any two points on an arc.

Circular curve. A curve with a constant radius.

Clinometer. A hand-held instrument that combines a vertical circle, a spirit level and a sighting device for coarse but rapid measurement of vertical angles.

Closed traverse. A survey traverse which starts and ends on known control stations.

Closure. Agreement between computed and known parts of a control network.

Combination factor. A factor used to convert ground distances to grid distances on a map or projection system. The product of the scale factor and either the elevation factor or sea level factor.

Compass. An instrument that indicates the direction of north and the directions of other points with respect to north.

Compass rule adjustment. A method of balancing a traverse survey. Corrections corresponding to the closing errors in latitude and departure are distributed according to the proportion: length of line to total length of traverse.

Compilation. Selection, assembly and graphic presentation of all relevant information required for the preparation of a map or chart.

Compound curve. Two or more circular arcs turning in the same direction having common tangent points and different radii.

Constraint. External limitations imposed upon the adjustable quantities (observations and coordinates) in a network adjustment.

Construction survey. Establishment of points and elevations for building of engineering projects.

Contour interval. Difference in elevation between two adjacent contour lines.

Contour line. A line on a map joining points of equal elevation.

Control point. A monumented point for which coordinates are known.

Control survey. A survey to establish reference points, elevations, or lines to be used as the starting point for subsequent surveys.

Conventional survey. As distinguished from GPS observations. A loose generic term embracing the use of theodolites, EDMs, chains, levels, etc.

Convergence. See mapping angle.

Convergence of meridians. The angular drawing together of geographic meridians in passing from the equator to the poles.

Conversion factor. A quantity by which the numerical value in one system of units must be multiplied to arrive at the numerical value in another system of units.

Coordinate conversion. A coordinate transformation when both coordinate systems are based on the same mathematical reference surface.

Coordinates of a point. The distances measured north and east of a reference point having zero coordinates.

Coordinate System. Any two or three-dimensional reference frame which can be used to locate objects in space.

Coordinate transformation. Changing the coordinate values of a point from one system to those of another system.

Coordinated Universal Time (UTC). Time counted from 0 hours at midnight at 0 degrees longitude (Greenwich). Central Standard Time (Wisconsin) is UTC minus 6 hours and Central Daylight Savings Time is

UTC minus 5 hours.

Corner. A point determined by the surveying process.

Cross section. A profile of the existing surface taken at right angles to a reference line.

Curvature correction. The correction applied to account for the divergence of the surface of the Earth from a horizontal plane.

Data collector. An electronic field book designed to store field data, both measured and descriptive which also may have the ability to communicate with electronic surveying instruments.

Datum. An assumed or fixed horizontal or vertical reference surface.

Deck. Floor of a bridge or structure.

Deflection angle. A horizontal angle measured from the prolongation of the preceding line to the following line. Deflection angles to the right are positive; those to the left are negative.

Degrees of freedom. The number of observations which are in excess of the number actually needed to calculate the unknowns.

Delta X, delta Y, delta Z. Coordinate differences expressed in the coordinate system for a pair of points.

Departure. The change in easterly displacement (Delta E) of a line.

Disk. See survey disk.

Differential Leveling. Determining the differences in elevation between points using a surveyor's level.

Eccentricity. Amount of deviation from center.

EDM. Electronic Distance Measurement.

EDMI. Electronic Distance Measuring Instrument.

Elevation. The vertical distance above or below a given datum.

Elevation factor. The factor used to convert ground horizontal distances to geodetic distances at ellipsoid height of zero.

Ellipsoid. A mathematical best-fit representation of the Earth's surface. Formed by rotating an ellipse about its minor axis.

Ellipsoid height (h). The elevation of a point above the reference ellipsoid for the horizontal datum, currently NAD 83.

Engineering surveys. Preliminary and layout surveys used for the design and construction of facilities.

Error. The difference between an observed or computed value of a quantity and the theoretical or defined value of that quantity.

Error of Closure. The amount by which a quantity obtained by a series of related measurements differs from the true or fixed value of the same quantity.

Error ellipse. A confidence region of a point's accuracy represented by an ellipse. Represents an area within which the probability of two- or (three)-dimensional errors is a constant.

Expedient planimetric map. A map that is produced from vertical aerial photography and shows only horizontal features. No vertical information is shown.

False easting, false northing. Arbitrary coordinates assigned to the origin of a mapping projection to prevent the occurrence of negative coordinate values.

Feature code. Desired CADD representation of a certain object or feature.

Fixed coordinates. Point coordinates which are not subject to adjustment.

Flight line. The prescribed ground path over which an aircraft moves during the execution of its mission.

Foot, International. Defined as exactly 0.3048 meter.

Foot, U.S. Survey. Defined as exactly 1200/3937 meter. The unit of linear measure in Wisconsin for surveying.

Foresight. In leveling, a sight taken to a bench mark (BM) or turning point (TP) to obtain a check on a leveling operation or to establish an elevation on a point. In a traverse, the foresight is a sight taken to a point in order to establish a reference distance and direction.

Fully constrained. A network adjustment in which all points in the network which are part of a larger control network are held fixed to their published coordinate values. Used to merge smaller with larger control networks.

Geodetic azimuth. The clockwise angle measured usually from north between the mathematical reference geodetic meridian and the observed line.

(Geodetic Azimuth = Grid Azimuth + Mapping Angle).

Geodetic control. Control points which take into account the size and shape of the earth.

Geodetic distance. The distance between two points on the reference ellipsoid. It differs from the ground distance by a correction based on the elevation (or sea level) factor for the line.

Geodetic meridian. A line on a reference ellipsoid which has the same longitude at every point.

Geodetic Reference System 1980. A rotational ellipsoid having a semi major axis of 6,378,137 meters by definition and a semi minor axis of 6,356,752.31414 meters by calculation. The reference ellipsoid for the North American Datum of 1983.

Geographic coordinates. Latitude, longitude, and height above the reference ellipsoid.

Geoid. The average position of mean sea level. The equipotential surface in the gravity field of the Earth which coincides with the undisturbed mean sea level extended continuously through the continents. The direction of gravity is perpendicular to the geoid at every point.

Geoid height (N). The distance of the geoid above (positive) or below (negative) the mathematical reference ellipsoid.

Global Positioning System. A three-dimensional positioning technique based on the reception and analysis of NAVSTAR satellite signals.

GPS. See Global Positioning System.

Government lot. Sections made fractional by barriers, such as bodies of water. The lot number is the legal description of that tract of land.

GRS 80. See Geodetic Reference System of 1980.

Grid azimuth. The clockwise angle measured usually from north on a projection grid between the central meridian of a plane coordinate projection system and the observed line. Grid Azimuth = Geodetic Azimuth - Mapping Angle

Grid distance. The distance between two points on a plane coordinate projection system. It differs from the geodetic distance by a correction based on the scale factor for the line.

Grid north. The direction of the central meridian in a plane coordinate projection system.

Grid meridian. Meridians parallel to a central meridian on a coordinate grid.

Grid transformation. The conversion between geographic and map projection coordinates.

Ground distance. The horizontal distance between two points as measured on or near the surface of the ground.

Gunter's Chain. Early (1800s) measuring device consisting of 100 links and 66 feet long.

Hand level. A hand-held instrument used for approximate leveling.

Height of instrument (HI). Height of the optical axis of the instrument above the station (bench mark). Commonly referred to as "the HI."

Horizontal control. A network of stations of known geographic or grid coordinates referred to a common horizontal datum, which control the horizontal positions of subsequent surveys.

Hydrographic survey. A survey which defines shoreline and depth of a body of water.

Image point. Picture point chosen from existing ground base objects after aerial photography is flown. Consists of a well-defined describable object with a position that can be determined.

Initial point. The point from which a survey is initiated. Also see point of beginning.

Inscription. Information on a survey disk identifying the agency supplying the survey disk (usually the same agency physically setting the monument and usually the first agency to perform observations at the survey station), the type of survey station, and a contact for more information about the station. When survey disks were cast of brass, the inscription information was incorporated in the casting. Today survey disks are normally formed (stamped) from a metal pellet and the inscription information is usually stamped on the survey disk as

part of the process of making the disk. Also see “stamping.”

Invert. The inside bottom of a pipe or culvert.

Invert elevation. The minimum flow elevation.

Lambert conformal projection. A conformal map projection in the shape of a cone, on which all geodetic meridians (lines of longitude) are represented by straight lines which meet in a common point outside the map limits and parallels (lines of latitude) are represented by a series of arcs of circles having this common point for the center of the arcs. Meridians and parallels intersect at right angles, and angles on the Earth are correctly represented on this projection. The direction of the central meridian on the projection establishes grid north.

Landowner. A person(s) who legally owns the land.

Laser level. A device which emits a horizontal laser beam for leveling operations.

Latitude (of a course). The change in northerly displacement ( $\Delta N$ ) of a line.

Latitude (geodetic). Angular distance measured north or south of the equator on a reference ellipsoid.

Least-squares adjustment. A method of adjusting observations by producing the smallest change to the original field measurements. Simultaneously adjusts angular and linear measurements to make the sum of the squares of the weighted residuals a minimum—hence the name.

Level line. (1) A straight line on a level surface (e.g., a beam of light perpendicular to the direction of gravity at a single point); therefore, a curved line relative to the surface of the Earth. A level line is NOT a line of constant elevation. (2) The route of a series of bench marks leveled during a leveling project.

Leveling. The surveying operation to measure the vertical distance between point(s) to determine the elevation of the point(s).

Level of significance. An expression of probability. A one-sigma (standard) error is said to have a level of significance of 68%. For one-dimensional errors, a 95% level of significance is expressed by 1.96 sigma, and a 99% level of significance is expressed by 2.576 sigma.

Longitude (geodetic). An angular distance measured east or west from a reference meridian (usually Greenwich, England) on a reference ellipsoid.

Lost corner. A PLSS corner whose position cannot be determined, beyond reasonable doubt, either from traces of the original markers or from acceptable evidence or testimony that bears upon the original position, and whose location can be restored only by reference to one or more interdependent corners.

Magnetic declination. The angle between the magnetic and geodetic meridian at any place, expressed in degrees east or west to indicate the direction of magnetic north from true north.

Map projection. A rigorous mathematical expression of the curved surface of the ellipsoid on a rectangular coordinate grid.

Mapping angle. The angle between grid north on a mapping projection and the meridian of longitude at a given point. Also called the angle of convergence.

Mean sea level (MSL). The average height of the surface of the sea for all stages of the tide. Elevations used to be commonly referenced to MSL. Since MSL is not a constant elevation at different locations it is no longer used as a reference for elevations. See also National Geodetic Vertical Datum of 1929 and North American Vertical Datum of 1988.

Meridian. A north-south reference line from which differences of longitude and azimuths are reckoned.

Metes and bounds survey. A method for describing boundaries of property by giving the bearing and length of each successive line.

Minimally constrained. A network adjustment in which only enough constraints to define the coordinate system are employed. Used to measure internal consistency in observations.

Monument (for geodetic survey). A permanent reference point for horizontal or vertical positioning. Usually including an identifying name stamped on a bronze disk set in the top of a concrete post or drill hole in a concrete structure.

Monument (for a boundary survey). A permanent reference point for horizontal positioning. Usually with an identifying name stamped on it.

Mosaic. See aerial mosaic.

National Geodetic Survey (NGS). The federal agency—under the National Ocean Service, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce—which is responsible for establishing and maintaining the basic nationwide geodetic network.

National Geodetic Vertical Datum of 1929 (NGVD 29). Equipotential surface representing mean sea level which is used for referencing orthometric heights.

NAVSTAR. NAVIGATION Satellite Timing And Ranging. A system of orbiting satellites used in navigation and positioning. Commonly referred to as the Global Positioning System (GPS).

North American Datum of 1927 (NAD 27). Reference surface for horizontal positions. Adjustment utilized the Clarke Spheroid of 1866 and held fixed the latitude and longitude of station Meades Ranch in Kansas along with the azimuth to nearby station Waldo.

North American Datum of 1983 (NAD 83). Reference surface for horizontal positions. Adjustment utilized the GRS 80 ellipsoid, centered at the mass center of the Earth, and held fixed the latitudes and longitudes of numerous control stations.

North American Vertical Datum of 1988 (NAVD 88). Equipotential surface approximating the surface of the geoid. Adjustment incorporated additional level lines to account for inconsistencies in NGVD 29.

Obliterated corner. A PLSS corner with no remaining traces of the monument or its accessories, but whose location has been perpetuated, or a point which may be recovered beyond reasonable doubt by the acts and testimony of the interested landowners, competent surveyors, other qualified local authorities, or witnesses, or by some record evidence.

Offset line. A supplementary line close to and roughly parallel to a main line at a known distance and direction from the main line.

Open traverse. A survey traverse that begins on a known control station but does not end at known control. There is no check whatsoever on the accuracy of such a traverse.

Orientation. The act of establishing the correct relationship in direction with reference to known control or azimuth. The rotation or the set of rotations needed to make the axes of one rectangular Cartesian coordinate system parallel to the axes of another.

Original ground. The existing position of the ground surface prior to any construction activities.

Orthometric height. The elevation of a point above or below the geoid. A relationship between ellipsoid height and orthometric height is obtained from the equation  $h=H+N$

where:  $h$  = ellipsoid height

$H$  = orthometric height

$N$  = geoid height

In Wisconsin, the geoid height is always a negative value and is approximately -100 feet.

Overlap. In aerial photography, the amount by which one photograph includes the same area covered by another, customarily expressed as a percentage.

Owner. A person(s) with legal ownership to real or personal property.

Owner/occupant. A person(s) with a legitimate interest in the land or activities on the land which may include—but is not limited to—the legal owner, renter of buildings or land, occupant, caretaker, farmer of crops or animals, or neighbor.

Panel. A target design used for control station identification on aerial photography.

Parameter. In general, any quantity of a problem that is not an independent variable.

Peg test. A method of testing and adjusting the collimation of a level instrument.

Photogrammetry. The science, art, and technology of obtaining reliable information from photographic images.

Photogrammetric control. Control established by photogrammetric methods as distinguished from control established by ground methods. Also called minor control; multiplex control.

Pier. A vertical structural member, usually a column supporting beams, girders, etc., between abutments.

Plane rectangular coordinates. A system of coordinates in a horizontal plane, used to describe the positions of points with respect to an arbitrary origin. The origin is established by a pair of axes which intersect at a right angle. The position of a point is determined by the perpendicular distances to each of the axis. Also called plane

coordinates.

Plane survey. A survey in which the surface of the Earth is considered a plane. Surveying done under the assumption that the surface of the Earth is flat.

Planimetric Map. A map representing only the horizontal position of features.

Planimetry. Parts of a map which represent everything except vertical relief.

Plat. A diagram drawn to scale showing land boundaries and subdivisions thereof, together with all data essential to the description and identification of boundaries shown.

PLSS. Public Land Survey System.

Point of beginning (POB). The point from which a survey is initiated. Also see initial point.

Point of curvature (PC). The point in a line survey where a tangent ends and a circular curve begins.

Point of intersection (PI). The point where two tangents meet.

Point of tangency (PT). The point in a line survey where a circular curve ends and a tangent begins.

Point of vertical curve (PVC). The point of change from a line of uniform slope to a vertical curve.

Point of vertical intersection (PVI). The point of intersection of two lines, each having different slopes.

Point of vertical tangent (PVT). The point of change from a vertical curve to a line of uniform slope.

Position. Data which define the location of a point with respect to a reference system.

Positional accuracy. A term used in evaluating the overall reliability of the positions of features on a map or chart relative to their true position, or to an established standard.

Precision. In statistics, a measure of the tendency of a set of random numbers to cluster about a number determined by the set. It is distinguished from accuracy by the fact that the latter is a measure of the tendency to cluster about a number (true value) not determined by the set, but specified in a different manner.

Prism. A corner cube of retro-reflective glass used to transmit light rays back precisely parallel in the same direction as they are received.

Profile. A vertical representation of a surface along a fixed line of reference.

Preliminary survey. An initial survey which forms the basis for engineering design.

Property survey. A survey to retrace or establish property lines or to establish the locations of structures within property limits.

Quadrangle. A rectangular area covered by a map or plat, usually bounded by given meridians of longitude and parallels of latitude.

Radial survey. A survey carried out radially (Azimuth/Distance) from one fixed point.

Random errors. Errors which do not follow physical laws nor can be defined mathematically. As an example: bubble not centered at the instant a level rod is read.

Random line. A trial line, directed as closely as possible towards a fixed terminal point which is not visible from the initial point.

Real-Time Kinematic (RTK). A method of positioning using GPS.

Reciprocal vertical angles. Vertical angles measured over a line at both ends in trigonometric leveling to eliminate the effects of curvature and refraction.

Reference Line. A line used as a reference or base for measuring other quantities. The reference line may coincide with the centerline or a right-of-way line at some locations.

Relative Accuracy. An evaluation of the positional orientation of one point or feature with respect to another.

Resection. The determination of horizontal position of a survey station by observed directions or lengths from the station to points with known positions.

Residual. The difference between any measured quantity and the most probable value for that quantity.

Residual error. The difference between any value of a quantity in a series of observations, corrected for known systematic errors, and the value of the quantity obtained from the combination or adjustment of that series.

Reticle. A mark, such as a cross or system of lines, lying in the image plane of a viewing apparatus and used

singly as a reference mark for observations.

Retracement. A term applied to a survey that is made for the purpose of verifying the direction and length of lines, and identifying the monuments and other marks of an established prior survey.

Right-of-way. A strip of land granted by fee or easement for construction, maintenance, or other designated use. DOT right-of-way is land owned by DOT for transportation purposes.

Route survey. Preliminary, control, and construction surveys which cover a long but narrow area, as in transportation corridors.

Scale factor. The multiplying factor used to convert a geodetic distance to a grid distance. A number by which a distance obtained from a map by computation or measurement is multiplied to obtain the actual distance on the datum of the map.

Sea level factor. The factor used to convert horizontal ground distances to geodetic (mean sea level) distances.

Skew. A clockwise angle measured from the back tangent to the centerline of a structure or culvert. Skew of a structure or culvert is also measured by the method of right hand forward (RHF) or left hand forward (LHF) when looking in the direction of increasing stationing. A skew of 70( is the same as 20( RHF; a skew of 95( is the same as 5( LHF.

Slope stake. A construction grade stake which marks the outer limits of the grading and is set or offset to indicate the point where the backslope or fill slope intersects the original ground. It also serves as a control point from which horizontal and vertical measurements can be made to aid in constructing earth grades.

Span. The unsupported length of a structure.

Spiral curve. A transition curve of constantly changing radius.

Stadia constant. The ratio which is multiplied by the stadia interval to obtain the length of a line of sight.

Stadia interval. The length of rod subtended between the top and bottom crosswires in a surveying instrument.

Stamping The information on a survey disk identifying it from other similar survey disks. The stamping information normally includes the station (bench mark) designation and the year the monument was first observed. If other information has been stamped on the disk or logo cap (e.g., an elevation), that information is considered to be part of the stamping information. Historically, the station designation and year were hand stamped on the survey disk and were called "the stamping" to differentiate that information from the inscription information. Also see "inscription

Standard deviation. A value expressing precision which is defined as the square root of the variance.

State plane coordinate system. The plane rectangular coordinate system established by the National Geodetic Survey for use in defining positions of points in terms of plane-rectangular (Y and X) coordinates.

Station (Construction survey). A point on a baseline (often the centerline) that is a specified distance from the point of commencement.

Station (Geodetic survey). A physical location or site at which, from which, and to which observations have been made. Usually marked by a permanent monument including a disk with stamped designation.

Stereo model. The mental impression of an area or object seen as being in three dimensions on photographs when viewed with a stereoscope.

Superelevation. The banking of a curved section of road to help overcome the effects of centrifugal force.

Survey. The result (product), or anticipated result, of surveying. Examples and usage: a topographic, hydrographic, public land, geodetic, or GPS survey; a survey marker, monument, disk, station, bench mark, or crew.

Survey cap. A survey marker, constructed of metal or plastic, designed to fit over the end of a pipe or rod. The setting agency name may be imprinted on the top of the cap.

Survey disk. A survey marker constructed from a circular piece of flat or domed metal, usually bronze or aluminum, with a perpendicular stem at the center to anchor the marker in concrete. The stem may be pushed into fresh concrete or set into a drill hole with epoxy resin. The setting agency name is usually imprinted and the station name stamped on the disk.

Surveying. The science, art, and technology of determining the relative positions of points above, on, or beneath the surface of the earth, and portraying such information on paper or in digital files. Activities include calculating areas, defining boundaries and establishing control based on the points. Examples and usage: topographic,

hydrographic, land, or geodetic surveying; surveying activities, operations, data, methods, equipment, instruments, or terms.

Surveying operations. Any, or all, field activities to support property boundary surveys, geodetic or project control surveys, environmental surveys, species and habitat surveys, geotechnical evaluations, and other fieldwork. "Surveying operations" may range from just walking across a field or along a railroad track to excavating for soil sampling, archaeological excavation, or survey monument installation.

Systematic error. An error in a measured value which follows some physical law or which can be expressed as a mathematical function.

Tangent. A straight line, often mentioned with respect to a curve.

Target. The distinctive marking of a ground point to aid in its identification on a photograph.

Target document. An aerial mosaic or quad map depicting the annotation and location of all needed ground control for a photogrammetric project.

Three-wire leveling. A method of leveling applied when the reticle of the level has three lines. The rod is read at each of the three lines and the average is used for the final result.

Tolerance. The maximum allowable variation from a standard or from specified conditions.

Topographic survey. A survey which has for its major purposes the determination of the vertical relief of the surface of the earth and the location of natural and constructed features thereon.

Total Station. An electronic theodolite combined with an EDM and an electronic data collector.

Traverse. A method of surveying in which lengths and directions of lines between points are obtained from field measurements, and used in determining positions of the points.

Triangulation. A method of surveying in which the stations are points located at the vertices of a chain or network of triangles.

Tribrach. Centering device for mounting surveying equipment on a surveying tripod. The three-armed base of a surveying instrument, which carries the foot screws used in leveling the instrument.

Trigonometric leveling. The determination of elevation differences from observed vertical angles combined with the lengths of lines.

Trilateration. A method of surveying wherein the lengths of the triangle sides are measured, and the angles are computed from the measured lengths.

True north. The direction from an observer's position to the geographical North Pole.

Turning point. A solid point used in leveling, where an elevation is temporarily established so that the level may be relocated.

USPLSS. See PLSS.

U.S. Survey Foot. See Foot, U.S. Survey.

UTC. See Coordinated Universal Time

UTM. Universal Transverse Mercator grid system.

Variance. A value by which the precision of any group of measurements is expressed. Defined as the sum of the squares of the residuals divided by the number of measurements.

Vector. A three-dimensional line between two points, defined by a direction and a magnitude.

Vertical angle. See Zenith Angle.

Vertical control datum. Any level surface (for example mean sea level) taken as a reference from which to reckon elevations. Although a level surface is not a plane, the vertical control datum is frequently referred to as the datum plane.

Vertical curve. A parabolic curve joining two gradelines.

Vertical exaggeration. The increase of the vertical scale over the horizontal scale of a terrain model.

Waving the rod. The slight waving of the level rod to and from the instrument, which permits the surveyor to take a precise (lowest) rod reading.

Weight. The relative worth of an observed value as compared to any other value. A factor by which a quantity is

multiplied to increase or decrease the effect of that quantity on the results of an adjustment.

WisDOT field representative. The Department field person providing daily planning, scheduling, or on-site coordination of the field surveying operations and usually is the liaison with owners in the project area; is typically a more senior person such as a crew chief, project manager, project leader, lead worker, specialist, or similarly titled person if working for a consultant, and may be directing other field workers or working alone.

Witness corner. A monumented survey point usually on the line of survey near a corner. Established as reference when the corner itself is so situated as to render its monumentation or ready use impracticable.

Witness mark. A mark placed at a known distance and direction from a property corner or survey station to aid in its recovery and identification.

Wing wall. An abutment extension designed to retain the approach fill.

World Geodetic System of 1984 (WGS 84). A rotational ellipsoid having a semi-major axis of 6,378,137 meters by definition and a semi-minor axis of 6,356,752.31424 meters by calculation. The reference ellipsoid for the Global Positioning System.

Zenith. That point of the celestial sphere vertically overhead. The point at which a line opposite in direction from that of the plumb line at a given point on the Earth's surface meets the celestial sphere.

Zenith angle. A vertical angle measured downward from the zenith direction.

Zone constants. A set of parameters used to define a mapping projection. Such constants include central meridian, standard parallel, and latitude of origin.

## **FDM 9-80-5 Survey Mathematics**

*October 28, 1994*

The attachments that accompany this procedure provide a summary of the principal mathematical relationships that govern surveying procedures.

### **LIST OF ATTACHMENTS**

<a href="#">Attachment 5.1</a>	Curve Formulas
<a href="#">Attachment 5.2</a>	Trigonometric Formulas
<a href="#">Attachment 5.3</a>	Cosine Law - Oblique Triangle
<a href="#">Attachment 5.4</a>	Coordinate Geometry