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1994 *Engineering Field Notes* Article Award Winners

We would like to thank everyone who took the time to fill out and send in a rating sheet. We realize that your time is valuable, so your vote was really appreciated.

We would also like to acknowledge everyone who made the effort to write and submit an article. In order for *Engineering Field Notes* to continue to be a valuable resource to personnel in the field, it is important that we continue to receive such relevant articles. According to the comments received, *Engineering Field Notes* articles are saving the Forest Service time and resources.

And now, the winners of the close race for the top three articles in 1994 are:

Article	Author
"Licensing Requirement of Federal Engineers"	John L. Zirkle
"Burgess Junction Visitor Center"	Lexie Benson
"Interagency Agreement Between the USGS and Forest Service for the Production and Maintenance of a Single-Edition Primary Series Quadrangle Map"	André J. Coisman

Congratulations, *Engineering Field Notes* authors!

Geographic vs. Cartographic

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Editor's Note: This article first appeared in the July issue of the Geometronics Service Center's newsletter, DATUM. *If you would like a copy of that newsletter or more information about it, please contact GSC at DATUM:WO3A or fax at 801-975-3478.*

One of the more hotly debated issues in the geographic information systems (GIS) community is that of "geographic" data versus "cartographic" data. With digitized maps finding their way into GIS as base data to which other data themes (resource, etc.) are tied or registered, many in the community have expressed concern regarding the cartographic characteristics of these base data.

First, what are we saying when we use the terms "geographic" and "cartographic?" Reflecting the view held by many in the community, geographic is understood to mean the exact position of features (roads, streams, buildings, etc.) as they exist on the ground. Clear and concise perhaps, but how exact is the position—how accurate within 1 centimeter, 1 meter, 10 meters? In practice, the degree of positional accuracy is usually determined by striking a balance between the requirements behind the application (known and anticipated) and the cost of collecting and maintaining the data.

There is more, however, to the meaning of geographic than position. Geographic has a content component as well as a positional component. In the context of a digital geospatial data base, geographic content can be defined as a set of represented features—for example, roads or drainage. How wide or inclusive should this set be? Should it include every feature or entity found on the ground (a "true" geographic representation), or a subset of one particular theme, for example, inhabited constructed features of greater than 500 square feet? Let's say that you are interested in building a data base for a specific area that would contain only roads and drainage—a subset of all the geographic features and entities that could be included. In the case of roads, you, as the builder of the data base, and your users/customers decide what road features to select or include, and what to ignore (if any). Perhaps all paved and improved surface roads are part of the data base, but abandoned roads and trails are not.

Deciding which drainage features to collect and hold is a process of selection, too. In our example, a strict interpretation of geographic could mean the inclusion of every road, trail, and track, and every possible drain course, flowing or not. Taking a step back and looking at the data base holistically, what about all those other geographic features such as mines, dams, fence lines, and buildings—from "out" facilities to shopping malls? What about political and administrative boundaries, and cadastral data?

Collecting all possible features and entities in their exact positions becomes a very large, very costly undertaking—as is the task of maintaining the currency of these data over time. Building geospatial data bases often becomes an exercise in tradeoffs. A key element underlying these tradeoffs is resolution. A very-high-resolution data base could contain nearly all geographic information imaginable—almost a one-to-one representation. What can we afford to build and maintain? In some ways, this sounds almost like a cartographic problem—how much geographic information can (should?) a map or data base carry?

Now that we have a better understanding of the term geographic, let's turn to the other side of the issue—"cartographic," the selected representation of geography on a map. A cartographic position can be thought of as the position of a symbol shown on a map to represent a feature such as a paved road. In most cases, the road's position on the map reflects the position of the road on the ground—within the limits set by scale and National Map Accuracy Standards (NMAS). For the 1:24,000-scale Forest Service Primary Base Series (PBS) map (built from the U.S. Geographical Survey (USGS) topographic map series), NMAS state that 90 percent of well-defined map points are within 40 feet of ground location horizontally, and one-half the contour interval vertically. In cases where a road is in close proximity to another linear feature on the ground, say a railroad, the road symbol on the map would be displaced or otherwise modified according to established conventions. The purpose is to allow the map to accommodate both the road and railroad symbols—a map legibility issue. On the ground, the distance between the center lines of the road and railroad may be 25 feet, and only 0.0125 inches on a 1:24,000-scale PBS map. Showing the railroad symbol and the road symbol in their true "geographic" positions on the map would cause the symbols to be partially overprinted. Since the dawn of modern topographic mapping in the United States (early 20th century), the general-purpose topographic map was the primary carrier of base geographic information. To ensure clarity and consistent treatment of features, these maps were produced to rigid standards. Of course, these standards were laced with cartographic conventions that did not permit piling symbols on top of symbols.

Just as content is important in understanding the term "geographic," it is equally important when considering the cartographic side of things. Cartographic content is the representation of only those features that can be portrayed effectively on a map, considering map scale and legibility constraints. Only so much detail can be shown on a topographic map before the map (and the map user) begin to suffer. The content of a topographic map is a subset of what could be found on the ground. For example, only a defined set of transportation features are shown—those that meet the range of established criteria for class and length. A similar approach is taken in the case of drainage, where only perennial and most intermittent drain courses exceeding a certain length are shown. Even drainage density is subject to cartographic interpretation. As an example, the treatment of intermittent drainage on USGS topographic maps of arid regions, such as Arizona, has been less than consistent over the years. The drainage treatment of an early 1960's quadrangle map will often not match an adjoining late 1970's map, nor will either match an adjoining 1980's map. In nearly all cases, the uppermost or "headwall" reaches of drain courses were not recorded and carried on the final printed map—the third- and fourth-order drains we speak of today.

This brings us to the notion of cartographic generalization—a mix of what we have discussed under cartographic position and cartographic content. Cartographic generalization is the method (and the result) of limiting the amount of information shown on a map, taking into consideration scale and legibility concerns. Techniques include:

- Smoothing—removing sharp jags in lines
- Simplification—showing a representative pattern such as urban tint, or showing only a few oil storage tanks in a tank farm rather than every single one
- Selection/elimination—not showing features that fail to meet minimum size or density criteria
- Displacement—the road–railroad example
- Suppression—not showing linear symbols like section lines and power transmission lines that run coincident or nearly so with road or other "higher priority" symbols

While one could argue that all features shown on a map have been generalized to some degree, the effects of generalization are most prominent in areas where the amount of cartographic detail is most dense, such as built-up areas with extensive transportation systems, complex shorelines, and braided streams. For the typical rural topographic map, it is estimated that fewer than 5 percent of the features shown have been deliberately repositioned for cartographic purposes. Of course, this threshold will vary from map to map. Again, the general-purpose topographic map was designed to meet a broad range of uses and was not intended to offer a complete inventory of all geographic features and entities in their exact locations.

As we began to build digital geospatial data bases over the last several years, most of us have found out that the standard topographic map—in our case, the PBS—has served as the best available source of base geographic information for the creation of GIS. Content was generally consistent and current, and the positional accuracy was known or at least understood. Of course, a data file produced from digitizing the location of map symbols preserved the cartographic nature of the source map—symbol displacements, generalization, content, and so forth. As many GIS users begin to exercise their data bases, they find that some of the features represented in the data base do not exactly reflect the same features on the ground in terms of position, shape, and density. Are these data flawed or useless? Not necessarily, discounting the occasional blunder found on the map or introduced in the digitizing process.

Another observation often made in the discussion of geographic versus cartographic is that cartographic data are not topologically structured or "polygonized"—a process where linear connectivity and area adjacency are explicitly defined. In a strict sense, the symbolized features shown on a paper topographic map are not topologically structured. However, the eye and the mind can build connectivity and adjacency relationships intuitively, simply by looking at the map. Digitized map information collected in a vector form can be topologically structured once small gaps or breaks contained in symbols are joined while digitizing or in a postprocessing step. For example, a road symbol shown on a map that passes under another will have a gap that allows the overpassing road to be symbolized. In a digital representation, the underpassing road can be digitized through the gap, preserving the linear connectivity of the underpassing road. Forest Service Cartographic Feature Files (CFF's), while not topologically structured when first produced, can be structured by users building GIS data bases. USGS's Digital Line Graphs, collected from USGS topographic maps and similar in many ways to CFF's, are topologically structured when initially collected.

Most of us would agree that the closer a geospatial data base comes to being fully geographic in terms of position and content, the better. How do we get there? Setting the map aside and recollecting all geographic information to a full "geographic standard," i.e., remapping to a higher standard, is possible; however, such an effort would be time-consuming and very costly. Estimates to create one all-new 7.5-minute, 1:24,000-scale standard topographic map, with accompanying digital data from the ground up, approach $25,000—much more for maps containing dense built-up areas. This would only yield the set of geographic features portrayed cartographically that we find today on a topographic map. While the $25,000 figure is an estimate, most of us could not afford to recollect to a full geographic standard—expanded content with a higher order of horizontal and vertical accuracy.

An alternative would be to work with existing base geographic information provided by digitized maps, and to improve positional accuracy (using the most accurate positions available) and expand content as opportunities permit. In the course of routine data base maintenance and updating, new features can be added and existing features modified using Global Positioning Systems (GPS). High-resolution Digital Orthophoto Quad (DOQ) imagery that meets a higher level of positional accuracy than digitized map data can be registered with parts of the exiting data base and used as a template for adding new features and changing the alignment or position of others. In some cases, there may be opportunities to incorporate higher accuracy, enhanced content base data available from users and producers outside the Forest Service, such as State natural resources departments, county transportation departments, and municipalities. While not likely to address mainstream data needs within national forests, these sources could be used effectively along the forest/nonforest interface and in areas where watersheds and ecosystems extend beyond forest boundaries. Using GPS, DOQ's, and other data sources, our data bases would evolve over time to become more geographic in nature.

Cartographic data have value in building GIS data bases. To ensure that we receive maximum benefit, we need to understand the characteristics these data have—both strengths and weaknesses. The topographic map, a cartographic representation of geography, has been the carrier of base geospatial information for many, many years. In a sense, the map has delivered to us a reasonably consistent inventory of base geographic data. It is up to us to convert and use these data wisely, and to continue to improve this inventory in the years ahead. Digital geospatial data bases will become the carriers of our geographic inventory, and the maps spun from these data bases will reflect that inventory.

To learn more about the geographic versus cartographic issue, contact your Regional Geometronics Leader or Anne Boeder (A.Boeder:WO3a) at the Geometronics Service Center, phone: 801–975–3434.

Solar-Powered Fan Improves Vault Toilet Venting

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The Prescott National Forest has used a solar fan to augment the "sweet-smelling technology" design on their standard single dual-vault toilet (figure 1). The solar fan was initially installed at one lakeside toilet where winds tend to change directions and swirl, which made it difficult to

Figure 1.—Prescott's standard single dual-vault toilet at Lynx Lake.

properly locate the toilet for best venting. At times, the vaults would vent up through the risers, making it uncomfortable to use the toilets.

One 24-volt DC fan was installed at the top of each vent pipe and powered by a solar module (figure 2–6) . The solar modules were concealed above the vent pipes on a sheet metal assembly. No part of the solar system is visible from the ground, thus deterring vandals and thieves from harming the system. The controls are mounted inside a small storage room building.

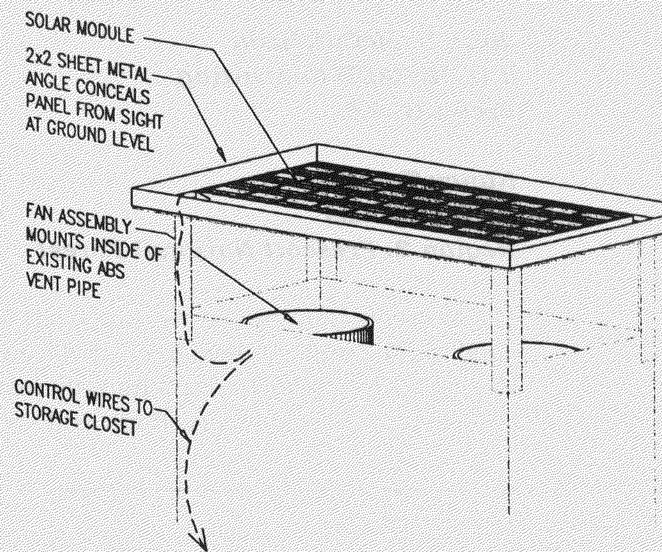

Figure 2.—Solar-powered fan for vault toilet vent.

Figure 3.—The solar module nearest the fan's protective cover is removed.

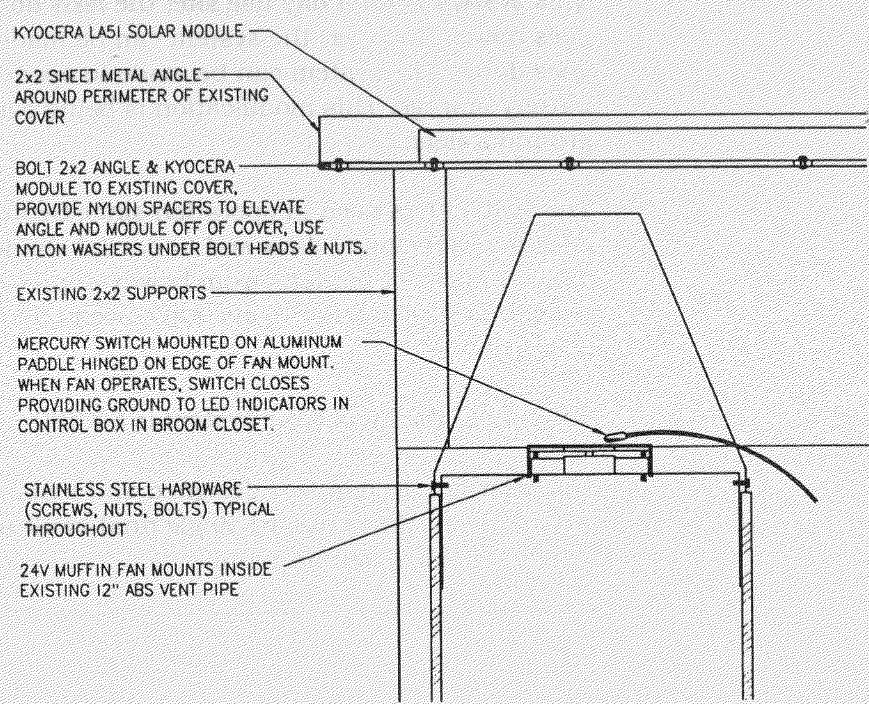

Figure 4.—Cross section of solar-powered fan system.

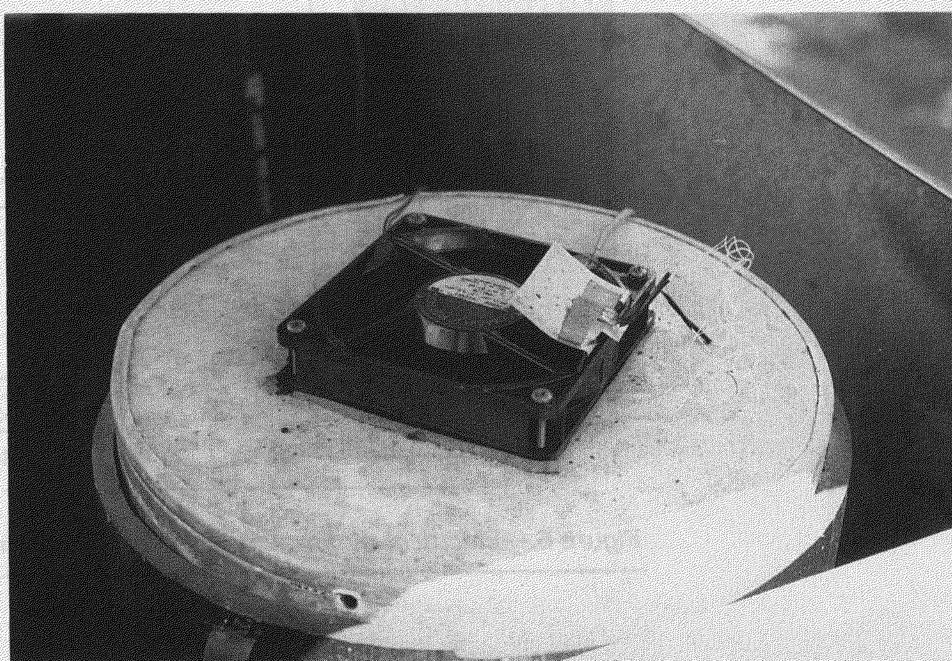

Figure 5.—Fan mounted in the vent pipe.

This system is for a day use site; the fans do not operate after the sun goes down. However, the system can be made to operate after the sun goes down. The system can be made to operate 24 hours by adding battery storage. This modification is being considered for some campground toilets.

The system has been in operation since September 1994, and operates effectively on cloudy days and in partial shade. Sheet metal cones were added to protect the fans from blown-in precipitation after a few months of operation. The toilet rooms have been odor-free since the system was installed.

The cost of the Lynx Lake system is $1,500.

The solar fan system was designed and installed by consultant John McCutcheon; the standard single dual-vault toilet was designed by facility engineer Dennis Stuhr.

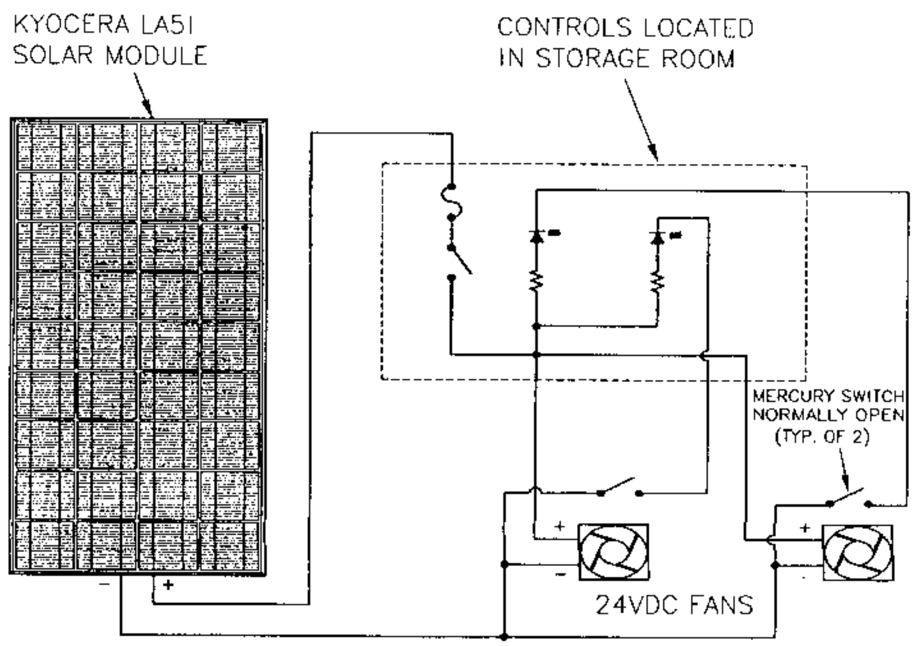

Figure 6.—Electrical diagram for solar-powered fan.

North American Datums—NAD27 and NAD83

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Editor's note: This article first appeared in the August issue of the Geometronics Service Center's newsletter, DATUM. *If you would like a copy of that newsletter or more information about it, please contact GSC at DATUM:WO3A or fax at 801-975-3478.*

With all of the fun we are having building, maintaining, and using geospatial data bases, it would be easy to overlook one of the basic underpinnings of how we relate the geographic locations or positions of things to the surface of the Earth. Establishing accurate positions requires a datum—a reference system that relates positions to a common origin or defined starting point. A vertical datum is a level surface used as a reference for elevations. A horizontal datum is used as a reference for horizontal or x, y coordinate positions.

We have the privilege today to work with not just one horizontal datum, but two—the North American Datum of 1927 (NAD27) and the North American Datum of 1983 (NAD83). The NAD27 has been around since the late 1920's and, until recently, has been the datum of choice for the United States. Nearly all surveying, mapping, and geodetic work accomplished through this period has been based on NAD27. A new geodetic reference system, designed to improve geodetic accuracy and make the North American geodetic system more compatible with modern worldwide systems, was established in the late 1970's. This system is known today as NAD83.

The Nation's surveying, mapping, and geospatial information user communities are faced with the task of converting to the 1983 datum—some have nearly completed the change, others have yet to start. In many cases, all new parcel surveys and large-scale, high-resolution municipal and county mapping projects are based on NAD83. The Federal Government has, on several occasions, stated its intent to adopt and implement the new datum through forums such as the Federal Geodetic Control Committee of the 1980's and today's Geodetic Subcommittee of the Federal Geographic Data Committee.

It is no simple task for an organization to take on a new datum while continuing to work with data (maps, digital data, and so forth) based on enormous investment in NAD27. Make no mistake, these datums are different. We need to understand the characteristics of these systems so that we can better assess the risk of using data from mixed datums and the effort required to transition from one datum to another. The following discussion provides an overview of datums in general, and compares and contrasts NAD27 and NAD83. We do not offer a full technical treatment of the subject or suggest a strategy for conversion to NAD83. We hope, however, that some of the issues raised will stimulate dialogue that could lead to an integrated Forest Service approach to the conversion challenge.

The Shape of the Earth

Most of us would agree that the Earth is round or spherical. We understand, however, through our experiences on the face of our planet that the Earth is not truly spherical. Information gathered since the dawn of transoceanic navigation and astronomical observations has suggested that the Earth has less than ideal spherical characteristics. As needs for more accurate mapping and surveying grew through the late 1700's, it became important to determine a more accurate representation of the Earth's shape. This brings us to geoids, ellipsoids, and datums.

Geoids

Geodesists, those who study the science of Earth measurement, describe the Earth as a *geoid*—with a surface that is influenced by gravity. Because of variations in the distribution of mass and density of the Earth's components, the geoid surface generally rises over land masses and is depressed in oceanic areas. Adding to this mix is the fact that the Earth is flat at the poles and extends or bulges at the Equator. Flattening is caused by the rotation of the Earth around the polar (minor) axis. Even though these differences in the Earth's shape that keep it from being a perfect sphere are relatively small, they are important considerations for precise surveying and geodetic measurement—the cornerstone for determining accurate locations on the Earth's surface.

Ellipsoids

Acknowledging that the Earth's shape can be described as a geoid is a step forward; however, for surveying and mapping to proceed, a regular geometric reference surface must be used. To construct a reference surface, observations on the geoid are transferred to a regular form that most closely approximates the geoid. This regular surface is called an *ellipsoid*. In a sense, the ellipsoid is a mathematical model of the geoid—for the entire world, or for only a part (a continent, single nation, or region). Ellipsoids developed for geodetic and mapping purposes are often called reference ellipsoids. Various reference ellipsoids have been developed over the years by many countries to support mapping and surveying programs. Typically, these have been based on the local precision of the ellipsoid in describing only their portion of the Earth's surface or their area of interest.

Datum

Until recently, the United States used the Clark Ellipsoid of 1866 as its reference ellipsoid for establishing a *datum* (or starting point) for horizontal control needed for surveying and large-scale accurate mapping. In the early 1900's, the National Geodetic Survey (NGS) established a network of accurately surveyed points across most of the United States based on the Clark Ellipsoid of 1866. During the 5-year period from 1927 to 1932, these points were adjusted into a common system or datum, with its reference or initial point fixed at Meades Ranch in Kansas. This horizontal datum became known as NAD27, and consisted of approximately 200,000 points described by latitude and longitude, and about 500,000 points described by latitude, longitude, and elevation.

NAD83

By the late 1950's and early 1960's, advances in space exploration and satellite geodesy placed demands for exact positional accuracies on the existing geodetic control network that NAD27 could not consistently support. Using the most advanced surveying technology available at the time, the Federal Government launched the High-Precision Transcontinental Traverse project in 1961. The primary purpose of the project was to accurately position additional satellite tracking stations along the Florida coast; however, the NGS, having successfully used new electronic distance-measuring devices, elected to extend the project to include a survey of the entire country. At its conclusion in 1976, the survey had established accurate positions for more than 2,750 points strung along a network that extended 22,000 kilometers in 44 States.

Recognizing that NAD27 had some flaws that would not accommodate the extreme accuracies needed by many emerging applications, and that several survey errors had accumulated since its adoption, the decision was made to construct a revised North American datum based on the field work accomplished by the High-Precision Transcontinental Traverse. Known as NAD83, the new datum uses the Geodetic Reference System (GRS80) reference ellipsoid—instead of the Clark Ellipsoid of 1866. The fixed datum reference point is held at the Earth's center of mass and does not have a single origin (a place where the ellipsoid theoretically touches the geoid), as does the Clark Ellipsoid. NAD83 was designed to be compatible with worldwide systems such as the World Geodetic System 1984 (WGS84)—a valuable link to the growing amount of spatial data becoming available through WGS84.

NAD27 and NAD83 Compared

The variations in the defining parameters of these reference ellipsoids—Clark 1866 and GRS80—account for a significant amount of the coordinate shift that is evident between NAD27 and NAD83. Table 1 summarizes some of these parameters. The readjustment of the original survey used to establish NAD27, and data collected under the High-Precision Traverse, introduces a secondary component of the overall coordinate shift.

Table 1.—Defining parameters of NAD27 and NAD83.

Datum Elements	*NAD27*	*NAD83*
Reference ellipsoid	Clark 1866	GRS80
Equatorial axis	6,378,206.4 m	6,378,137.0 m
Polar axis	6,356,583.8 m	6,356,752.3 m
Best fitting area	North America	Worldwide
Fixed datum reference point	Meades Ranch	Geocentric (Earth's mass center)
Reference units	U.S. Survey Feet	Meters

Absolute coordinate shifts between the two datums vary by locations across the continental United States, ranging from less than 10 meters in Indiana and Illinois to 100 meters along portions of the Pacific Coast in California, Oregon, and Washington. This means that nearly all locations in the United States will have a slightly different latitude and longitude under NAD83. Physical features, boundaries, and land survey lines will not actually move about the surface of the Earth, but their coordinates—their "location addresses"—will change.

To illustrate this point, let's look at a 1:24,000-scale, 7.5-minute Primary Base Series (PBS) map based on NAD27—the Whiteface Reservoir, Minnesota, quadrangle (quad). The area covered by the quad map falls within a 7.5-minute latitude by 7.5-minute longitude "rectangle" (not a true rectangle, but we'll use the rectangle shape for the sake of argument). The quad map corners are spaced at 7.5-minute intervals calculated on NAD27. For example, the southeast corner has the coordinate of 47 degrees 15 minutes latitude, and 92 degrees 7 minutes 30 seconds longitude; and the northwest corner coordinate is 47 degrees 22 minutes 30 seconds latitude, 92 degrees 15 minutes longitude. On NAD83, these quad corners will shift to "new" NAD83 7.5-minute corner locations. For the Whiteface Reservoir map, the four corners will move approximately 6 meters north and 14 meters east. The NAD83-defined quad area now contains portions of Minnesota that were not part of the NAD27-defined quadrangle—areas just to the north and east of the original quad. Conversely, portions of the NAD27 quad will not be contained within the NAD83 quad area—areas that had been included in the southern and western margins of the original quad. This shift also holds for digital data collected from NAD27 quadrangle maps or data formatted into NAD27 quadrangle units. Imagine trying to join a NAD27 data layer with an adjacent NAD83 layer!

Since NAD27 and NAD83 are built on two different reference ellipsoids, some differences beyond the absolute coordinate shift are evident. The geodetic adjustments made under NAD83 refined the positions of existing control monuments across North America, thereby "improving," or, more accurately, locating features on the surface of the Earth. For example, with NAD83 the distance between New York and San Francisco improves by a few meters—the result of using a "better" ellipsoid to more accurately fix the positions of the two cities.

Another way to gauge the impact of improved positions is to consider the use of a 7.5-minute NAD83 Digital Orthophoto Quad (DOQ) with digitized NAD27 vector road data. Most DOQ's built by the Forest Service and the U.S. Geological Survey (USGS) contain quad corner marks or "ticks" embedded in the image—one set for the primary datum (in our example, NAD83), and one set for the secondary datum, NAD27. The ticks are shifted or offset in the manner described previously. The NAD27 data file can be registered to the NAD83 DOQ associating the corner ticks (or equivalent) in the NAD27 roads file with the secondary datum NAD27 ticks in the DOQ. Corner registration should be nearly exact. But what about the "registration" of the vector roads with the road images in the DOQ? Since we are working with two different reference ellipsoids in this example, the positions of the road features shown on the NAD83 DOQ and corresponding features on NAD27 may differ slightly—assuming that the roads were digitized accurately. How slight is "slightly"? In the Pacific Northwest, where differences between NAD27 and NAD83 are typically the greatest in the lower 48 States, it is estimated that positions of corresponding features on the Clark 1866 and GRS80 ellipsoids are likely to differ by less than 1 meter. For applications using data collected from 1:24,000 or smaller scale sources where extreme accuracy is not needed, this difference may be negligible.

In summary, for practical purposes NAD83 does two things. First, the latitude–longitude geographic coordinate system is redefined, resulting in absolute coordinate shifts on the order of many meters. Second, through the use of an improved ellipsoid, the positions of features are refined or improved—from just a few centimeters in many cases to nearly a meter. In practice, only the most accurate surveying and large-scale mapping projects will be impacted by these minor changes or improvements in positions. For most, the absolute coordinate shifts remain the largest factor when converting to NAD83.

Mixing NAD27 Data With NAD83 Data

As noted earlier, vast amounts of geospatial information available today were built on NAD27. Large-scale topographic maps produced by USGS are NAD27-based, as are the Forest Service PBS maps constructed from these same USGS bases. Digital data collected from these map sources, such as Cartographic Feature Files and Digital Line Graphs (DLG's), reflect the NAD27 nature of the source map. Unless otherwise transformed, resource information developed from NAD27 map products also contain the NAD27 imprint. Digital Elevation Models produced over the years are "cast" on NAD27, as are most other mainstream data products. In nearly all cases, the geographic information system (GIS) data bases we are assembling are NAD27-based. For the near term, if our data bases are 100 percent NAD27, we should have little problem effectively integrating and using the data for day-to-day decisionmaking.

Nothing, however, remains static for long, especially when working with changing geospatial technologies and ever-expanding mission requirements. Already, we are including more and more Global Positioning System (GPS) data in our data bases—data collected in the NAD83/WGS84 system. We must exercise caution when integrating these data with existing NAD27 data. This is only the start, however. What do we do when we need to gather data for a series of watersheds that extend well beyond a forest boundary? Most would conduct a search for existing data held by the surrounding geospatial community—other Federal agencies, State offices, county public works departments, and so on. How do we react when we learn that some of the data we could use, such as DOQ's and the current county transportation network, happen to be on NAD83, whereas our own data base is on NAD27? Data integration can be quite a challenge when our sources are from mixed datums and we need to integrate vertically (data layering over the same geographic area) and horizontally (tiling, or joining to adjacent data layers). As the greater geospatial community continues its transition to NAD83, how do we effectively share data?

Because the differences between the two datums are known or can be estimated using mathematical modeling techniques, coordinates on one system can be converted or transformed to the other system. Nearly all mainstream GIS, remote-sensing, and automated mapping systems have coordinate transformation capabilities that support the conversion from NAD27 to NAD83 and vice versa. Most are based on the North American Datum Conversion transformation methodology developed by NGS. Conversion tools, when properly used, will allow users to share data and to integrate data bases indefinitely.

Trends

Progress on nationwide conversion to NAD83 has been spotty. For many years, NAD83 has been heavily promoted by the professional organizations that serve the geodetic, surveying, and mapping sciences communities. The Federal Government has stated on many occasions its intent to convert federally funded surveying, mapping, and geospatial data development activities to NAD83. The Geodetic Subcommittee of the Federal Geographic Data Committee continues to work toward this end. Several Federal agencies have taken early steps to establish NAD83 as their foundation for geographic sciences programs. In 1990, largely in response to an emerging partnership with the Department of Agriculture, the USGS began the production of NAD83-based DOQ's. This partnership led to the creation of the National DOQ Program, which serves the Farm Service Agency, Natural Resources Conservation Service, Forest Service, National States Geographic Information Council, and USGS (which also acts as a broker for Department of the Interior agencies). In 1994, USGS shifted the production of topographic maps and DLG's derived from related map revision activity from NAD27 to NAD83. Public Land Survey System coordinate data being collected under the Bureau of Land Management Geographic Coordinate Data Base program is available in NAD83. The Forest Service Geometronics Service Center produces NAD83 DOQ's for the Forest Service, meeting the standards established under the National DOQ Program. Of course, we are aware of GPS data collection that is underway in scores of agencies.

Most States have passed legislation mandating compliance with NAD83 and the related State Plane Coordinate System of 1983 (SPC83). As such, many State, county, and municipal high-resolution, large-scale surveying and data development programs are working within NAD83.

Prospects

Eventually, the greater geospatial community—including the Forest Service—will be working within the NAD83 environment. Until then, we need to be fully aware of the horizontal datums we mix and use. Dialog concerning datum conversion and integration issues should continue, perhaps setting the groundwork for a transition strategy that can be applied across the Forest Service. In the meantime, we need to share our knowledge, ideas, and experiences as we work with spatial data of varied datums.

To this point, we have made no reference to our new vertical datum—the North American Vertical Datum of 1988—another topic for future discussion.

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For more information about NAD27 and NAD83, contact your Regional or Forest Surveyor or your Regional Geometronics Leader. Technical publications and other information are available from NGS. See the NGS entry in "Vectors" (*DATUM*, August 1995, p.13) for information on how to obtain NGS products.

Laser Surveying on the Six Rivers National Forest

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Civil Engineering Technician
Region 5, Six Rivers National Forest

This is not a full-fledged article, just an update on our use of the laser for surveying on the Six Rivers National Forest. The other day we were out doing a site survey on an ongoing contract (one of our biggest watershed restoration projects), and it struck me how fully integrated the laser is into our daily work habits.

During this past year, we have used the laser for practically all of our engineering survey efforts. We used AmeriCorps crews and a variety of personnel with little or no survey experience to survey more than 10 miles of road for decomissioning and obliteration (figure1). At the same time, detailed corridor surveys were performed on the major drains. Even people unskilled with surveying equipment have been able to learn this system quickly and get the job done.

I have used the laser for archeological surveys, stream monitoring, vegetation survey on a lake, trail surveys, road obliteration surveys, and, of course, surveys for road construction and reconstruction. One specialized survey that we did was on a large slide area that was too steep to safely walk on (figure 2). I set up to the side of the slide area, made a note that these were all going to be "ground shots," and just shot directly to the ground in the automatic mode. Later, I entered a minus instrument height, and presto! We had a completed survey. The entire survey took only 2 hours. Any other conventional-type survey would have meant that someone would have had to occupy the middle of the slide area; would have taken 1 or 2 days; and would have involved unsafe working conditions.

Another specialized survey was a lake survey. The specialist wanted to survey vegetation creep into the lake. We sent one instrument onto the lake with a reflector in a kayak and made measurements from the shore. This not only made the job of surveying fun, but was very efficient and maintained a high degree of accuracy.

It's a little hard really to express how useful the laser system has become in our everyday field work. But it's safe to say that if the laser ever needs to go in for repair, I'll be on the phone in a second trying to find another one. Doing a survey without the laser is almost impossible now. Its use has become a necessity.

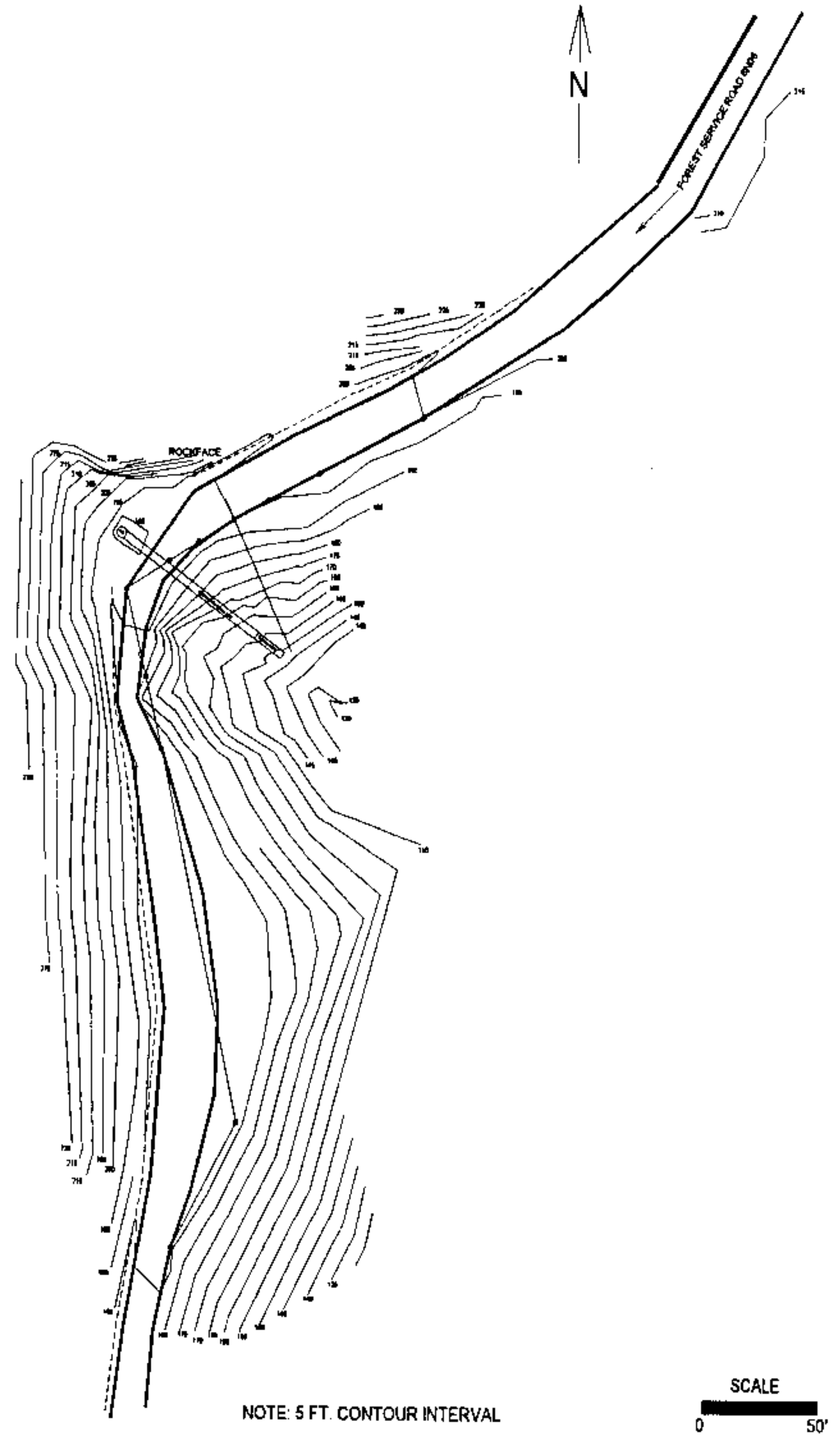

Figure 1—Lower Trinity Ranger District road repair on Route 6.

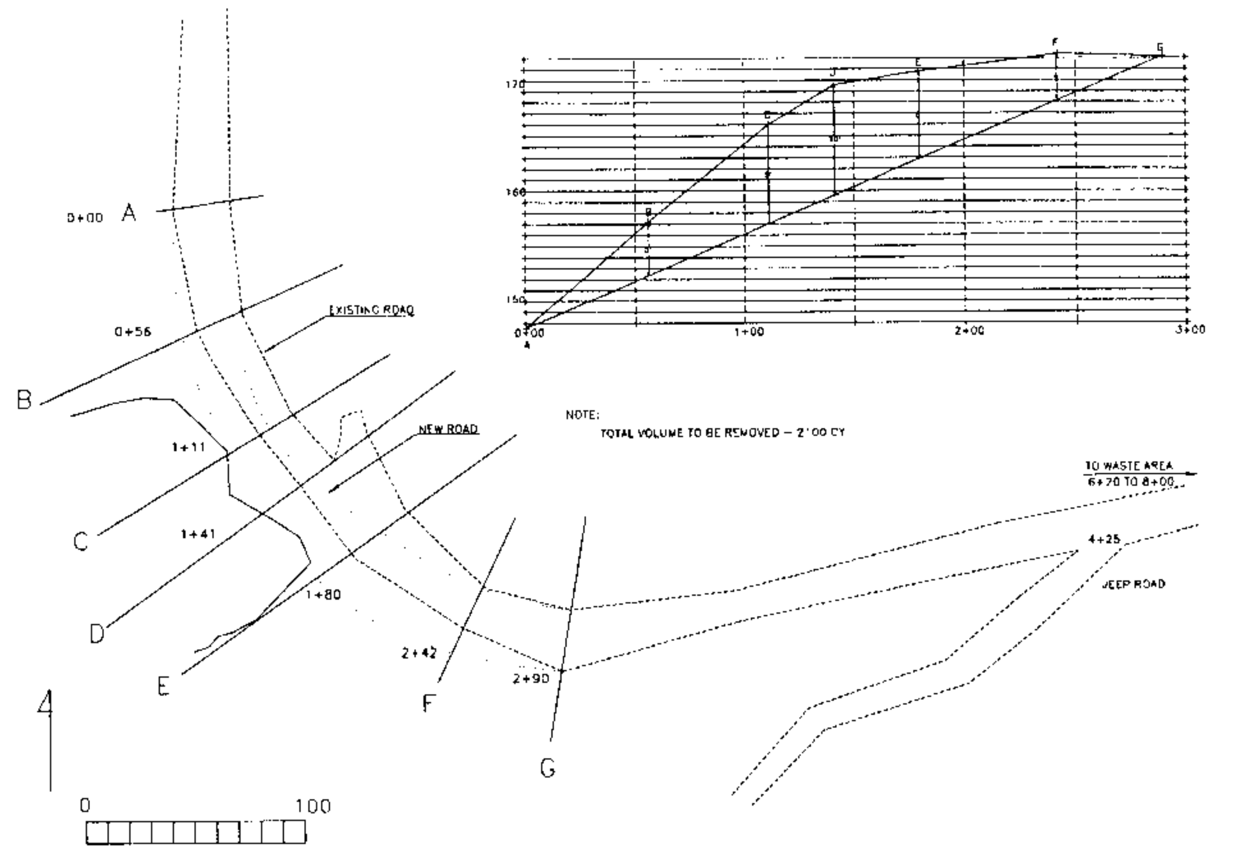

Figure 2—Road realignment.

Bibliography of Washington Office Engineering and Technology & Development Publications

This bibliography contains information on publications produced by the Washington Office Engineering Publications Section and the Technology & Development Centers located in Missoula, Montana, and San Dimas, California. The listing is arranged by publication series and includes the title, author or source, document number, and date of publication.

This issue lists material published since our last bibliography (*Engineering Field Notes*, volume 26, September–December 1994). Copies of *Engineering Field Notes*, *Technology & Development News*, Engineering Management Series, and other publications listed herein are available to Forest Service personnel through the Engineering Staff Technical Information Center (TIC). Copies of "Project Reports," *Tech Tips*, and "Special & Other Reports" are available from the Technology & Development Center that is listed as the source.

USDA Forest Service
Engineering Staff, TIC
201 14th St., SW
Washington, DC 20250

USDA Forest Service
San Dimas Technology & Development Center
444 E. Bonita Avenue
San Dimas, CA 91773

USDA Forest Service
Missoula Technology & Development Center
Fort Missoula, Bldg. 1
Missoula, MT 59801

Engineering Field Notes

Engineering Field Notes is a quarterly periodical that supplies the latest technical and administrative engineering information and ideas related to forestry and provides a forum for the exchange of such information among Forest Service personnel.

EFN by Title

1994 *Engineering Field Notes* Article Awards	Editor. EFN 27 (January–April 1995): 1–4.
1994 *Engineering Field Notes* Article Award Winners	Editor. EFN 27 (September–December 1995): 1.
1994 Forest Service Engineers of the Year	Editor. EFN 27 (January–April 1995): 5–15.
Development of Cushion Aggregate on Native Surfaced Roads by Use of the Roto Trimmer	Northrup, Jim L. EFN 27 (May–August 1995): 3–5.
Energy-Efficient Lighting System Installed in USDA Jamie L. Whitten Federal Building	Murtagh, Ed. EFN 27 (May–August 1995): 3–5.
Ergonomics	GRIST. EFN 27 (May–August 1995): 1–2.
Forest Service Conversion to Metric Measurement	Coghlan, Gerald T. EFN 27 (May–August 1995): 1–2.
Geographic vs. Cartographic	Napier, Barry. EFN 27 (September–December 1995): 3–7.
Improving Culvert Entrances to Increase Flow Capacity	Grimaldi, Carol. EFN 27 (May–August 1995): 15–33.
Laser Surveying on the Six Rivers National Forest	McKinnon, Dennis. EFN 27 (September–December 1995): 21–23.
North American Datums—NAD27 and NAD83	Napier, Barry. EFN 27 (September–December 1995): 13–19.
Portable Generator	GRIST. EFN 27 (January–April 1995): 53–54.

EFN by Author

McCutcheon, John D. and Taylor, Nancy. EFN 27 (September–December 1995): 9–12.	Solar-Powered Fan Improves Vault Toilet Venting
McKinnon, Dennis. EFN 27 (September–December 1995): 21–23.	Laser Surveying on the Six Rivers National Forests
Moll, Jeffry E.; Harrison, Michael; Turner, Ransom; and Sutton, Warren F. EFN 27 (January–April 1995): 27–39.	The Spelunker's Delight: Cave Surveying Made Easy
Murtagh, Ed. EFN 27 (May–August 1995): 3–5.	Energy-Efficient Lighting System Installed in USDA Jamie L. Whitten Federal Building
Napier, Barry. EFN 27 (September–December 1995): 3–7.	Geographic vs. Cartographic
Napier, Barry. EFN 27 (September–December 1995): 13–19.	North American Datums—NAD27 and NAD83
Northrup, Jim L. EFN 27 (January–April 1995): 41–51.	Development of Cushion Aggregate on Native Surfaced Road by Use of the Roto Trimmer
Simila, Keith. EFN 27 (May–August 1995): 7–14.	The Technology and Development Program: A Blueprint for Success
Standing, Paul and Jenner, Steve. EFN 27 (January–April 1995): 17–25.	Solving Dry Problems with Geotextiles

Technology & Development News

Technology & Development News contains information on specific projects, new ideas, and new technologies being developed by the Technology & Development Centers to help solve many different resource management problems.

Title	***Issue***
Call for Assistance—Trail Equipment	May–June 1995
Central Tire Inflation (CTI) Computer Program	May–June 1995
CD-ROM of AutoCAD Drawings Planned	July–August 1995
DGPS Aircraft Systems Seminars	May–June 1995
Dry Weather Commensurate Share Study Report Complete	May–June 1995
Evaluation of DGPS Aircraft Guidance Systems	January–February 1995
Far East GPS Training	July–August 1995
First Precision Positioning Service Receivers Sent Out	July–August 1995
Gravel Bags for Pack Stock	September–October 1995
Grizzly Bears and Food Storage	January–February 1995
LASERSOFT Survey Platform	September–October 1995
Moving Map Display for FPM	July–August 1995
National Standard Wildland Fire Engine Committee Chartered	September–October 1995
National Tree Marking Paint Committee Meeting Held	September–October 1995
New Aviation/Fire *Tech Tips* Issued	September–October 1995
New Recreation Publications Issued	March–April 1995

New Recreation Publications Issued	July–August 1995
New Recreation Publications	September–October 1995
New Timber *Tech Tips* Issued	March–April 1995
New Timber *Tech Tips* Issued	May–June 1995
New Video	January–February 1995
Portable Retardant Bases Tech Tips Issued	July–August 1995
Presentation of Aircraft DGPS Test Results	March–April 1995
Recent MTDC Publications	September–October 1995
Snowmobile Paper	January–February 1995
Spray Drift Task Force	March–April 1995
Transponders	January–February 1995
Tree-Marking Paint	March–April 1995
Tree Damage Publication	May–June 1995
Tree Shelter Durability Study	September–October 1995
Trimble Centurion GPS Receiver Evaluation	March–April 1995
Two Central Tire Inflation (CTI) *Tech Tips*	July–August 1995
Water Treatment System	September–October 1995
Worker Orientation	May–June 1995

Engineering Management Series and Other Publications

The Engineering Management (EM) Series contains publications serving a special purpose or reader and publications involving several disciplines that are applied to a specific problem.

Cartographic Specifications and Symbols. October 1994.	EM 7140-24
Guidelines for the Use of Digital Imagery for Vegetation Mapping. September 1995.	EM 7140-25
Water and Wastewater Systems Self-Study Training Course, Part 1, Job Performance Requirements—Construction Certification Program. Revised May 1995.	EM 7115-511-100
Water and Wastewater Systems Self-Study Training Course, Part 2, Specifications and Drawings—Construction Certification Program. Revised May 1995.	EM 7115-511-100A

Tech Tips

Tech Tips are brief descriptions of new equipment, techniques, materials, or operating procedures.

Title	***Source***	***Number***	***Date***
Central Tire Inflation (CTI) Reduces Sediment Up to 84%—A Method to Help Meet New Water Quality Standards & Guidelines	SDTDC	9525–1303	04/95
CTI Fire Engine Safety	SDTDC	9551–1304	04/95
Design Specifications of a Mini-LIDAR to Track Pesticide Droplets in the Atmosphere	MTDC	9534–2316	09/95
Fixed Tank Systems for Type II and III Helicopters	SDTDC	9557–1307	07/95
Heavy-Duty Leather Gloves: Resized, Improved, and NFPA Compliant	MTDC	9567–2332	07/95
Hot Coals	SDTDC	9523–1309	09/95
HR–1 Helicopter Rappel Harness	MTDC	9557–2305	02/95
Improved Bag Design Provides Easier Fire Shelter Access	MTDC	9551–2335	05/95
Jet Boat Hearing Safety	SDTDC	9523–1308	08/95
Military PLGR GPS Receiver	MTDC	9571–2334	06/95
New Forest Service Briefcases	MTDC	9551–2336	06/95
New Method for Marking Logs	SDTDC	9524–1302	04/95
New Warm Weather Sleeping Bag	MTDC	9551–2333	05/95
Northern Pocket Gopher	MTDC	9524–2337	07/95
Obliterating Animal Carcasses With Explosives	MTDC	9523–2315	01/95

Pipe Bundler and Pipe Mat Stream Crossings	SDTDC	9524–1301	02/95
Portable Retardant Bases	SDTDC	9557–1305	06/95
Positive Locking Feed Control Assembly for the Premo MK III Sphere Dispenser	MTDC	9551–2310	01/95
Rock Carriers for Trail Work	MTDC	9523–2849	09/95
Static Bonding and Grounding When Handling Flammable and Combustible Fuels	MTDC	9551–2323	03/95
Toilet Vent Stack Maintenance	SDTDC	9523–1306	07/95
Trimble CENTURION GPS Receivers	MTDC	9571–2317	02/95
Visitor Information Boards in Recreation Areas	MTDC	9523–2302	11/94

Project Reports

Project Reports are detailed engineering reports that generally include procedures, techniques, systems of measurement, result, analyses, special circumstances, conclusions, and recommendations rationale.

Title	***Source***	***Number***	***Date***
About MTDC: Missoula Technology and Development Center	MTDC	9571–2814	01/95
Animal Resistant Garbage Containers	SDTDC	9523–1205	07/95
Blasting Activities on the Tongass National Forest: Trip Report	MTDC	9571–2801	11/94
Care, Use and Maintenance of Hose for Wildland Fire Applications	SDTDC	9551–1204	06/95
Cleaning Recreation Sites	SDTDC	9523–1206	08/95
Planning Guide for On-Site Greywater Disposal Systems for Recreation & Administrative Sites	SDTDC	9523–1201	04/95
DGPS in Aerial Spraying in Forestry: Demonstration and Testing: Final Report	MTDC	9534–2848	09/95
DGPS Navigation Systems for Agricultural Aircraft in Forestry: Test Plan	MTDC	9534–2807	10/94
Fireline Trenchers: 1934–1994	MTDC	9551–2811	01/95
The FS–14—An Improved Smokejumper Parachute Canopy	MTDC	9557–2822	03/95
Geosynthetics for Trails in Wet Areas	MTDC	9523–2839	09/95
Gravel Bags for Packstock	MTDC	9523–2840	06/95
Health Hazards of Smoke: Fall 1994	MTDC	9551–2808	
Health Hazards of Smoke: Spring 1995	MTDC	9551–2831	

Investigating Wildland Fire Entrapments	MTDC	9523–2845	08/95
Low Impact Food Hoists	MTDC	9523–2809	11/94
Making a Crew: Part I: Putting a Crew Together: Worker Orientation Training Program—Facilitator's Guide	MTDC	9567–2803	04/95
Missoula: Forest Pest Management (Level 1)	MTDC	9534–2826	07/95
Missoula: Reforestation and Nurseries (Level 1)	MTDC	9524–2828	06/95
Missoula Technology & Development Center: Forest Pest Management 5-Year Program: Supporting Forest Health	MTDC	9534–2825	02/95
MTDC 1994 Publications: Missoula Technology and Development Center	MTDC	9571–2818	
Non-Chemical Orchard Sanitation: FY 95 Progress Report	MTDC	9534–2846	06/95
The Northern Pocket Gopher—Most of What You Thought You Might Want to Know, but Hesitated to Look Up	MTDC	9525–2806	08/95
Remote Detonation System for Blasting	MTDC	9571–2821	06/95
Remote Waste Management	SDTDC	9523–1202	05/95
The Role of Atmospheric Stability in the Dispersion of Pesticides in the Atmosphere	MTDC	9534–2829	03/95
Selection and Use of Preservative Treated Wood in Forest Service Recreational Structures	SDTDC	9523–1203	05/95
Snowmobile Stopping and Sign Recognition Distances	MTDC	9523–2813	12/94
Techniques and Equipment for Gathering Visitor Use Data on Recreation Sites	MTDC	9523–2838	08/95

Testing DGPS Aircraft Guidance and Recording Systems for Use in Complex Terrain: Preliminary Report	MTDC	9534–2812	11/94
Thermal Insect Control: FY 95 Progress Report	MTDC	9534–2843	06/95
VALDRIFT 1.0—A Valley Atmospheric Dispersion Model With Depositon	MTDC	9534–2844	08/95

Special and Other Reports

Special and Other Reports include papers for technical society meetings and transactions, descriptive pamphlets, bulletins, and special purpose articles.

Title	Source	Number	Date
Composting Toilets	SDTDC	9523–1803	07/95
Foam Applications for Wildland & Urban Fire Management	SDTDC	Volume 7, No. 1	05/95
Foam Applications for Wildland & Urban Fire Management	SDTDC	Volume 7, No. 2	08/95
Interagency Retardant Base Planning Guide Fixed and Rotor Wing	SDTDC	NFES 1259*	03/95
Lot Acceptance, Quality Assurance, & Field Quality Control for Fire Retardant Chemicals	SDTDC	NFES 1245*	04/95
Spark Arrester Guide, Multiposition Small Engine (MSE) [Volume 2]	SDTDC	NFES 2363*	05/95
Spelunker's Delight: Cave Surveying Made Easy	SDTDC	9523–1801	02/95
Soil Stabilizers	SDTDC	9523–1804	09/95
Your Fire Shelter: 1995 Edition	MTDC	9551–2819 NFES 1570*	04/95
Performance Evaluation of Dense Gas Dispersion Models (Reprinted from *Journal of Applied Meteorology*, Vol. 34, No. 3)	MTDC	9534–2830	03/95
Environmental Fate and Accountancy, Chapter 7 (In: *Biorational Pest Control Agents: Formulation and Delivery*, American Chemical Society Symposium Series 595)	MTDC	9534–2842	

*National Fire Equipment System (NFES) publications must be purchased from the National Interagency Fire Center (NIFC), Bureau of Land Management Warehouse, Supply; 3905 Vista Avenue, Boise, ID 83705.

Errata to "Spelunker's Delight: Cave Surveying Made Easy"

In the January–April 1995 issue of *Engineering Field Notes*, a sentence on the first page of the "Spelunker's Delight: Cave Surveying Made Easy" article was incorrect. The last sentence on page 27 of the article reads "... assist in monitoring cave rescues." This sentence should read "... assist in monitoring cave resources."

Engineering Field Notes

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