Technical Supplement 2

Use of Historic Information for Design

Issued August 2007

Cover photo: Historical maps, aerial photos, and other information can be used to put the stream in context today. Rates of bank erosion, meander migration, channel width, riparian vegetation, and watershed land use and cover conditions can be estimated using historical information and may provide valuable data for the current design.

Advisory Note

Techniques and approaches contained in this handbook are not all-inclusive, nor universally applicable. Designing stream restorations requires appropriate training and experience, especially to identify conditions where various approaches, tools, and techniques are most applicable, as well as their limitations for design. Note also that product names are included only to show type and availability and do not constitute endorsement for their specific use.

Technical Supplement 2

Use of Historic Information for Design

Contents

Introduction **TS2–1**

Basic data sources and techniques **TS2–1**

Contemporary descriptions **TS2–1**

Weather events and climate **TS2–1**

Land use **TS2–1**
Land use changes TS2–3
Land (cadastral) surveys TS2–3

Historic condition **TS2–5**
Field evidence TS2–5
Litter TS2–6
Permanent landscape features TS2–6

Historic maps **TS2–10**
Instrumented topographic surveys TS2–12

Aerial photographs **TS2–12**
Ground-based oblique photography TS2–12
Photographs of site TS2–14
Descriptive accounts and interviews with residents TS2–14

Summary and conclusions **TS2–14**

Tables

Table TS2–1 Sources of historic condition information TS2–5

Figures

Figure TS2–1 Precipitation time trends in the Driftless area of the Upper Midwest, 1867–1974 TS2–2

Figure TS2–2 Changes of land use, Coon Creek, WI, 1850–1975 TS2–3

Figure TS2–3 Sediment deposition rates based partially on topographic surveys at selected valley sites in Coon Creek Basin, WI, 1853–1977 TS2–4

Figure TS2–4	Cross sections of Middle Oconee River at Highway 11 bridge, Jackson County, GA, showing stream aggradation between 1928 and 1969, based on bridge plans and resurvey	TS2–6
Figure TS2–5	Headwater erosion rates based on sediment accumulation behind a small dam, Vernon County WI, 1936–1977	TS2–8
Figure TS2–6	Sediment yields for the Tennessee River Basin c.1940–1975, based on TVA reservoir surveys	TS2–9
Figure TS2–7	Original land survey plat of the confluence of Sandy Creek with the North Oconee River, dated 8 Jan. 1785	TS2–11
Figure TS2–8	Air photos showing changes in land use in Vernon County, WI, between 1934 and 1967	TS2–13
Figure TS2–9	Oblique ground photos showing improvement of tributary streams in Vernon County, WI, 1940–1974	TS2–14

Technical Supplement 2

Use of Historic Information for Design

Introduction

This technical supplement describes the use of historic information in the assessment of stream and watershed form and process. Form and process of effects in one place, however, may be the cause of form and/or process elsewhere. The historic assessment of climate and land use can also address causes. This information can be invaluable in the determination and assessment of goals and objectives.

Basic data sources and techniques

The value of the historical approach is shown not only by the number of practitioners who use an historical basis in determining project goals but also by the number of methodological papers on this topic which have appeared in the last quarter century. The reader is directed to Thornes and Brunsden (1977); Hooke and Kain (1982); Gregory and Walling (1979, 1987); Grove (1988); Cooke and Doornkamp (1990); Trimble and Cooke (1991); Trimble (1998); Collins and Montgomery (2001); Trimble (2001); Brown, Petit, and James (2003); Gurnell, Peiry, and Petts (2003). While it is possible to identify some general principles of using historical data, it is impossible to give clinical directions on their use because every application is different; the reader should refer to the works listed above. Instead, this chapter presents some basic approaches using historical data and analyses of the study of stream and watershed forms and processes.

Contemporary descriptions

Written accounts take two basic forms. The first is a description of past events or changes, while the second is the description of contemporary or baseline conditions useful for later comparisons. One must consider the scientific credentials of the observer and the stage of scientific development at time of the observation. Accounts from scientific observers tend to be dependable and are often extremely helpful, especially when they relate to direct observations like the clarity of streams. Observations from less-qualified people also can be helpful, but may need more qualification or interpretation. Newspapers, periodicals, books, government records, and unpublished manuscripts are somewhat less valuable sources.

Weather events and climate

Recorded climatic records, especially regular records kept by governmental agencies, are often of exceptional value to stream studies. Figure TS2–1 shows an example of available precipitation data for the Driftless Area in the Upper Midwest, along with some analyses (U.S. Weather Bureau data; Trimble and Lund 1982). Official climate records extend to the mid-19th century in the United States, but scattered records were collected earlier. Particular storms may have significant geomorphologic effects locally or over larger areas, but little daily data are available. Cuts and fills in streambanks over time can also reflect the geomorphic history of a stream, where these data are available.

Stream and sediment discharge records—Stream discharge data for the United States extend to about 1850, are quite plentiful for this century, and most are easily available on the Internet. Suspended sediment data are available for certain streams, starting as early as about 1905. Web sites for various agencies with data on water quality and quantity are found in Ward and Trimble (2004) and described in NEH654.05.

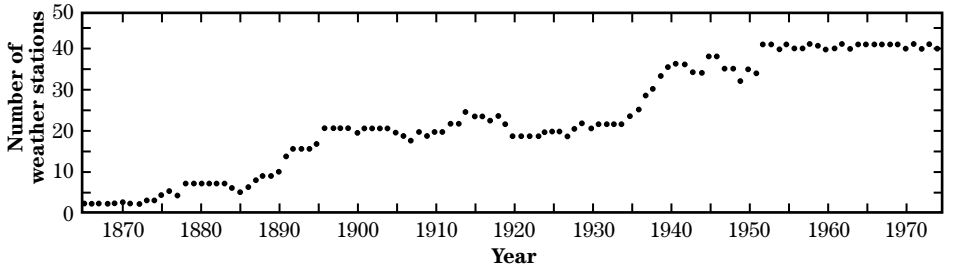
Land use

Land use has been increasingly recognized as a major causal factor in stream change. Reconstructions of land use need to be as precise as possible because increasingly sophisticated information about the hydrologic and geomorphic effects of different land uses and treatments are available. Historical land use may be correlated with contemporaneous geomorphic phenomena in model building.

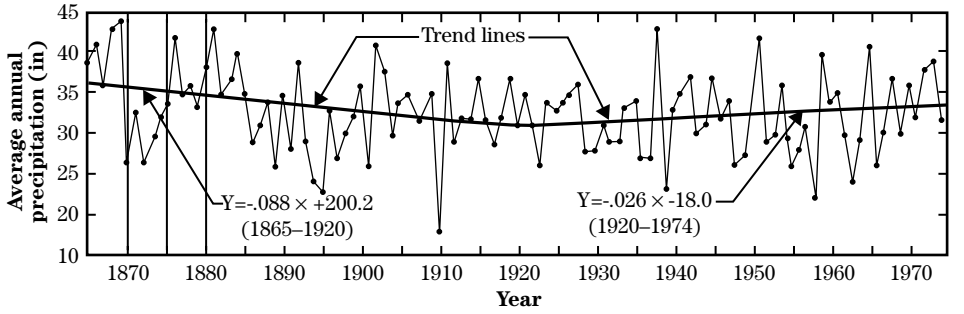
Agricultural census data may be complex and confusing because categories and definitions often change from one census to the next. For the United States census, county enumerations are for “land in farms” only and sometimes cover only fractional parts of counties. Where available, the census manuscripts,

Figure TS2–1 Precipitation time trends in the Driftless Area of the Upper Midwest, 1867–1974. The sigma notation denotes 1 standard deviation from the mean. (a) Number of weather stations; (b) Average annual precipitation and time trends, (c) Relation of annual precipitation and storms exceeding 2.5 inches in 24 hours; (d) 3-yr moving average annual precipitation.

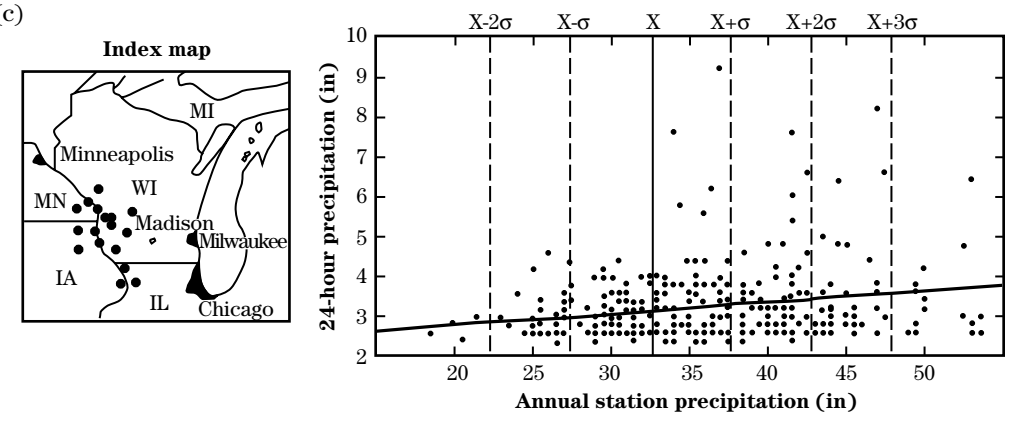
(a)



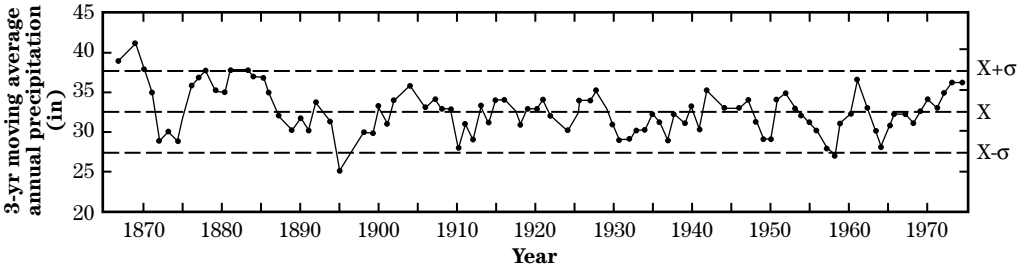
(b)



(c)



(d)



rather than the published reports, give far more detailed information. Another major problem is that areas of enumeration units change with time, so that the boundaries and areas must also be reconstructed (Trimble 1974). Unfortunately, as yet there are no guides to the use of census data in reconstructing historic land use, and a great need clearly exists.

Land use changes

Although not specific to a stream's local geomorphic condition, land use change information should be compiled. This can assist the stream restoration designer in ensuring that a proper analogue is selected for design work. If land use in a watershed has changed substantially, historic and even local geographic analogues may be inappropriate templates for design work. Changes in land use may be gradual, abrupt, or seemingly episodic over time, depending on climate fluctuations, population changes, and shifts in agricultural commodity markets, as illustrated in the example data set shown in figure TS2–2 (U.S. Census of Agriculture data, Trimble and Lund 1982).

Land (cadastral) surveys

While only planimetric land surveys can often supply important information to the fluvial geomorphologist. The original United States land surveys have been used to establish pre-agricultural flood plain conditions, upland vegetation, and stream widths. In other areas and in more recent periods, ongoing land resurveys sometimes give useful descriptions of geomorphological interest. Figure TS2–3 illustrates stream cross-sectional surveys and trends in watershed sediment delivery rates for the Coon Creek Basin in Wisconsin (Trimble and Lund 1982).

Figure TS2–2 Changes of land use, Coon Creek, WI, 1850–1975

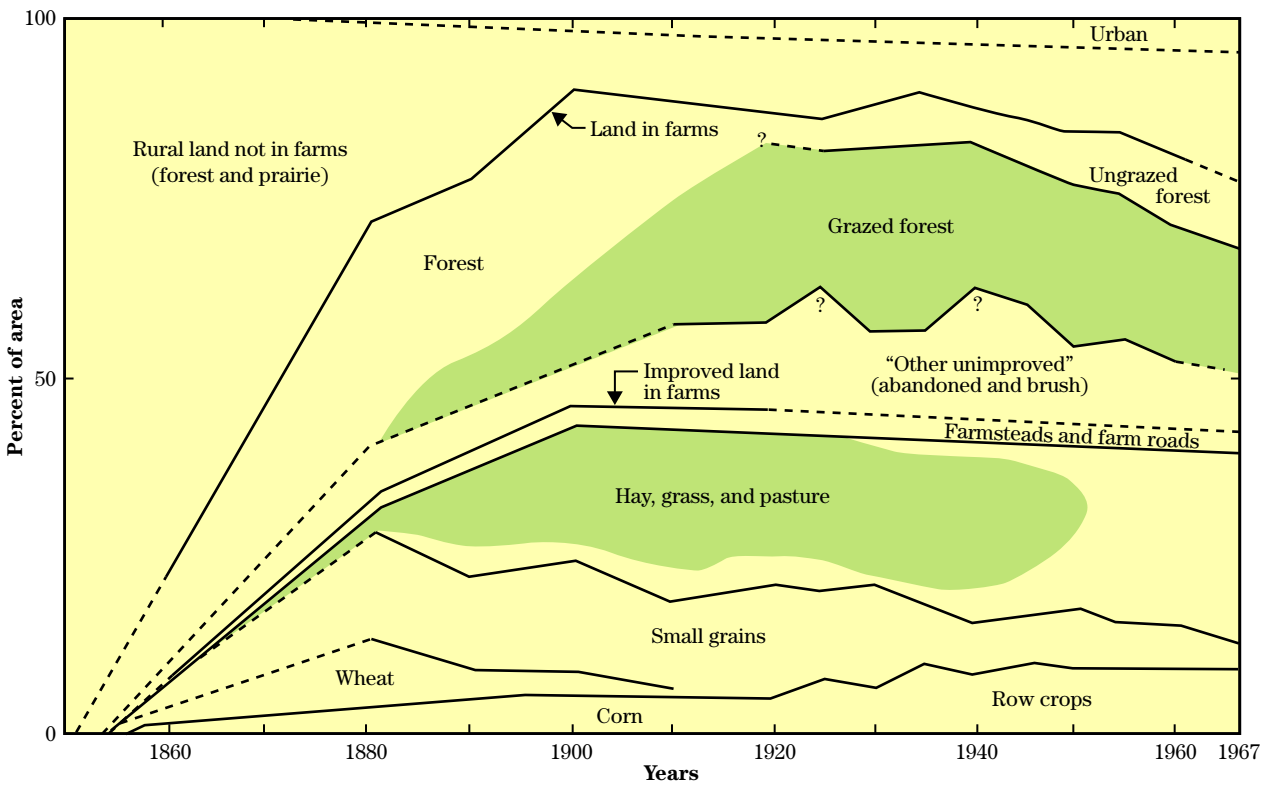
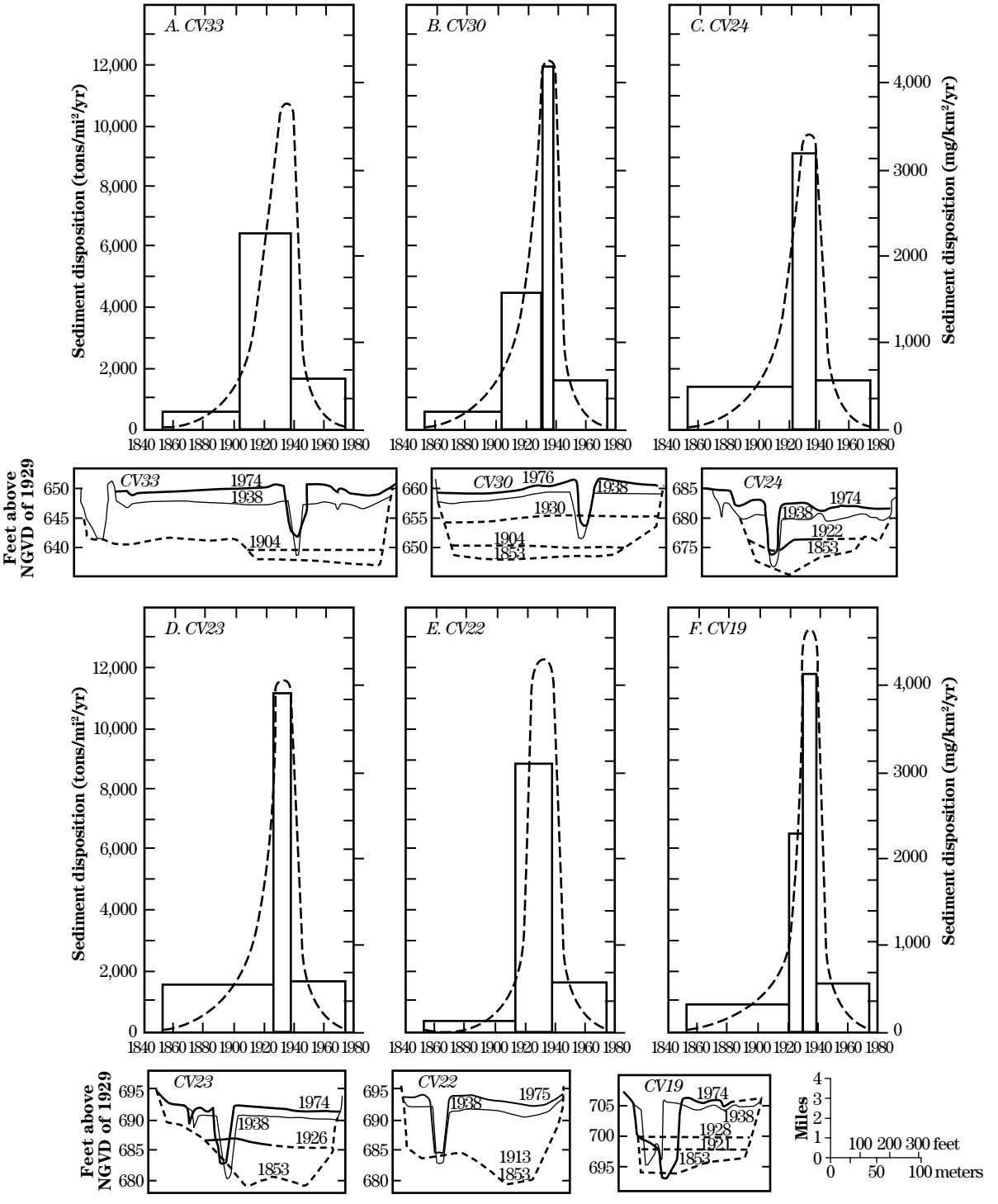


Figure TS2–3 Sediment deposition rates based partially on topographic surveys at selected valley sites in Coon Creek Basin, WI, 1853–1977



Historic condition

A stream's historic condition may be a useful target condition for physical restoration work if the causes of the degraded condition are local. The historic condition integrates many natural and human variables that controlled stream character at that past time. The historic condition can be an appropriate template for restoration design if these variables are relatively unchanged. Sources of information on a stream's historic condition include photographs and maps, written references and reports, people with long-time knowledge of the area, highway and railroad bridge data, and field evidence (table TS2–1). The more accurate information that can be obtained about the historic stream planform pattern, longitudinal profile, and cross-sectional dimension, the greater the information can contribute to development of a template for restoration work. The information about the historic condition, in most cases, is of limited accuracy will probably contribute only a part of the information necessary to develop a restoration design.

Field evidence

Where a channel has been substantially modified from its historic condition (for example, channelized) or relocated by people, some field evidence of the historic stream condition may be preserved in the form of natural surface topographic features, soil patterns, and vegetation patterns. Surface topographic features may help to characterize the historic stream and include relict channel sections, cut banks, levees, stream terraces, and flood plain wetlands. Flood plain wetlands, or wetland soils indicative of the former presence of wetlands, may also help to determine the stream's historic position and pattern. However, recent flood plain fill, alterations, or deposits may obscure remains of natural features. Riparian zone vegetation may obscure natural features, but leaf-off times would yield better results. Aerial photographs should be obtained to aid in locating these natural features if the stream reach to be restored is substantial in length.

Cultural features with documented locations may provide field evidence of the former position of the stream channel and bank prior to any changes in the stream's depth, cross section, or location. Bridge support and streambank stabilization structures that were constructed in or immediately adjacent to the stream may provide particularly good information. In urbanized areas, gravity-fed sewer system pipes and manholes typically follow stream valleys. Exposure of subground portions of these features can provide dramatic evidence of stream position change, with exposure of subground instream cultural features being strong evidence of downcutting. Where numerous cultural features provide evidence of a stream's former vertical and or horizontal position, the more likely that the watershed condition has changed substantially over time and the less likely that these features would be useful as historic analogues, since stream hydrologic condition may have changed substantially since their construction. Local cultural features may also have been the cause of current degraded conditions. If so, it is important to identify potential cultural features that could impact stream conditions and collect sufficient information to determine whether or not a stream is still responding to altered conditions caused by these constructed features.

Table TS2–1 Sources of historic condition information

Source of historic condition information	Aerial photo	Map	Descriptive accounts	Surface photo	Field evidence	Survey notes	Bridge design data
Planform pattern	✓	✓			✓	✓	✓
Channel dimension			✓	✓	✓	✓	✓
Longitudinal profile			✓	✓		✓	✓

Litter

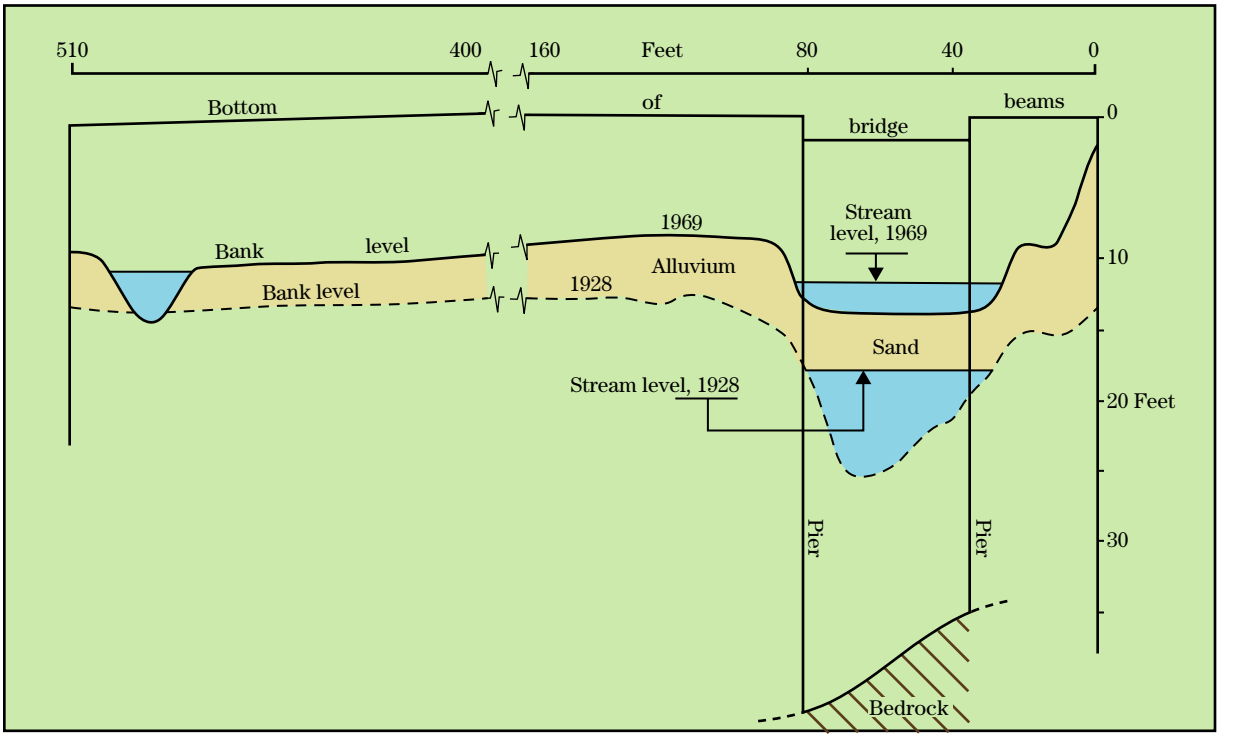
Litter includes mobile artifacts such as tools, vehicle parts, bottles, cans, package wrappers, and any other dateable artifacts. Although litter may be precisely dated in some cases, its location can only give an earliest possible date. For example, a can dateable to 1939 may have been dumped into a stream in 1950 where it was later buried in a point bar in 1952. The point bar may have eroded away in 1960 and the can buried 20 centimeters deep on a downstream flood plain. The only allowable conclusion is that there has been a minimum accretion of 20 centimeters at the final location since 1939. However, finding several items at similar levels with similar dates might allow a stronger inference. For example, an intact dump located in a flood plain with several items of similar dates could be valuable.

Permanent landscape features

Common, permanent landscape features including bridges, dams, mills, reservoirs, fords, fish traps, roads, canals, causeways, and buildings can sometimes act as gages to assist in measuring fluvial change.

Bridges—Inspection of older bridges by a practiced eye can often yield immediate information about stream processes. Reduced cross-sectional flow area under the bridge may indicate that the stream is aggrading. Burial of structural members (wingwalls) that are usually exposed to the stream may also indicate aggradation. Degrading streams, on the other hand, can often be diagnosed by old water lines left on structural members by exceptionally large openings and by the exposure of structural members (footings, pilings) which are usually placed beneath the water surface. Figure TS2–4 shows changes in stream morphology based on comparison of bridge plans with new survey data (Trimble 1970b).

Figure TS2–4 Cross sections of Middle Oconee River at Highway 11 bridge, Jackson County, GA, showing stream aggradation between 1928 and 1969, based on bridge plans and resurvey



Often of greater value are bridge plans. These usually include a stream and valley cross section surveyed before bridge construction that can be resurveyed for comparison. In comparing profiles, it must be ensured that the present bridge has not induced local scour or deposition, which would make comparison difficult or invalid. Often, plans include a detailed topographic map of the stream reach, and some plans may also include surveyed cross sections at some distance upstream or downstream. The latter surveys are particularly valuable because they are less affected by scour effects induced by some bridges.

Often, several bridges were built and rebuilt at the same site. Highway bridge plans in the United States often go back to the turn of the century and railroad plans to the mid- to late 19th century. Fortunately, the same vertical datum is normally used for successive bridges at a site, so that resurveys of century-old profiles are possible. Even when a datum changes, parts of the old bridge may be excavated to reestablish elevations.

Bridges are usually inspected periodically by government agencies. The resulting reports usually contain considerable description and measurements of site conditions and often include photographs that allow time-lapse photography.

Dams, *mills*, *reservoirs*, *fords*, *and fish traps*—Changes in streams often create severe problems in the operations of mills and reservoirs, and such problems may be documented. While nearly all water-powered mills had reservoirs, most of these were channel-type pools that had very low trap efficiency for sediment. More fortunately, some mills, and later hydroelectric and flood-control dams, have a large volumetric capacity in relation to their drainage area and, therefore, have a high trap efficiency so that sediment yield can be measured with some confidence. These data have the advantage of often being long term and include normally unmeasured sediment (bed load), but caution must be taken to consider the sediment from shoreline erosion. Many reservoirs are resurveyed periodically. These survey data can be obtained from government agencies or the people who surveyed the reservoir.

Figure TS2–5 shows a series of detailed surveys of sediment accumulated over time behind a gully-plug dam in Wisconsin (Trimble and Lund 1982).

Figure TS2–6 shows the variability in sediment production rates in watersheds in the Tennessee River Basin (Trimble and Carey 1992).

Roads, *canals*, *and causeways*—Roads (including railroads) and causeways serve as benchmarks to measure changes in stream morphology and process such as lateral movement of streams or gullies. When the location of a road or canal in relation to the stream can be determined from documentary evidence such as old maps or aerial photographs, its present location will allow an average rate of lateral migration to be calculated. Authorities will normally take whatever measures are necessary to protect a road or canal affected by a laterally migrating stream. Some sort of documentation is normally prepared, often with plans and maps. Structures put into place then act as benchmarks to measure future stream movement. Other road protection structures useful for future measurement are dikes, levees, and riprap. Additionally, roads are often raised by fill above normal flooding or aggrading flood plains, and the level of the old road beneath may be determined from construction plans, borings, or excavations.

Buildings—Except for occasional mills, buildings are rarely constructed on active flood plains and even when close to streams, they are usually sited on terraces. Thus, when a structure is affected by sediment, it indicates important changes in the stream or in sediment regime. Generally, when a building is significantly impacted by water and/or sediment, steps are taken to move or raise the building, if possible. If not, the building is usually dismantled, leaving only the foundation, which itself can serve as a benchmark. Once the foundation has been covered with sediment, however, the location must be established from old maps, land plats, eyewitness testimony, or even subsurface radar. Likewise, the chronology must be established from maps, land survey plats, tax records, or eyewitness accounts. Unlike roads and causeways, which may be located by borings, it is best to excavate around as much of the building as possible because it is necessary to see how the building's occupants interfaced with the stream. For example, did an entrance face the stream? Artifacts between the building and the stream such as steps, walks, fences, and small outbuildings would imply that the area was frequented by people at one time, thus implying low frequency of flooding. Buildings also may be occasionally useful for measuring stream channel erosion.

Figure TS2–5 Headwater erosion rates based on sediment accumulation behind a small dam, Vernon County, WI, 1936–1977

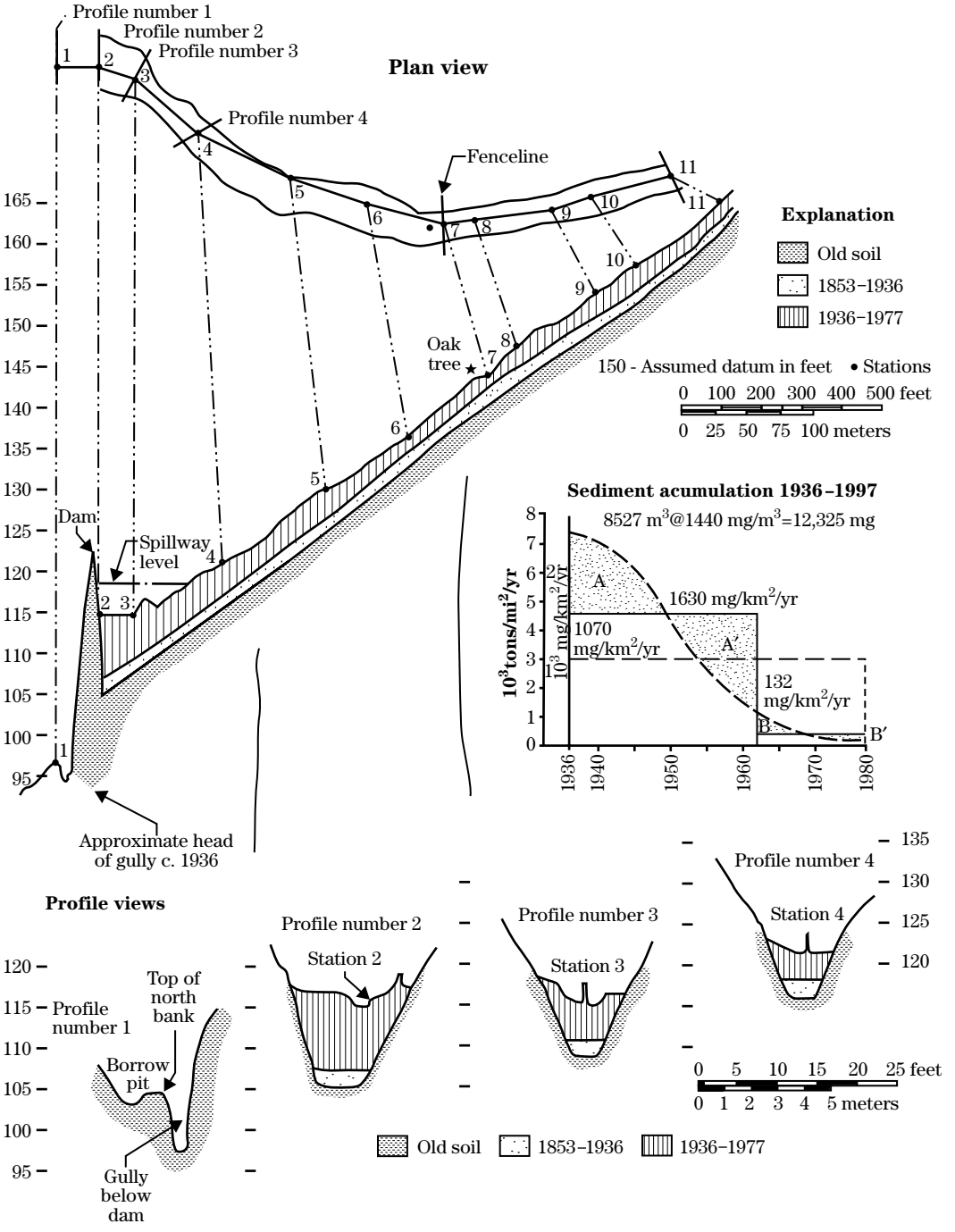
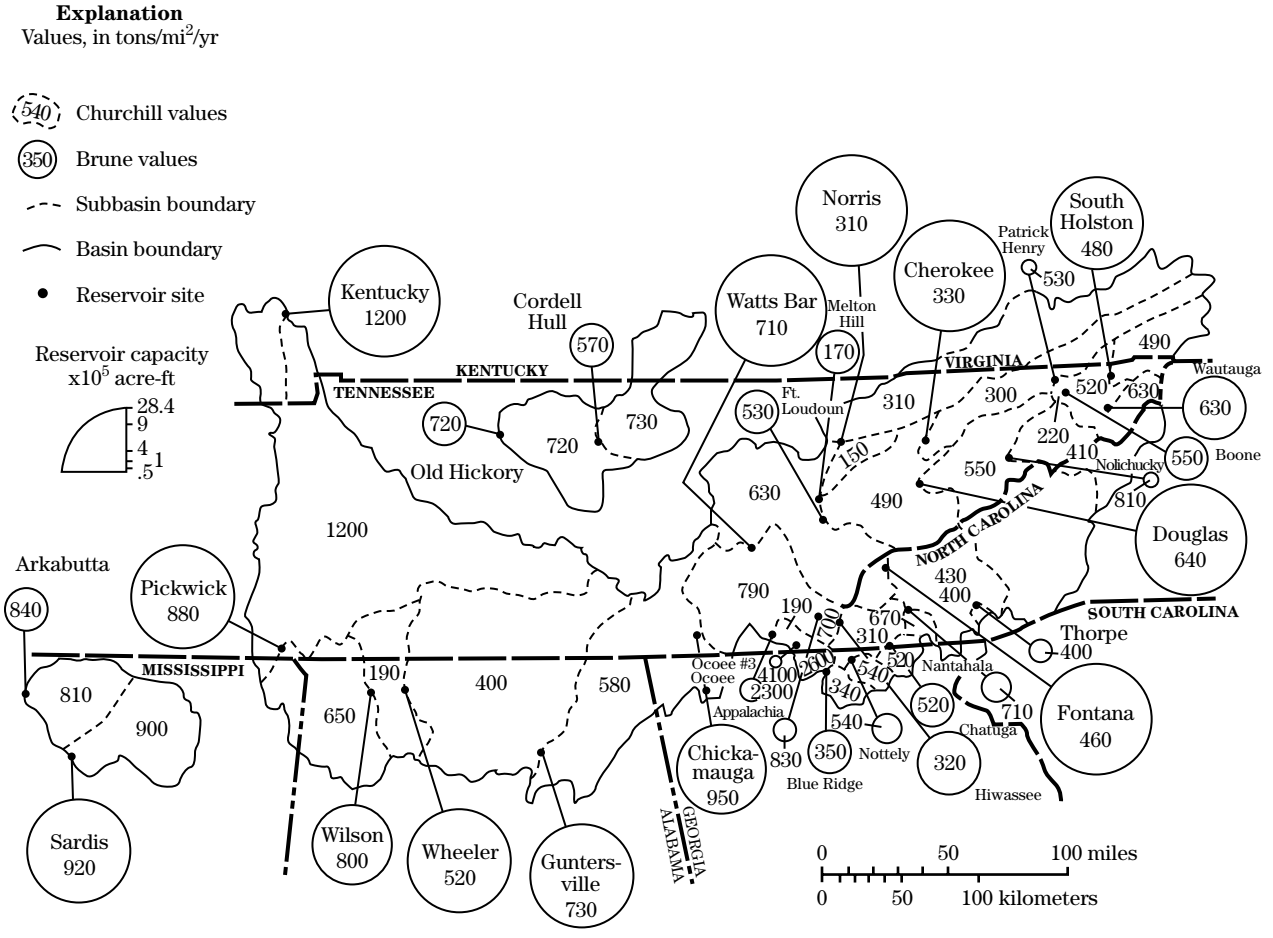


Figure TS2–6 Sediment yields for the Tennessee River Basin c.1940–1975, based on TVA reservoir surveys



Historic maps

Historical maps can be an invaluable source of site-specific information to characterize past stream conditions. Historical maps are housed in many different collections, including libraries and historical societies, as well as local, state, and Federal government agency offices. For many areas of the United States, U.S. Geological Survey (USGS) maps are the oldest accurate maps available. USGS maps date from 1879 when systematic mapping of the country was begun in the West. Web sites of the USGS, National Archives, and Library of Congress are particularly valuable sources for locating older maps. The USGS Web site also contains information on mapping standards.

Information on past stream condition that can be derived from historic maps is limited by map scale, accuracy of original survey work, and climatic controls on stream character. In many areas, USGS topographic maps are often the largest scale historic maps available. Because USGS topographic maps are produced at infrequent intervals, only very long-term trends can be determined. This may prevent a detailed understanding of the effects of short-term physical processes and stream morphological responses.

Before the advent of aerial photography, streams were sketched in the field. The USGS generally mapped streams when water levels were at normal stage. The sketching of shorelines of broad rivers, however, was a perplexing problem due to periodic fluctuations in width. Riparian vegetation and other features also reduced map accuracy, depending on the date of observation. USGS map accuracy improved with the use of aerial photography beginning in the 1930s. Map accuracy further improved following establishment of national accuracy standards in the 1940s and the establishment of better horizontal control features in the 1950s. Since the 1940s, national map accuracy standard requires that 90 percent of defined test points are within 40 feet of their true horizontal position (large scale USGS maps, 1:24,000 scale). Older USGS maps were not subject to this standard. Currently proposed standards require that definite streams be depicted within 0.02 map inches (40 ft at 1:24,000 scale) of their horizontal position.

The mapped accuracy of stream width by the USGS also depends on mapping conventions related to stream width. Before 1954, USGS maps depict streams as double lined only when actual width could be displayed without exaggeration. In 1954, USGS adopted a standard whereby the minimum stream width required for depiction using double lines on a map was 40 feet for 7.5-minute maps and 80 feet for 15-minute maps. These criteria, however, had probably been widely used for several years beforehand. In 1993, the minimum width requirement for a stream to be depicted as a double line on 7.5-minute maps was increased to 50 feet. Streams narrower than this width criterion are depicted as single lines. On USGS maps from the 1800s through the 1950s, streams mapped as single line were depicted as tapering to become narrower towards the headwaters, and small side tributaries were depicted using a smaller weight single line than the mainstream. However, this was done to connote that the stream width decreases proceeding towards the headwaters, rather than to map specific stream widths. From the 1950s onward, all streams too narrow to meet the double-line width criterion are depicted as single bluelines of the same width, regardless of their actual width. Therefore, it is not possible to accurately determine the width of streams mapped as single lines on historic or current USGS maps.

In the vicinity of an engineered feature, such as a road or railroad, mapmakers often displace natural features slightly to allow for depiction of both engineered and natural features in a space on the map otherwise too small to permit both to be mapped to scale. Thus, this displacement possibility should be considered when using maps as sources of information about historic stream planform and width in vicinity of engineered features.

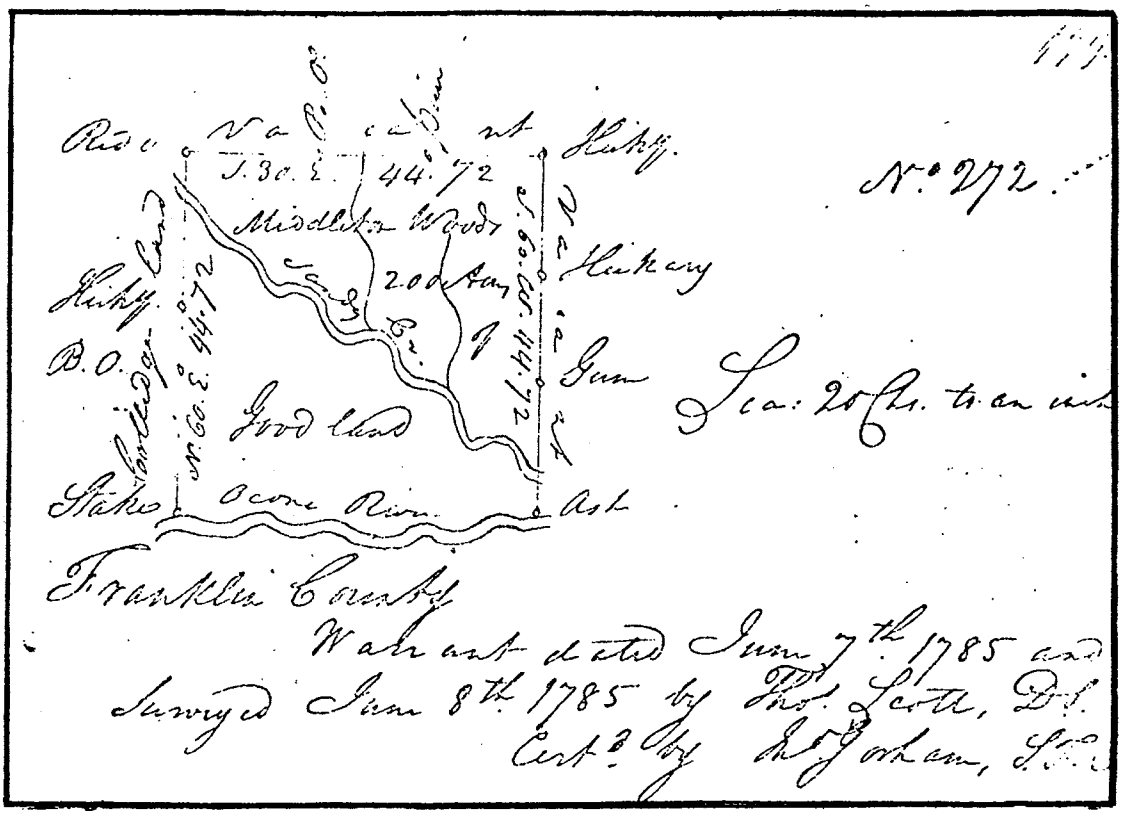
Positions of streams in arid regions are often relatively indefinite, as a consequence of infrequent flow conditions. In these regions, it would be inappropriate to scrutinize historic maps for specific channel location information.

Historic USGS maps can provide only limited information on elevational and longitudinal profile changes. National map accuracy standards established in the 1940s require that 90 percent of tested elevations on all USGS contour maps on all publication scales lie within a half the mapped contour interval. Currently proposed standards require that definite streams be depicted within a half contour interval of their verti-

cal position on USGS maps. In mountainous regions, the wide footage between contour intervals generally limits the ability to detect stream elevation and longitudinal profile changes, where substantial change has occurred. In flat areas, the great lateral distance between contour intervals typically limits the ability to accurately determine elevation changes over time. The range in potential change, however, is inherently much less.

Historic survey maps and associated notes can also be valuable sources of information. Surveys provide far greater detail than do regional maps. Streams were important resources to property owners, and creeks and rivers often form property boundaries, increasing the likelihood that valuable information on stream condition may be recorded in property surveys. Local governments, libraries, and local historical societies may also have historic property survey information. Surveys conducted in association with construction of structures over and along a stream by private individuals, commercial enterprises, and government agencies are of particular value. Government agencies involved in streamside projects potentially include highway departments, water supply and sanitary sewer agencies, the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), U.S. Department of Interior (DOI) Bureau of Land Management (BLM), and USACE. The agencies involved in these past activities can be contacted for potential historic survey information that they have on file. Figure TS2–7 illustrates how the historical condition can be compared to the current condition, based on old land survey maps and information (Trimble 1970b). Because of stream aggradation, the area noted as good land in 1785 was swamp by the 20th century.

Figure TS2–7 Original land survey plat of the confluence of Sandy Creek with the North Oconee River, dated Jan. 8, 1785



Instrumented topographic surveys

While not available for many locations, topographic surveys may be the best quality data available. In this category are general topographic maps, which have existed in the United States for more than 100 years, created mostly by the USGS; precise river surveys, usually by the USACE; detailed maps of coastal areas including stream and estuaries with bathymetry, usually by the U.S. Coast and Geodetic Survey; stream stage-discharge studies by USGS and other agencies; and flood studies by various agencies.

Aerial photographs

The first aerial photographs available date from the 1800s when photos were taken from balloons and kites. Geographic coverage by these photos, however, is very limited. Aerial photography became widely practiced in the 1930s. The Library of Congress maintains a collection of aerial photographs taken between the early 1900s through the 1940s, and information on how to obtain these can be obtained at the Library of Congress Web site. Photographs taken by Federal agencies from the 1930s through 1940s for mapping purposes that cover approximately 80 percent of the area of the lower 48 states are available through the National Archives. Information on how to obtain copies of these photos is on the National Archives Web site. The USGS maintains a collection of aerial photographs taken since the 1940s. Information on obtaining copies of these photos can be obtained by visiting the USGS Web site. Streams located within cropland regions would also likely be included on aerial photography conducted by the USDA. Aerial photography dating from the 1950s is available from the USDA Aerial Photography Field Office. High quality aerial photographs are taken of nearly the entire country every 5 to 7 years by the National Aerial Photography Program. These photos are available from 1987 onward through the USGS.

Figure TS2–8 shows dramatic watershed land use changes and changes in streams and drainage patterns between 1934 and 1967 (Trimble and Lund 1982). Note the rectangular fields in the old system and the contour strip farming in the new. Note also the great decrease of drainage density (gullies) resulting from better land use and decreased overland flow.

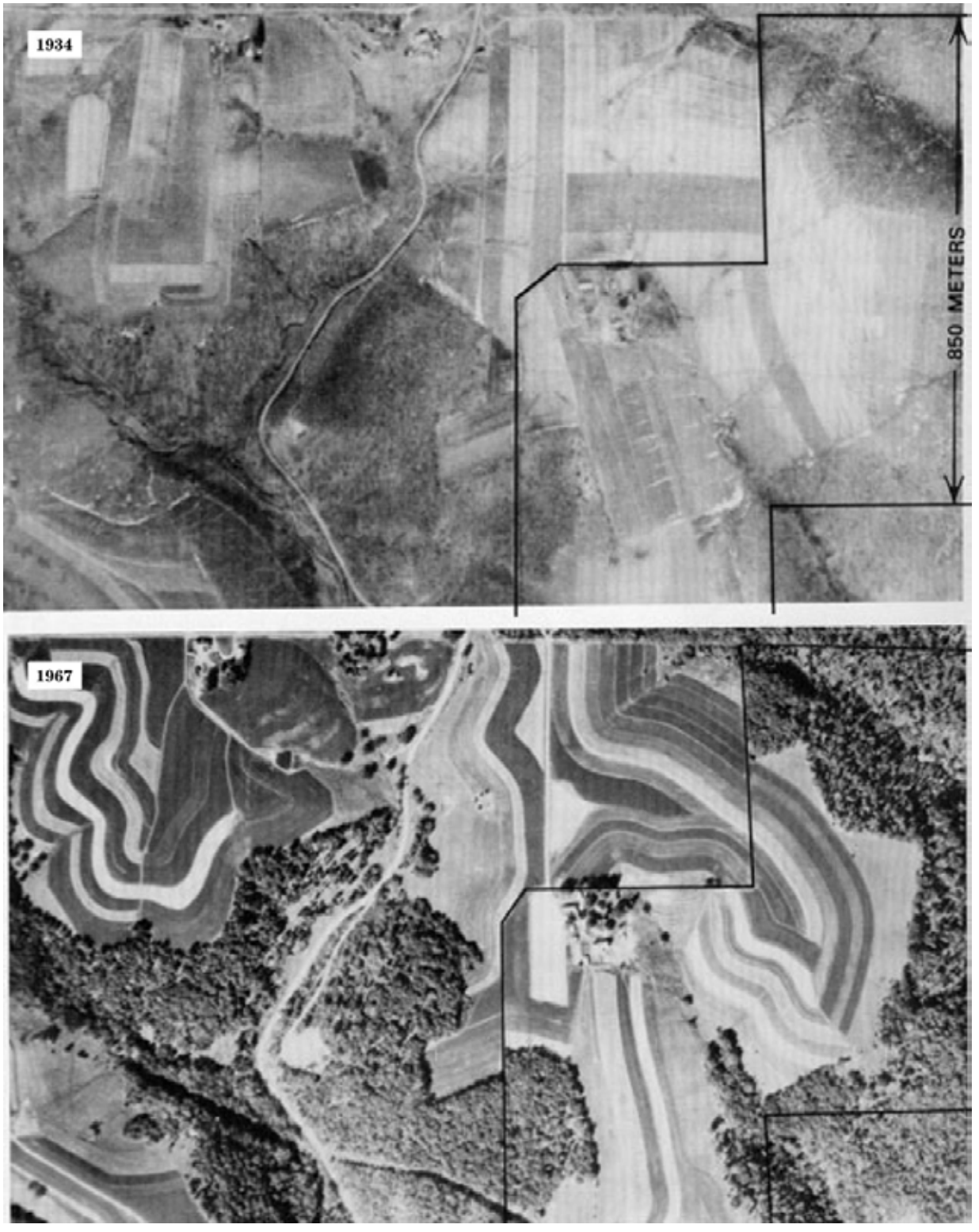
Because of the great number of factors affecting the resolution of aerial photographs, there is no rule of thumb guiding the minimum linear dimension that can be resolved on historic aerial photographs. Major factors influencing aerial photograph resolution include atmospheric conditions, ground conditions, aircraft movement, lens character, film character, camera height (flying height), camera position with respect to the Earth's surface, camera quality, and whether the film was black and white or color. For the USGS, camera height was determined primarily by the desire to compile contours accurately for mapmaking. If the height was appropriate for contour mapping, it was generally good enough to map planimetric features including streams. Historically, color film was much grainier than black and white, further limiting the resolution of historic color aerial photographs. Also, because of potential variation in scale across an aerial photograph due to distortion, information on historic stream condition is of greatest value when taken from a relatively small area of any given photograph.

Aerial photographs, dating from as early as 1917, have been used to demonstrate and date fluvial changes, along with the land use changes which were responsible for those stream changes. The general coverage of stereographic aerial photography in the United States dates from 1937 to 1938, but limited coverage exists from circa 1925. The value of aerial photography is a function of scale, photographic quality, and availability of stereographic coverage. Stream and valley aggradation is difficult to detect on air photos, but some attendant effects, such as the creation of backswamps and vegetational changes, can be seen and measured. On upland areas, air photos can be used to quantify land use and consequent erosion.

Ground-based oblique photography

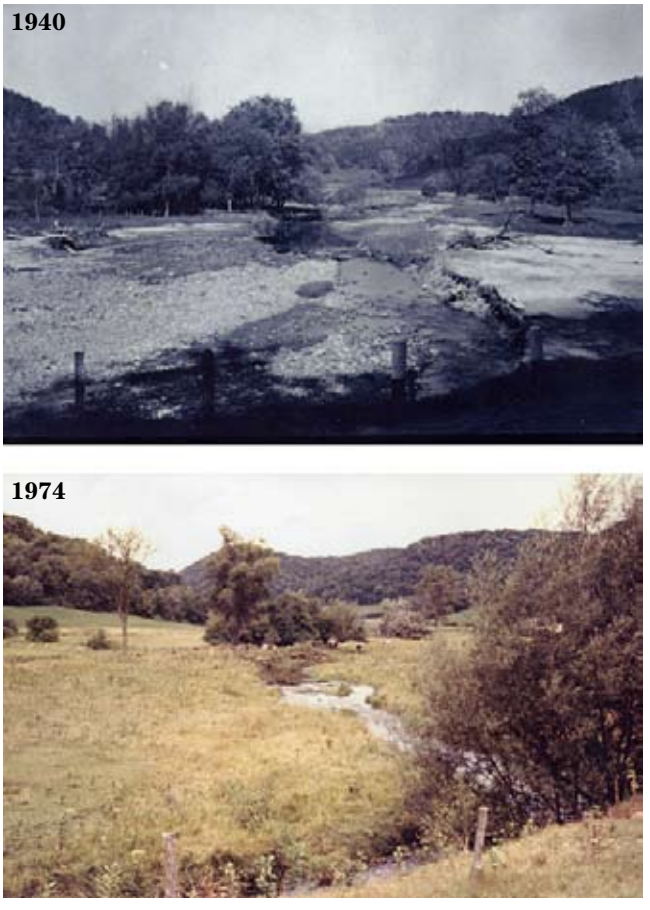
Ground-based oblique photography has been used to date geomorphological processes dating back well into the 19th century. Figure TS2–9 shows an example of the use of such pictures taken at different dates. The 1940 photograph in figure TS2–9 shows a typical tributary in 1940. Note the eroded, shallow channel composed of gravel and cobbles, with coarse sediment deposited by overflows on the flood plain. Such tributaries were de-

Figure TS2–8 Air photos showing changes in land use in Vernon County, WI, between 1934 and 1967



scribed as resembling gravel roads. The 1974 photograph in figure TS2–9 is a remake of the 1940 photograph. The stream channel is narrower, smaller, and more stable. The coarse sediment has been covered with fine material, and the flood plain is vegetated to the edge of the stream. This condition has continued and improved over the past 30 years (Trimble and Crosson 2000). All data are from the U.S. Weather Bureau (Trimble and Lund 1982). Although not as systematically available as aerial photography; ground-based photography has existed longer and generally offers better scale and resolution for time-lapse comparisons. Many major repositories of such photographs exist, but queries should always be made to museums, libraries, and individuals. In some cases, photogrammetric techniques can also be used with oblique photography, making it possible to make precise measurements.

Figure TS2–9 Oblique ground photos showing improvement of tributary streams in Vernon County, WI, 1940 and 1974



Photographs of site

Stream sites of interest by government or commercial interests following the advent of photography in the mid-1800s may have been captured in historic photos. Local residents may also have photographed the stream. These photos offer the advantage of potentially being relatively large in scale in comparison with maps and historic aerial photographs and can provide detailed local information to aid in interpreting changes in fluvial geomorphology over time. Historic photos may show local changes in depositional and erosional features in stream reaches and provide information on stream corridor character and human activities and land use. Unfortunately, locating these photographs can be difficult. Government agencies, local historical societies, and long-time area residents can aid in locating historic photographs. The Library of Congress maintains a national digital library from more than 100 historical collections that might also be worth reviewing.

Descriptive accounts and interviews with residents

Streams in long-settled areas or areas with major historic flooding events or other natural disasters impacting people may have been described in historic accounts. Local libraries can be good sources of this information. This information can be of particular use in cases where a stream condition is still evolving in response to a past disturbance, for which no obvious evidence is readily apparent. People familiar with the stream in the past, particularly long-term area residents that have a mental record of stream evolution, can often provide qualitative information on change in stream character.

Summary and conclusions

Although not always precise, historical data and techniques can provide powerful tools for establishing watershed conditions and stream forms and processes over the past few centuries, particularly during the last few decades. Comparative information can be used to determine the character of watershed and stream changes and may sometimes provide important quantitative measurements to support stream restoration designs.