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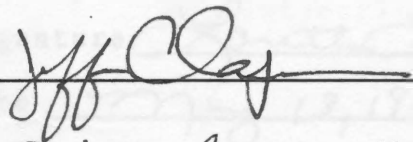
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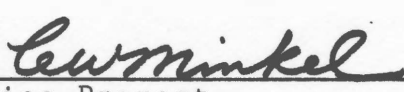
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THE BRAINERD MILL AND THE TELlico MILLS: THE DEVELOPMENT
OF WATER-MILLING IN THE EAST TENNESSEE VALLEY

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

Loretta Ettien Lautzenheiser

June 1986

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ABSTRACT

This study documents the archaeological and historical investigations of four water-powered mills in the eastern Tennessee Valley. This study points out the value of both archaeological and archival material to obtain a fuller picture of the function of these mills, and of their economic and social roles.

A review of the development of water power technology is included in this study. A knowledge of this technology is necessary to help in the formulation of clear research designs when investigating water powered mills.

The recovery of a large amount of power-transmission related artifacts helps to develop a clearer picture of milling practices in the region. An unusual turbine recovered from the Brainerd Mill has raised questions about availability and adaptations of state-of-the-art technology in frontier settlements.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION.....	1
Introduction	1
Theoretical Orientation	3
II. ENVIRONMENTAL SETTING.....	9
Physical Setting	9
Soils	10
Climate	11
Flora	12
Lithic Resources	13
III. WATER POWER DEVELOPMENT.....	14
History of Water Milling	14
Mechanics of Water Milling	16
Water Wheels	18
Vertical Wheels	19
Tub Wheels	21
Turbines	24
Mill Dams	29
Grist Mills	30
Mill Stones	32
Sawmills	34
Blacksmithies	35
Mill Regulations	36
IV. THE TELLICO MILLS.....	42
Introduction	42
Early Water Milling in Blount County	44
Kelso's Mill	46
Location	46
History	47
Archaeological Investigations at Kelso's Mill	50
Trigonia Mill	52
Location	52
History	52
Archaeological Investigations at Trigonia Mill	53
Trigonia Turbines	54
Shadden Mill	58
Summary	61

CHAPTER	PAGE
V. THE BRAINERD MILL.....	64
Introduction	64
Location	65
History of Brainerd Mill	68
Mission Period	68
Bird's Period	95
Archaeological Procedures	98
Excavation Procedures	98
Results	99
Mission Dam	100
Bird's Mill Dam	103
Analysis	105
Mill Stone Fragment	105
Turbine Bay	107
Glass	109
Turbines	110
Tailrace	118
Summary	122
VI. SUMMARY AND CONCLUSIONS.....	132
Indirect Methods	132
Limitations of This Study	136
Implications for Future Research	137
Special Aspects of Mill Research	137
Future Research Questions	139
REFERENCES CITED.....	143
APPENDIXES.....	153
Appendix I	
Appendix II	
VITA.....	164

LIST OF FIGURES

FIGURE	PAGE
1. Norse Wheel with Recurved Blades.....	17
2. Installation of Overshot Water Wheel.....	20
3. Tub Mill c. 1900 from Madison County N.C. now in the Mercer Museum.....	22
4. Turbine, both in and out of Case.....	25
5. Installation of Turbine.....	27
6. Crib Dam with Plank Covering.....	31
7. Location of Mill Sites Investigated in the Tellico Reservoir.....	43
8. Kelso's Mill Dam and Race.....	51
9. Trigonía Mill Site Plan.....	55
10. Small Turbine from Trigonía Mill.....	56
11. Trigonía Turbine, View of Bases.....	57
12. Trigonía Mill, Penstock and Turbines.....	59
13. Leffel Turbine Showing Lignum Vitae Bearings...	60
14. Fitz-Burnham Turbine from Shadden Mill, Main Drive Shaft Still Attached.....	62
15. Location of Brainerd Mill and Mission Dam.....	66
16. Brainerd Mill, Plan of Excavations.....	104
17. Recovery of the Brainerd Turbine.....	111
18. Turbine and Enclosure.....	111
19. Brainerd Mill Turbine and Base.....	112

FIGURE	PAGE
20. Turbine with Iron Vanes and Wooden Tub Exposed.	113
21. Close-up of Turbine Showing Vanes Mortised to Wooden Shaft.....	113
22. Brainerd Mill Turbine and Enclosure.....	116
23. Brainerd Mill Turbine Enclosure.....	117
24. Bird's Mill. A Metal Turbine is Barely Visible in the Uncovered Bay.....	130
25. Bird's Mill. Mill is Expanded and the Turbine Bay is Fully Covered.....	130

CHAPTER I

INTRODUCTION

Introduction

For the major part of its history, the discipline of American archaeology has been concerned with the study of humankind's prehistoric past. In the past twenty years, however, the study of the historic and recent past has gained acceptance by most people engaged in archaeological research.

One aspect of the historic past is the rise of industrialization. While the industrialization of the United States had a dramatic impact on the lives and lifestyles of the people and on their environment, the study of industrial sites has received little attention within the archaeological profession. Fortunately, this is changing, and in recent years archaeological investigation of industrial sites has increased.

One area of industrialization which had an important effect on technological change was the development of water power. While there has been research relating to water-powered mills, much of it has focused upon standing structures or above-ground remains. Renovation of standing structures has been undertaken by local historic societies or individual owners, but archaeological

investigation of mill ruins has not usually been of prime concern.

Interest in old mills has spawned a Society for the Preservation of Old Mills (SPOOM), with an accompanying journal, Old Mill News. While this journal is an excellent source of information on all things mill-related, a review of ten issues from 1981-1983 showed that there were no articles dealing with the archaeology of mill remains.

The Society for Industrial Archeology is a better source for accounts of mill archaeology, with the entire 1979 volume of Industrial Archeology devoted to mill-related articles. Unfortunately, the number of articles has been limited by the fact that the Society has only been in existence for about 12 years. In this group too, however, much emphasis is given to standing structures of all types of industrial complexes.

By incorporating the archaeological data with the historical documentation, it is possible to gain a more complete picture of the history of water-milling in a region, or that of a particular mill.

Mills were built, rebuilt, expanded and moved around at a given mill seat. Dams as well, were repaired, enlarged, relocated and abandoned; races and flumes were built, maintained, silted in, or added to. The pattern of

change or stagnation, revealed in many instances only by archaeological data, reflects the adaptation to technological advances.

Theoretical Orientation

This thesis contains reports of the investigations of four East Tennessee mills; Brainerd mill in Hamilton County, and Kelso's, Trigon and Shadden mills in the Tellico Reservoir in Blount, Loudon and Monroe counties. The research at these mills was sponsored by the Tennessee Valley Authority (TVA), and the reports of the investigations have been filed with that agency (Lautzenheiser 1982, and Lautzenheiser and Brown 1983).

The field work at these mills was undertaken by Dr. Jeffrey Brown as Principal Investigator. The author served as field director at the Tellico mills, and performed the analysis and report preparation for all the mills after Dr. Brown's untimely death. The investigations at the mills were undertaken to test the technique of indirect methods as proposed by Brown (1979).

Brown in his application of indirect methods to industrial archaeology, states that the documentary record is generally incomplete and contradictory, and may, as well, be inconsistent with the archaeological records. The anthropologically trained archaeologist will be aware of the contradictions and inconsistencies in the data and

realize that contradictions and inconsistencies are basic attributes of human thought and behavior. "Differences between real events and ideal standards provide opportunities to explain complex levels of human behavior. . ." (Brown 1978:13).

Indirect methods focus on the discovery and explanation of inconsistencies between archaeological and documentary data and seek to understand past behavior indirectly through comparisons of these data. This method assumes that historical documents often reflect ideal behavior or standards rather than real events (Brown 1978).

In designing the excavation of the water mills, it was necessary to know what the ideal standards for water-milling were at the time the mills were in operation. Oliver Evans' Young Mill-Wright and Miller's Guide (1836), originally published in the early nineteenth century, was the first standard volume on water-milling technology. The three volumes of Bennett and Elton's History of Corn Milling (1898, 1899, 1900), Hugh's Miller and Millwright (1862), Leffel's Construction of Mill Dams (1881), plus a history of industrial power by Louis Hunter published in 1979, provided an excellent background of information on the changes in milling technology, especially in the nineteenth century, when the

introduction of the turbine in 1842 revolutionized water power technology.

Documentation relating how those standards were utilized in each region was needed to compare the ideal standards with local and regional usage. The archaeological data would provide the actual evidence of whether or not the mills were conforming to state-of-the-art technology or "folk-tech" adaptations.

For the Brainerd mill, a large amount of documentary evidence was available for the early days of the mill in the Mission period. It was not until the excavation was underway that it became apparent that little if any of the original Mission mill remained, and the archaeological data were from the later Bird's mill at the same location.

At the Brainerd mills and at the Tellico mills, the salvage nature of the projects and the accelerated timetable of the impoundment of the Tellico Lake left little time to fully explore the documentary record prior to the excavation.

The paucity of data for the Bird's mill period had led to the assumption that the archaeological remains were those of the Mission mill. Although it was known that Bird had operated the mill, the extent to which the Mission mill had been replaced by a complete later mill was revealed through archaeological investigations. Bird did not merely operate or expand an existing mill, he

built an entirely new mill which destroyed most traces of the previous mill.

At the mills, evidence was found of both ideal standards and folk-tech operations. At Brainerd mill, the early days were frustrating, according to the historical documents. The original mill dam was of a type which conformed to industry standards, but standards which were designed for a different type of waterway. In this case folk-tech adaptations would have been more advantageous. The later success of Brainerd mill was due in part to changing technology--the development of the turbine--and to the construction of a dam suitable to the waterway.

The retrieval of an unusual turbine at Brainerd raised more questions than it answered. This turbine type was not documented, and the knowledge of its existence is due to archaeological research.

The mills at Tellico were salvaged in the week before the impoundment of the Tellico Lake. Indeed, crews were moving upstream in advance of the rising waters. Less archaeological work was done at these mills, and their value is much less in substantiating investigations of "real versus ideal" standards. These three mills were located in the same area and two, Trigonía and Shaddon, were located on the same watercourse. All three mills, however, contained different types of dams and turbines.

They serve primarily to document the many different ways mills can be adapted to similar environmental and cultural conditions.

The availability of mills, and in the East Tennessee region, of water-powered mills, indicated to some extent the productivity of an area. Donald Jeane (1974) disputed the notion that mills, at least in northwest Georgia, served as magnets for settlers or that mills formed the basis for later towns. While this may be true of larger towns, mills did influence the feasibility of settling in certain areas, or at least influenced the choice of crops grown there. Jeane ignores some basic considerations in his statement; mills were located where there was a power source, and mills were geared to farming areas. Grist mills and saw mills needed to be located near the source of supply, it being far easier to transport finished goods. The earlier mills were generally custom mills, not large commercial establishments. A mill would in fact attract settlers, not to a town, but to a farming community where they could be assured of having their grains ground.

Jeane (1974) also states that mills in northwest Georgia were not normally antecedent to roads, with only one instance of a significant mill preceding a major wagon road. In East Tennessee, however, it is evident that mills did precede roads. According to the Blount County

Court records for 1793-1804, mills were frequently used as points of reference for new roads, and even today many county roads throughout East Tennessee are named for the mills that stood along them.

Newell (1978) has pointed out that industrial archaeologists have tended to focus on the successful and unique sites, and those which are works of prominent architects and engineers. There has been little search for and examination of the experimental and transitional stages of development, or even of the failures.

Brainerd is one site where both failure and success at the same site and through time can be examined. Without the documentary evidence, it is possible that the Mission efforts would have been totally forgotten. The numerous artifacts and mill remains from the Bird period and the sparse documentation point out the importance of the archaeological aspects of the investigations. The investigation of the Brainerd site particularly stresses the importance of integrating both documentary and archaeological data to obtain a more complete picture.

CHAPTER II

ENVIRONMENTAL SETTING

Physical Setting

Brainerd mill in Hamilton County and the Tellico mills in Blount, Loudon, and Monroe counties all lie within the Ridge and Valley Physiographic Province. The Ridge and Valley region in Tennessee is known as the Great Valley of Tennessee. The ridge-valley topography trends north-northeast, displaying many striking geomorphic features, with a marked parallelism of ridges and valleys.

The valleys are mostly flat and alluvium-filled with general elevations of about 600 feet, and the ridges are much dissected and extend to about 900 feet in elevation (Fenneman 1938). In the southern section, the ridges are not so numerous and there is no division into an eastern and western valley belt. Longitudinal drainage is more prevalent in the south (Thornbury 1965).

The Ridge and Valley topography displays a conspicuous influence of alternating strong and weak strata upon topographic forms. A few major transverse streams, with notable development of subsequent streams, give to many areas a trellis-like drainage pattern (Thornbury 1965). The major part of the drainage makes

its final escape through the Tennessee Valley (Fenneman 1938).

This discharge of drainage through the valley makes the area a prime location for water powered mills. The establishment and success of water mills in the region were dependent on the availability of a water course with sufficient head to power the wheels. The Ridge and Valley region is well drained by numerous streams and rivers which rise in the higher elevations. Mill seats are the location of a marked descent in the fall of water, and the topography of the region is characterized by elevation changes.

Soils

Alluvial soils are deposited in the river valleys as a result of floods. These soils build up over a period of years, providing a fertile agricultural base. The larger flood plains are those that extend along most of the Tennessee River and its principal tributaries. The soils are deep and fertile and are renewed by frequent floods. Crops such as corn can be grown year after year without damaging the soil (Case 1925). Corn, the staple crop of grist mills, was grown not only for human consumption, but was also "cracked" for animal feed.

Climate

The growing season is approximately 207 days in length, with the first killing frost around November 1 (Tenn Agricultural Extension Service 1975). The average temperature in July 1978, was 81.2 degrees F., and the average January temperature was 30.3 degrees (NCC 1978).

Rain is well distributed throughout the year, with short dry spells occurring mainly during late August, September, and October. The heaviest rains are in March and May (Case 1925). The mean annual rainfall for the 101 years prior to 1976 was 52.36 inches. The maximum amount on record was 72.37 inches, recorded in 1929, and the minimum amount was 32.68 inches, recorded in 1904 (TVA 1979).

The availability of a reliable supply of water in the chosen water course was very important. Although the rain was generally well distributed throughout the year, the dry spells occurred during August, September, and October; the time of heaviest use for a grist mill. The lack of water in the race would prove to be a continual problem at Brainerd mill.

The most significant flood season is during the winter and early spring when the frequent migratory storms bring rains of high intensity. During this period,

widespread flooding and local flash floods can occur. Heavy thunderstorms in summer can produce local flash flooding as well (Dickson 1960).

Flora

Forest type is a descriptive term used to group stands of similiar character with regards to composition and development due to ecological factors, by which they may be differentiated from other groups of stands. The southern portion of the Ridge and Valley is in the Southern Forest Region while the remainder of Tennessee is in the Central or Hardwood region (Society of American Foresters 1954).

The Society of American Foresters (1954) and Little (1970) list the common trees found in this region. In the genus Quercus are found the southern red oak, laurel oak, willow oak, chestnut oak and pin oak. The shortleaf, loblolly, jack, and Virginia pines represent the genus Pinus. Also noted are the black locust, black ash, blue ash, yellow poplar, beech, sycamore, and pecan among others.

The wide variety of trees available contributed to the growth of sawmills. Both hardwoods and softwoods were available for use as building materials, and the existence of sawmills made lumber readily accessible.

Lithic Resources

The stone resources of the region were not a factor in the establishment of mills, since grindstones could be imported for use. Limestone was, however, occasionally used for buhrs, and the nearby mountains provided granites for use as stones (Finley 1933).

CHAPTER III

WATER POWER DEVELOPMENT

History of Water Milling

Man's first knowledge of grinding grain was attributed to Ceres in ancient myth and fable (Bennett and Elton 1898). Handstones were the earliest "mills" and underwent little change in form from prehistoric times to the Roman age. Mortars and pestles from the Abejas phase of Mexican prehistory, c. 3,000 B.C., resemble the modern mano and metate (MacNeish 1962).

In ancient Greece, the preparers of grain were called "pounders." This name was adopted by the Romans and survived as "pistores" into the Middle Ages, long after millers ceased to pound (Bennett and Elton 1898). Pistores were introduced into Rome around 167 B.C. when, after the defeat of Perseus, a group of captive Greek pounders were brought to Rome. Grinding then became a commercial craft and a male occupation, rather than a domestic task (Bennett and Elton 1898).

The quern, an Italian invention of about 2000 years ago, was one of the earliest grinding machines. It consisted of two stones, with the upper stone revolving on a pin in the lower stone. The original querns had a conical lower stone, with the upper stone convex in shape to fit over it. These gradually evolved to the shape of

millstones as we know them today. The top stone was drilled through at the top to form a hopper. The quern embodied a simple change from the thrusting or pounding motion of handstones and saddlestones to a continuous revolving motion which revolutionized classic milling. Some larger querns were operated by slaves or animals (Bennett and Elton 1898).

Water mills--mola aquaria--were the earliest power-mills in the world. One of the earliest references to a watermill was in 85 B.C. in Thessolonica. Water mills were slowly coming into operation at the time of the destruction of Pompeii; yet, due to the abundance of slaves, manual mills were not phased out for four more centuries (Bennett and Elton 1898).

The Greek water mills had a vertical shaft which was bedded on a rock in a stream bed or channel. The shaft supported a horizontal wheel which lay on the water and was turned by the current. The shaft passed through the lower mill stone and was fixed to the upper stone. The wheel, the shaft, and the upper stone all revolved together. There was no gearing, and one revolution of the wheel made one turn of the stone. The Greek mills were generally superseded by the Roman mill in the eighth century B.C. The Roman mill, possibly invented by the engineer Vitruvius, had vertical water wheels and cog-gearing (Bennett and Elton 1899).

The Norse mill was of the horizontal Greek type with a vertical shaft (Figure 1). These mills were in operation until well into the Middle Ages, with some isolated examples still in use in the late nineteenth century. They were usually housed in small huts which were built directly across small streams (Bennett and Elton 1899). The last development of water milling, the turbine, seems to be a direct descendant of the Norse mill.

Mechanics of Water Milling

Beginning about the sixteenth century, the typical mill consisted of a waterwheel beside or beneath the mill building; a dam at some point upstream to divert the flow into the headrace, to increase the amount of fall and to create a pond for storage of water; a canal called a mill-race or headrace, or a flume to carry the water from the dam to the mill; a penstock or sluice, with controlling gates to convey the water to the wheel; and a tailrace to carry the discharged water from the wheel back into the stream (Hunter 1979).

A mill-seat or water privilege was the point of marked descent in the bed of a stream where the concentration of fall simplified the harnessing of the flow (Hunter 1979). While having a pronounced mill seat was a favorable factor in locating a mill, occasionally

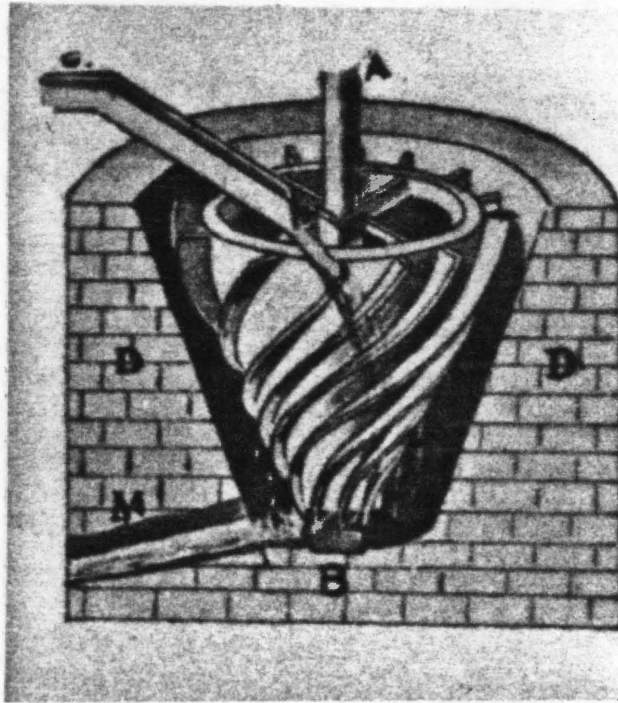


Figure 1. Norse Wheel with Recurved Blades (Bennett and Elton 1899).

the fall was not so pronounced, necessitating the construction not only of a dam, but of a long race to convey the water.

Sometimes as well, the topography of the area dictated that the mill itself be at a distance from the dam, again requiring a long race. Races could be well made with portions of their length stone or timber lined, or could be merely earthen ditches which had to be periodically redug.

The power developed by a water mill is determined by both the amount of water available and the head, or fall. The fall of water means the natural fall or drop in the course of a stream. The head is the vertical distance between the surface of the water at the dam down to the surface of the water where the wheel or turbine is located (Leffel n.d.). The available head and the amount of water flowing in the stream measured at cubic feet per minute, are the absolute factors in computing the power. The greater the head, the more power a given amount of water will produce.

Water Wheels

The usual mental picture of a water mill is one of a graceful vertical wheel turning beside the stream. Although an overshot wheel is usually brought to mind, there are actually three types of these vertical wheels;

overshot, breast, and undershot, with the overshot wheels being more common.

Vertical wheels. Overshot wheels receive water from a flume directly above them (Figure 2). These wheels are quite efficient, and in ordinary usage had a range of efficiency of from 50 to 85 percent of the power of the water. With falls of from 15 to 35 feet, the overshot wheel with a diameter close to the height of the fall, operated at an advantage which made it the preferred wheel. With falls of 8 feet or less, however, they lost efficiency (Hunter 1979). These wheels must be set at least 6 inches above the tail water to prevent the wheel dragging in the back current. For this reason, overshot wheels were not well adapted where the water level varies (Grimshaw 1882). These wheels were generally used where the volume of water was relatively low, but the fall or head, was great (LaForest 1982).

Undershot wheels receive water beneath the wheel. They are not driven by gravity as in the case of the overshot wheel, but by the impulse action of water flowing against the paddles or "floats" placed around the circumference of the wheel. They can develop as much as 60 percent of the potential power of the water, but are limited by the velocity of the stream (Grimshaw 1882). The introduction of a channel which conducted the water

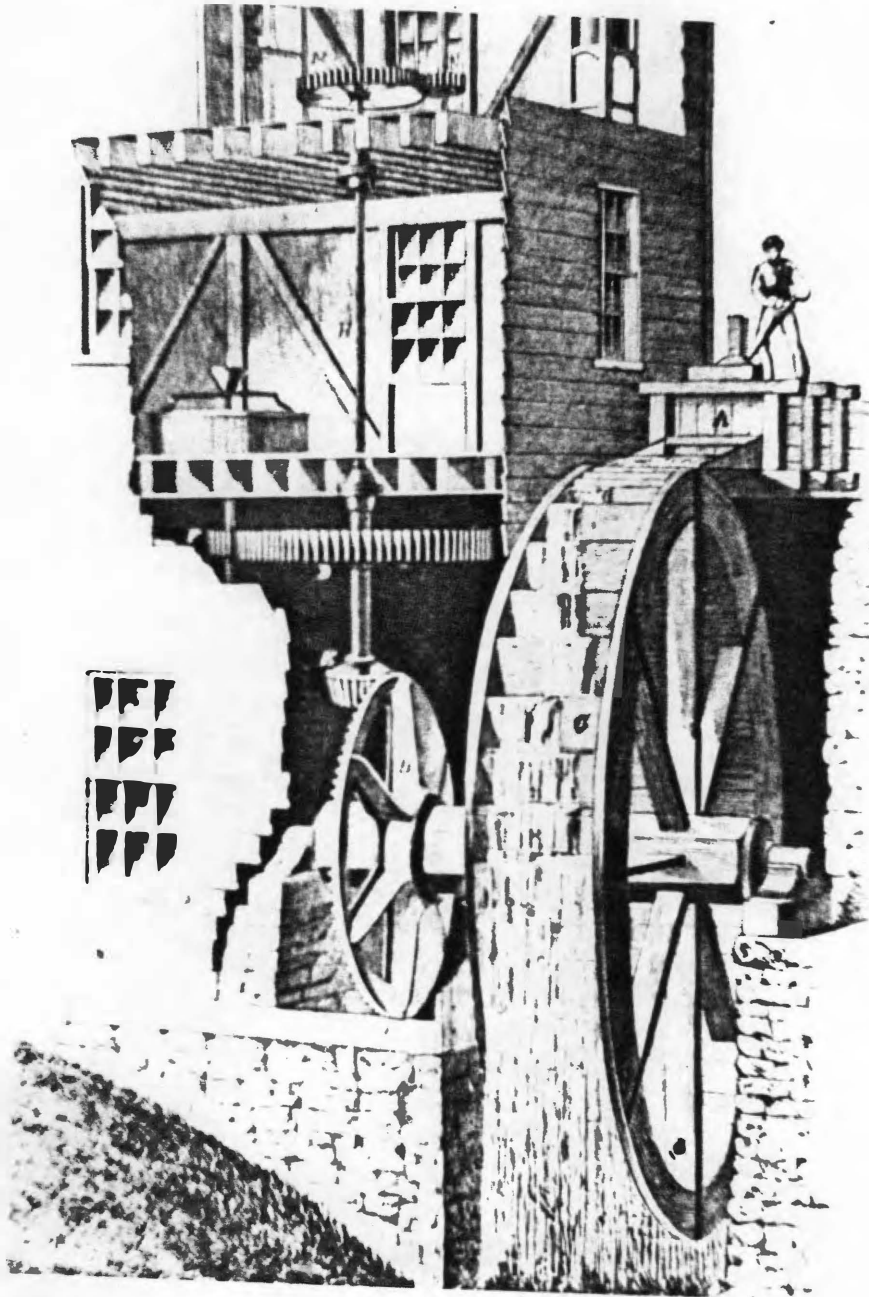


Figure 2. Installation of Overshot Water Wheel (Grimshaw 1882).

directly to the undershot wheel was an improvement that permitted greater utilization of the potential water power (Mead 1915). These wheels were generally used where the volume of water was great, but the fall was low (LaForest 1982).

Breast wheels receive water midway between the top and bottom of the wheel. They operate by gravity as do the overshot wheels. Breast wheels require a large portion of total fall to be used as head (Grimshaw 1882). Breast wheels turned with the direction of the stream flow giving them an advantage to overshot wheels in times of high water in the tailrace, as the breast wheel did not have to work against the current.

These different types of wheels were used according to the characteristics of the stream on which the mill was located. All of these exterior wheels were subject to damage or impediment by ice forming on them (Grimshaw 1882).

Tub wheels. The tub wheel was an early type of horizontal wheel (Figure 3). Tub wheels have horizontal wheels with vertical shafts which, in grist mills, passed through the lower stone and turned the upper stone (Hunter 1979). Tub wheels were generally made of wood with floats set into the vertical shaft. A tub wheel is reminiscent of the Norse mill except that, rather than being turned by

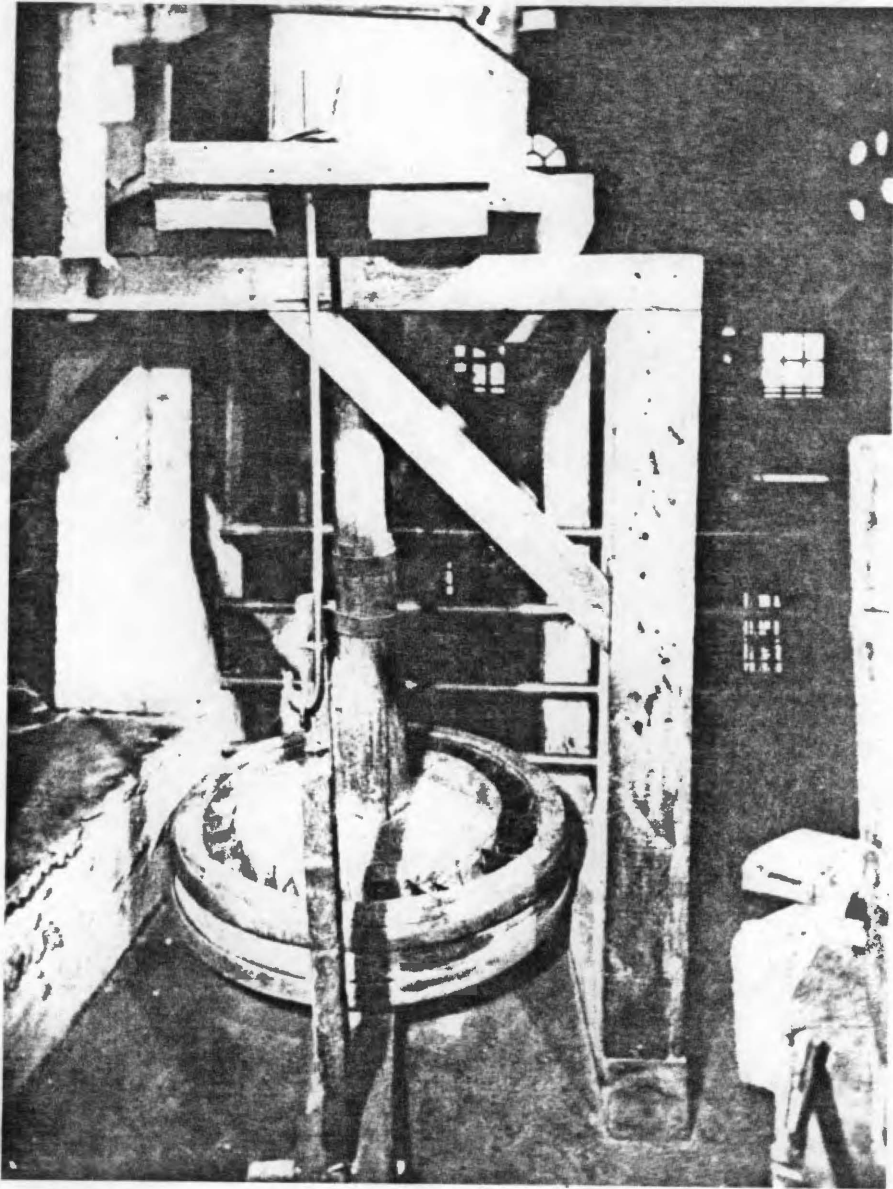


Figure 3. Tub Mill c. 1900 from Madison County N.C.
now in the Mercer Museum (Hunter 1979).

the current, water was carried by an inclined trough and directed so as to strike the floats or buckets tangentially at one side of the wheel (Hunter 1979).

Tub wheels were simple and inexpensive to construct. They were adaptable to small mountain streams and were practical for use by a single household. No cog or gear wheels were required, and dams were not always necessary; a small canal could serve to divert water from the stream into the wooden trough (Hunter 1979).

The smaller tub wheels developed no more than a fractional horsepower, and the large ones might develop 2 or 3 horsepower. The wheel operated with only about 10 to 15 percent efficiency, and was unsuitable for the demands of commercial operation in grist milling (Hunter 1979). Despite their waste of water, tub wheels were frequently employed for continuous-process methods because of the regularity of their motion (Hunter 1979).

The tub wheel was the inspiration for the reaction turbine; both having horizontal wheels with vertical shafts and being quick-running. Hydraulically they were different, with the strike-and-splash off action of the tub wheel contrasted with the pressure-reaction character of the turbine. The reaction turbine operated submerged, while the tub wheel could operate only above the tail water (Hunter 1979).

Turbines. The last development of water-milling was the introduction of the turbine (Figure 4). The turbine seems to have been directly derived from the action of the primitive Norse mill (Bennett and Elton 1899). The similiarity of the working of the voluted cone wheel to the turbine is apparent, but the Norse wheel is driven in one direction by the direct force of the water, while the turbine is turned in a reverse direction by the reaction of the current. Turbine wheels were refined and developed by various French inventors early in the nineteenth century (Mead 1915), but the person usually credited with the invention is Fourneyron, who developed a turbine in 1823 (Bennett and Elton 1899).

A reaction turbine is a horizontal wheel usually operating on a vertical shaft and differs from the impulse turbine in that the whole turbine is acted upon by the water at the same time and continuously. In a reaction turbine the water is directed against all points of the circumference at once, and the action of the water on any one bucket is repeated simultaneously all around (Grimshaw 1882). Reaction turbines consist of a runner and shaft which are the rotating parts, the gate or guide casting, and a discharge cylinder or draft tube (Leffel n.d.).

Turbines were first introduced into the United States in 1842, and gained rapidly in use in the next two decades

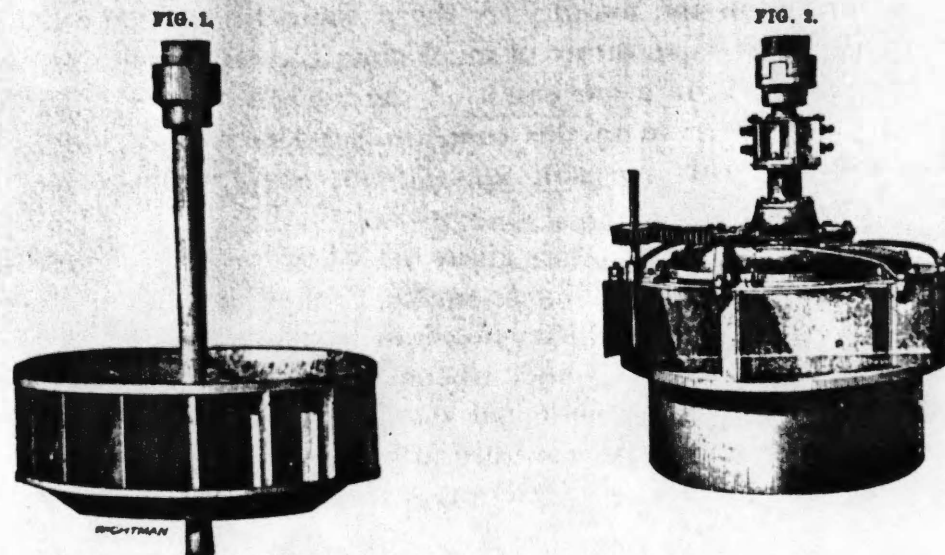


Fig. 1 shows the American Turbine out of the case.

Fig. 2 represents our small wheels and cases complete, ready to set in a penstock.

Figure 4. Turbine, both in and out of Case (Hunter 1979).

(Hunter 1979). By 1880, the turbine was described as the most popular water wheel in general use. The tub wheel, however, survived until recently in parts of southern Appalachia and other less developed regions of the western world (Hunter 1979).

Turbines could develop 80 percent or more of the useful effect of the water, being able to utilize the full head, while an overshot wheel must be set above the tail water, thus reducing the available head. An 11.5 inch turbine could give more power than a 22 foot overshot wheel. In addition, in an overshot wheel, the water begins emptying before it reaches the bottom, thus losing another portion of the water's potential energy (Grimshaw 1882).

The turbine usually receives water from a penstock, which is built up to the flume, and is frequently seated in the base of the penstock (Figure 5). The floor timbers for these turbine pits should be placed in the direction of the current, with their upper surface at the height of the standing tail water. The pit under the turbine should not be less than 2 feet below the floor timbers, and from 3 to 6 feet for larger turbines. The pit should extend several feet beyond the outside of the penstock and then gradually slope upward to the general level of the bottom of the tailrace. If there is not enough room for

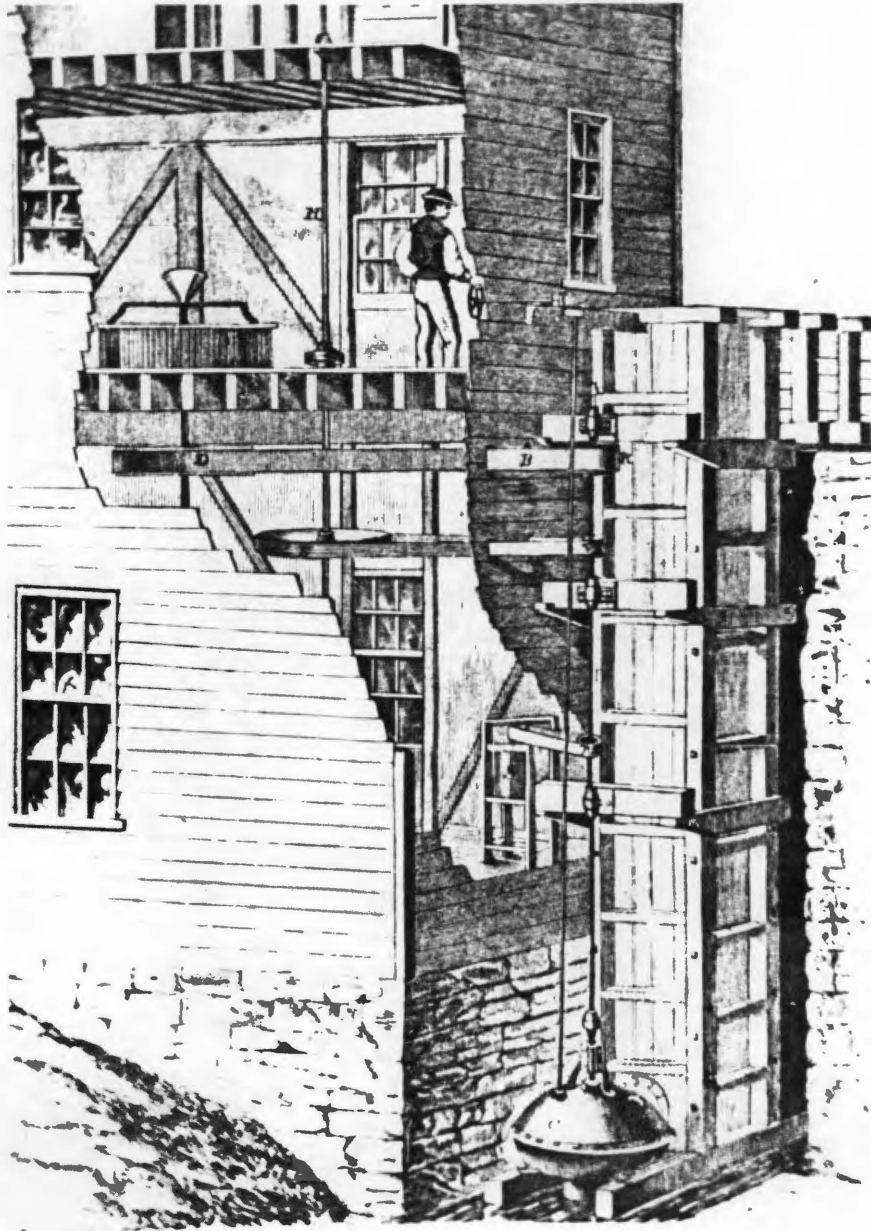


Figure 5. Installation of Turbine (Grimshaw 1882).

discharge, it will react upon the turbine and impede its movement (Grimshaw 1882).

The modern mixed-flow turbine was an American development. This design was the blending of the inward flow principle with the downward discharge of tub wheels. The mixed-flow turbine was the result of many years of evolution of turbines. These large capacity wheels were exemplified by the 1876 "Hercules" built by John McCormick. The buckets were deeper and protruded below the band allowing the outward discharge. These turbines had the advantage of being high-speed models with high rates of efficiency (Safford and Hamilton 1922).

The great advantages of turbines over the old style water wheels were summarized by Mead (1915:9-11):

Turbines occupy a much smaller space.

On account of their comparatively high speed they can frequently be used for power purposes without gearing and with a consequent saving in power.

They will work submerged.

In consequence of the ability to work submerged, the turbine can efficiently utilize considerable variations in head, to which condition the old style water wheel is not applicable.

Turbines may be utilized under almost any head or fall of water. They have been used under heads as low as sixteen inches and as high as 670 feet.

Turbine water wheels are built of much greater capacity than is practicable with overshot wheels.

By means of turbines, water powers of much greater magnitude can now be developed than would be possible with the older classes of water wheels.

Turbines are more readily protected from interference by ice.

Mill Dams

Dams could be elaborate or flimsy depending on the terrain and the needs of the mill. In cases where the supply of water was large and a high fall was not needed, a temporary dam composed of large stones was sometimes thrown across the stream in a diagonal direction (Leffel 1881). Such a dam was cheap and quick to build, but had to be frequently replaced, especially after heavy rains.

In building a permanent dam, the most important consideration was the foundation. A good foundation would be constructed to protect the dam against breaks and from the burrowing of animals such as muskrats (Hughes 1862). Dams could be built of stone or logs depending on the river bottom and the availability of each material. Stone dams have the advantage of not rotting, and if properly constructed are relatively permanent. If timber was abundant, log dams were most economical. They were also better adapted to a soft bottom (Leffel 1881).

A log dam is made by laying a log foundation with log cribs at each bank to anchor the dam. The dam could then either be a full crib dam or be built up with a

series of log layers. The upstream side of log dams should be covered with upright planking extending from the top log down to the apron and pinned or spiked to the logs (Figure 6). Filling the upstream side with rubble protects the pilings from being washed out by the whirlpools formed around them (Leffel 1881).

Grist Mills

Grist milling was probably the single most important use of water power, especially in the early days of this country. In Blount County, Tennessee, for example, licenses obtained during the period 1793-1804 to operate mills were overwhelmingly granted for grist mills. Permission to construct mills was granted for 12 grist mills, 10 (unspecified) mills, three grist and saw mills, and one sawmill (Blount Co. Court Minutes).

The initial use of the water wheel was to turn the mill stones. Originally one wheel operated one run of stones, but with the addition of gears and belts, additional runs of stones could be powered by one wheel. With even more gears, other equipment could be run off the wheel as well.

In the early 1800s, Oliver Evans invented the elevator, conveyor, drill, descender and hopper-boy (Bennett and Elton 1899). These means of conveying the grain and meal throughout the various processes eliminated

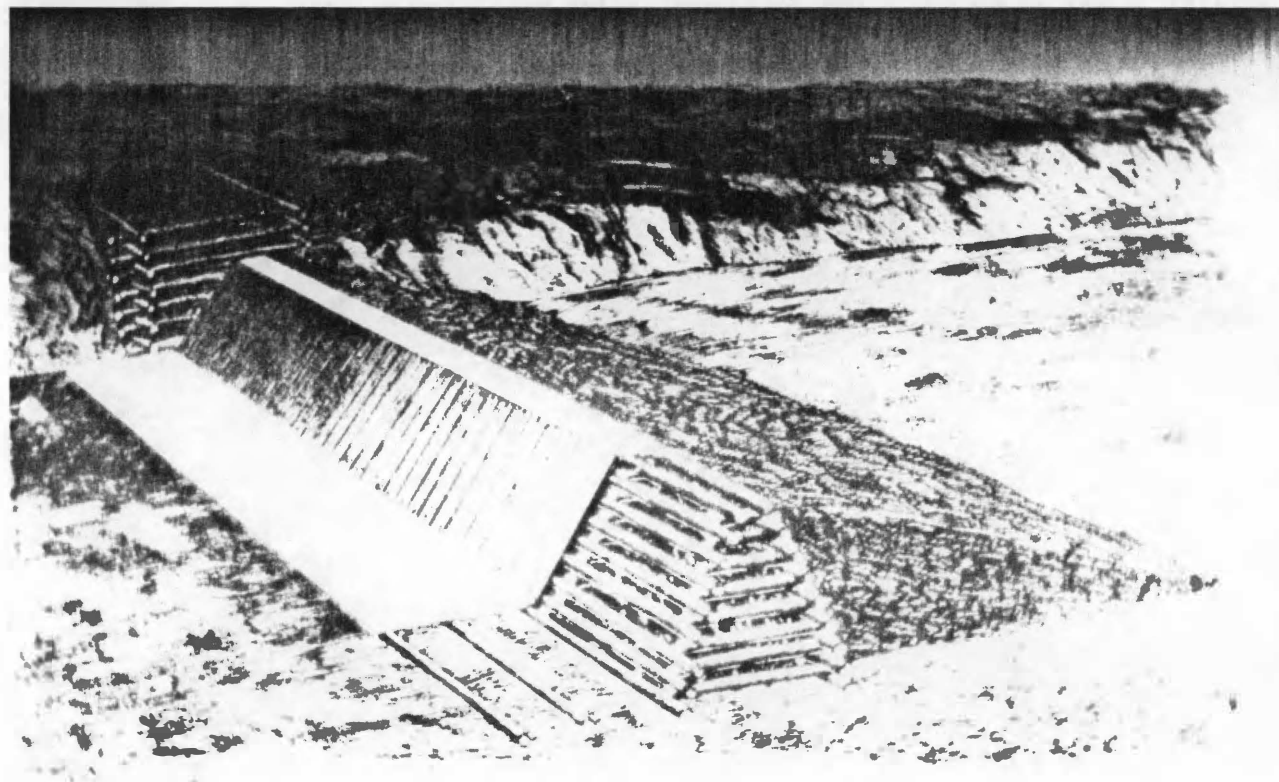


Figure 6. Crib Dam with Plank Covering (Leffel 1881).

the need for manually transporting them throughout the mill. All of these devices could be run off the wheel with appropriate gearing. Bolters as well no longer had to be hand-turned, but could be driven by the wheel. Bolters were sieves used to produce the various grades of flour and to eliminate sand, grit, and other impurities (Bennett and Elton 1898).

Evans, however, was not really interested in the smaller mill operations. The community custom-toll operation provided no market for his milling equipment, and his techniques were therefore not generally accepted until considerably later (Hunter 1979).

Mill Stones

Mill stones (buhrs) are considered the heart of grist mills, and as befits such an important item, are the subject of much literature and of folklore as well. For many years, the "French buhr" was considered not only the best mill stone, but the only mill stone. French buhrs were hard silicious material, and the ones with large even pores were the prime choice. Originally they did not contain furrows, relying on the texture of the stone to do the grinding (Hunter 1979).

Originally French buhrs were cut from a single block, but as the source of supply began to be depleted, stones were fitted together in sections and held together with

iron bands. These blocks were brought to America as ballast in sailing ships (LaForest 1981). American import firms such as Morris and Trimble of Baltimore would fit the blocks together, finishing them with cast-iron eyes. The stones from Morris and Trimble were destined for markets in Virginia, North Carolina, and Tennessee (Hughes 1862). This practice of piecing the imported stones together led to the erroneous belief that any banded stone was a French buhr (Ketner 1981).

Actually, the size and weight of millstones made the cost of importation impractical for the average miller. Hunter (1979) reports that good French buhrs were selling in 1850 for 48 pounds in England. Local stones were therefore not uncommon. The Knoxville Gazette of May 11, 1812, tells of several quarries of "Burr" millstones having been discovered in Grainger and Hawkins counties (Tennessee). A millstone quarry was reportedly located on Walden's Ridge, Sequatchie County, Tennessee (Arlie Hoodenpyle, personal communication), and Grindstone Mountain in western Hamilton County evidently received its name from being a source of millstones.

Good mill stones were selected for their even grit, even texture, and color and by their close resemblance to one solid piece of stone with the joints being nearly indistinguishable (Grimshaw 1882). The practice of furrowing stones possibly began in England around 1800.

The English stones had smaller pores and were chiseled with a pattern of furrows which enhanced their grinding ability (Hughes 1862).

Even when native stones began being used, the feeling that "French stones" were better persisted. If a stone was imported, it was thought to be better than native stones, no matter what its true quality. Actually, even French buhrs came in many grades from excellent to unusable. The fine white stones were the best, with blue stones good for corn milling. Although blue stones were harder to dress, (chisel in a pattern of furrows), they held the dress better when properly handled. The "trickster" stone was the Fox-burr, a yellowish stone, which although still a French stone, was nearly worthless (Hughes 1862).

Sawmills

The early settlers recognized the value of sawmills and welcomed them. Unlike England, where the large labor force and scarcity of timber had combined to force opposition to sawmills, the pioneers in the New World were eager to establish sawmills (Hunter 1979). Log cabins were the norm for shelter until sawmills could be built. Food and shelter were the first things to be provided for in the new country, and in early records of frontier

settlement, grist and saw mills were often paired. Later, however, sawmills began to outnumber grist mills.

The location of gristmills was determined only by the location of a mill seat, and, if necessary, grain could be carried on foot or horseback to the mill. Sawmills, on the other hand, required a location which would facilitate the delivery and transport of logs and lumber. As late as 1880, sawmills were the most numerous and widespread of all industrial establishments (Hunter 1979).

The old method of building sawmills was to attach the water wheel and saw to the same shaft (Hughes 1862). This caused a stiffness which reduced the actual power when used in connection with a crank. Gearing was later used to convey the rotary motion of the wheel to the required motion of the sawmill. Tub wheels were frequently used in sawmills in the up-and-down mill. Here it served as a convenient means of powering the log-carriage return at the end of the cut. This carriage return was known as the go-back (Evans 1836).

Blacksmithies

The rural blast furnace and forges, village foundries, tilt hammers or large blacksmithies were almost invariably driven by water wheels (Hunter 1979). Having a smithy as part of the grist or saw milling operation was a sensible

procedure. While the smaller mill irons could be made at the common blacksmithies, larger parts such as sawmill cranks and the heavier wheel gudgeons and millstone spindles could be forged effectively only at the larger smithies equipped with water-powered trip-hammers (Hunter 1979).

In small rural establishments, bellows or blowing tubs and forge hammers were operated directly from the water wheel shaft by means of cam tappets or by cranks. Generally an independent power source was used for each major piece of iron-working equipment. For example, the Springfield Armory in Virginia, the Ordnance Department's principal source of small arms, was run by multiple water wheels. In 1824, three of the five workshops employed 27 water wheels to drive the trip-hammers and other operations. These wheels, mostly undershot or tub wheels, developed several horse power to supply the blast and drive the forge hammer (Hunter 1979).

Mill Regulations

Probably as soon as the first canal was built to divert water to a mill, laws concerning water rights and locations of mills and dams were instituted. As early as A.D. 398 there were laws against diverting the water source for a mill; but by A.D. 485, there were evidently

so many mills pulling water out of the streams that it became illegal to divert freshwater supplies to private mills (Bennett and Elton 1899).

In Rome, the College of Pistors was the trade guild associated with milling. The pistors were millers for life and were not allowed to leave the profession (Bennett and Elton 1899). Not only did this rule apply to the miller, but to his sons and to his daughters' husbands as well. This ruling ensured that there would be enough millers to supply the needs of Rome.

In A.D. 536, the water to the mills of Rome was intercepted by the Goths, reducing the city to near starvation. The Commander Belisavius devised a mill to float on the Tiber River, using a wheel between two boats with the stones in one boat (Bennett and Elton 1899). These boat mills were so successful that similiar mills were in widespread use until the beginning of the nineteenth century. Boat mills were common in this country in the early days of settlement (Straight 1980).

The stringent laws for the protection of mills in Europe were attributed to Clovis (c. A.D. 481) and were well entrenched in the time of Charlemagne, who confirmed and consolidated them in A.D. 798. The Ancient Laws and Institutes of Wales were codified in the ninth and tenth centuries. They show a mill to be a valuable possession

which established for their owners the milling "soke" (Bennett and Elton 1899).

The soke was a Saxon term meaning privilege or liberty (Bennett and Elton 1900). The feudal laws of the milling soke gave the lords the sole right of building and working mills upon their own estates (Bennett and Elton 1898). Tenants were compelled to attend the mills of the lord, and the use of domestic querns was prohibited, forcing the tenants to use the mill for all their grinding.

In the Domesday Survey, A.D. 1080-1086, there were several thousand Saxon mills recorded (Bennett and Elton 1899), and the mills existing at that time were forever free from tithes. The "Anomalous Laws of Wales", ascribed to the tenth century, contained the dictum that a manorial lord owned the toll of his mills (Bennett and Elton 1898)

Tolls were originally "handfulls" and were not uniform until the thirteenth century (Bennett and Elton 1900). The standardized toll was generally $1/16$ to $1/20$ of the whole. Weighing of the grain to be ground was made compulsory in London in A.D. 1281.

Hostility to the exclusive milling privileges of manorial lords reached its height in the sixteenth and seventeenth centuries in England. In one area discontented burgesses set up a horse mill in defiance of

the lord's mills (Bennett and Elton 1898). This discontent led to the final abolition of the soke laws.

The medieval laws concerning milling and mill rights were remarkably similiar to the laws established in the New World. In Tennessee the location of mills and mill dams was of early concern to the young state. Individual owners were regulated in regard to where they could build a mill (Republican and Gazette Office 1832). The basic concern of the lawmakers was that dam and mill ponds not interfere with navigation or that the impounded waters did not overflow another person's property.

It should be noted that these regulations concerned commercial or public mills. The small family mills operated by tub wheels powered by small mountain streams were probably not licensed and therefore will not be in the court records.

If a prospective mill owner did not own both sides of the water course, or have permission to flood the lands above the proposed mill, he could petition for condemnation of the property, paying a just settlement. He must then build and have the mill in operation within three years, or the land would revert to the original owner (Meigs and Cooper 1858).

All navigable waters in the state were considered public highways, and any person obstructing the navigation of main channels by building mills or erecting dams unless

authorized by law, was liable to a penalty (Meigs and Cooper 1858). The Tennessee State Constitution defined the method in which mills could be built, and the individual counties were given control over the review of applications of prospective mill owners (Nye 1836).

Every person erecting a mill dam was required to maintain a gate or slope in the dam to allow passage of water craft. In the case of the Ocoee River, for instance, the gate was to be 40 feet wide (Harris 1840). On the Duck River the dam could not be higher than 7 feet. If a dam was higher than 7 feet, a 40 foot wide slope must be provided. Mill owners on the Duck were required to pay for any damages done to water craft if their dams were higher than 7 feet, except for that portion of the river between Columbia and Williamsport, where dams could not exceed 3 feet (Cannon 1842).

Public mills were defined as any grist mill which had ever ground meal for a toll. Each miller was required to bolt the flour ground at his mill (Meigs and Cooper 1858), and millers were required to grind grain in the order in which it was received. Toll was established at $1/7$ for a steam mill and $1/8$ for a water mill. For chopping grain the toll was $1/14$. The millers were required to keep sealed measures of one half bushel and one peck, and proper toll dishes for each measure (Meigs and Cooper 1858).

These regulations changed very little over the years and were virtually the same in 1884 as they had been in 1832 (Milliken and Ventress 1884).

CHAPTER IV

THE TELLICO MILLS

Introduction

In November of 1979, The Institute of Archaeology at The University of Tennessee at Chattanooga was contracted by TVA to conduct salvage recording of several mills in the Tellico Reservoir (Figure 7). Archaeological investigations of the prehistoric and some historic components had been on-going for a number of years, but it was only in the final days of the project that the mill sites in the reservoir area were studied as part of the industrial heritage of the region.

Crews under the direction of Dr. Jeffrey Brown, as Principal Investigator, with the author as field director, recorded the standing remains of the mill house and dam at Kelso's mill in Morganton and the Trigonía mill on Nine Mile Creek. In addition, archaeological crews excavated and recorded in place three turbines at the Trigonía mill. These three turbines, and another from the Shaddon mill on Nine Mile Creek, were recovered by TVA crews and are in storage in Norris, Tennessee.

The early impoundment of the waters of the Little Tennessee River behind the Tellico Dam forced crews to abandon the field after only limited recording.

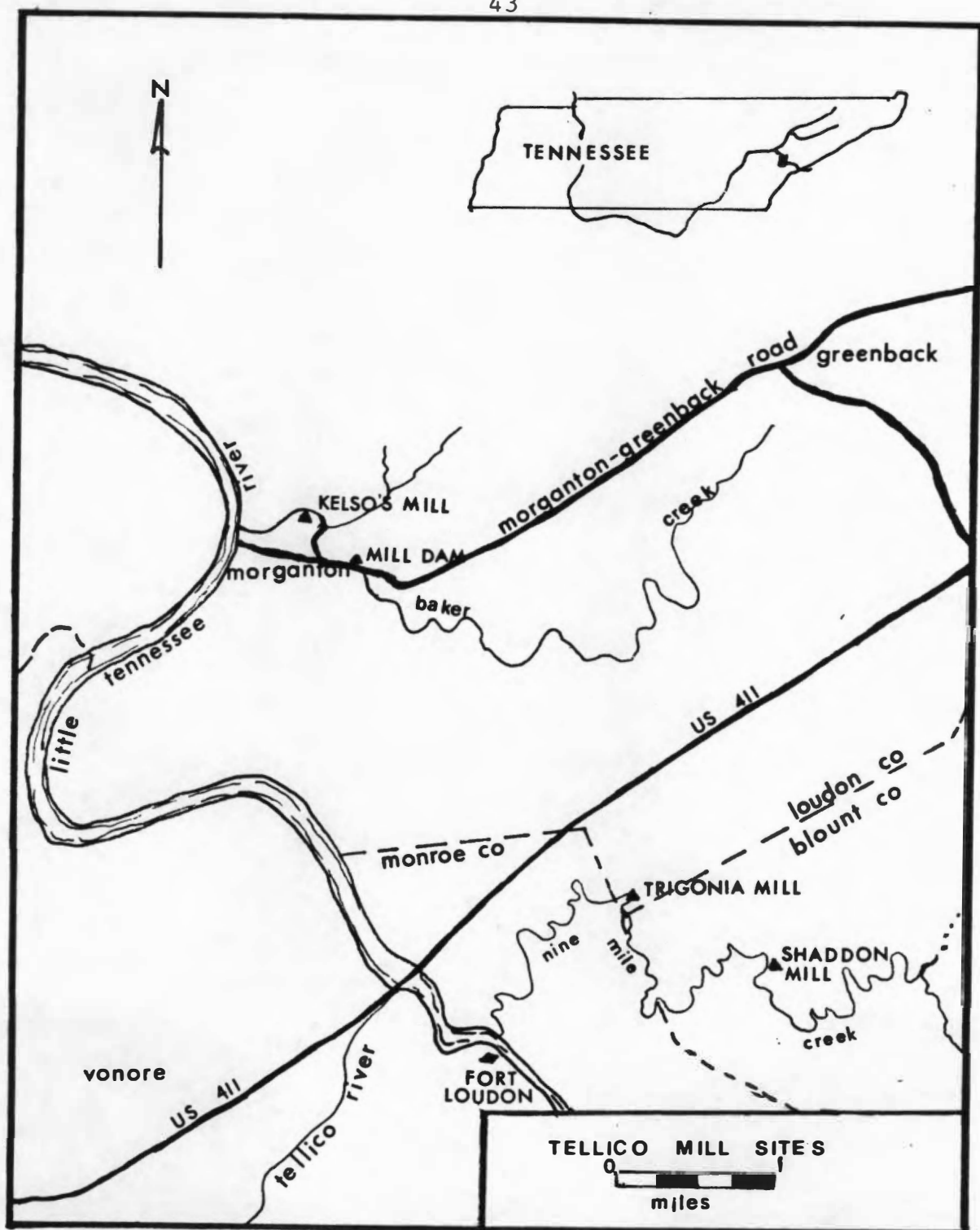


Figure 7. Location of Mill Sites Investigated in the Tellico Reservoir.

Early Water Milling in Blount County

The first mill erected in Tennessee was built before 1775 on Buffalo Creek in Carter County by Baptist McNabb. At about the same time, Matthew Talbot erected a mill on Gap Creek (Goodspeed 1887b).

Settlement of Blount County did not begin until 1785 (Goodspeed 1887b), and the erection of small tub mills began at the same time; the first mill supposedly was built near McTeer's Fort. The first seating of the Blount County Quarterly Court was in the fall of 1793, and one of the first orders of business was the granting of mill privileges. The first license to operate a public mill was granted to John Craig in September 1793, with licenses to John Wallace and Samuel Thompson also being granted during that seating of the quarterly court (Blount County Court Minutes 1773-1804).

There were evidently several mills established before that date, as reference is made in the County Court Minutes to mills which existed before the county was organized. These mentions were all in connection with a jury of view being sent to determine the best route for county roads. The mills named were the Bartlett mill, Alexander Kelly mill, Ambrose Legg's saw mill, Sloan's mill, Bob's mill and Coll Kelly's mill.

In December 1793, licenses were granted for three mills, including Matthew Wallas's mill on Baker's Creek. In 1795, two mills were licensed, and in 1796, two more, including Samuel Henry's mill on Baker Creek. David Edmondson's mill on Baker Creek was one of three licenses granted for 1797, and Richard Hudson's Baker's Creek mill was the only recipient for 1798 (Blount County Court Minutes 1773-1804).

In 1799, Hugh Kelso received a privilege for a public mill on Baker's Creek. The mill that Josiah Danforth was licensed to build in 1797 was in Maryville at the foot of Cusick Street and, when sold in 1802, was a powder, grist, and saw mill (Burns 1957). Andrew Kennedy's 1796 mill was located on the Little River. He discovered a natural tunnel through the rocks that he used as a mill race. Kennedy not only had a grist mill and saw mill but also made powder at the mill, which he sent to Jackson in New Orleans in 1814 (Burns 1957).

Daniel Best received permission to build a mill on Nine Mile Creek in 1809. The mill remained in the Best family until 1869, when the tract was sold to Robert M. Anderson and Stephen Wells. Wells bought out Anderson in 1876, and the mill was operated by Wells until 1954 when the Wellsville mill was dismantled (Burns 1957).

Samuel Henry installed French buhrs in a new brick building on Baker Creek in 1815. The mill became known as

the Brick mill and was later operated by J.M. Rorex, John R. Henry, and George Montgomery. The mill operated until the late 1940s. The Henrys also operated a small mill on the main stream of Baker's Creek (Burns 1957).

Josiah Johnson built a mill on Cloyd's Creek in 1817, and John Stephens received a permit to build a mill on Little River (now Rockford). Stephens was to leave a passage for boats, but later litigation indicates that he did not (Burns 1957).

Burns (1957) also lists the Friendsville mill of John Hackney begun in 1819. James Kirby and William McNabb were authorized to build a mill dam on the Little River in 1828. Their mill was located a little below Rockford and was later called Donaldson's mill and then McNabb's mill.

In 1842, Isaac White built a small mill on Crooked Creek on what came to be known as White's Mill Road. At about the same time, Michael Best built a mill on Nine Mile Creek on what is now called Best Mill Road. His mill was later operated by Elijah Brown, James Murphy, and Zephaniah Cotant (Burns 1957).

Kelso's Mill

Location. The mill at Morganton was known to residents as the Morganton or Heiskells' mill. At the time of the archaeological investigations, the mill was

being referred to as Kelso's mill by TVA, and that name is continued in this report.

The mill was located to the southeast of the bridge about 2900 feet above the mouth of Baker's Creek at the Little Tennessee River (Figure 7 p. 43). This bridge was on the road formerly known as the Morganton Ferry-Greenback Road.

History. The Blount County Court ruled in 1799 that Hugh Kelso "had leave to build a mill on Baker's Creek at or near the mouth there of, he being the owner of the land on each side of said creek."

It appears that even though he owned the land on each side of the creek, the waters of the dam would evidently overflow a portion of the land of Reuben Charles (Blount County Court Minutes 1773-1804). In response to Kelso's petition to establish a public mill, a jury of view was ordered, in June of 1799, to view and value one acre of land of Kelso's and one acre of land of Charles'. The jury was composed of Samuel Hambry, Samuel Hensey, James Montgomery, and Capt. David Caldwell.

At the next seating of the court in November 1799, the jury reported that they had valued one acre of Charles's land at 75 cents and one acre of Kelso's land at 50 cents. Kelso agreed to pay 75 cents for the value of the land overflowed by the dam (Blount County Court

Minutes 1773-1804), but Kelso and Charles continued in litigation for another year before the final mill license was granted.

Hugh Kelso was a Revolutionary War soldier who moved to Greene County in 1793, receiving a grant of 640 acres of land (Alexander 1979). Greene County was then a portion of the Territory South of the River Ohio.

Prior to 1799, when he petitioned to build his mill on Baker's Creek, Kelso moved to Blount County in the new state of Tennessee. Kelso appears on the Blount County tax rolls in 1801 (Sistler and Sistler 1977).

In May 1800, he purchased 640 acres at the mouth of Baker's Creek at the Tennessee River (as the Little Tennessee was then called). The sellers were Alexander Kelly and Archibald Lucky (Blount Co. Court Minutes 1773-1804). Alexander Kelly had operated a mill prior to the establishment of Blount County records, but it is not known if this mill was located on Baker's Creek on this tract.

The town of Morganton was established by legislative act on October 25, 1813, to be laid out at the mouth of Baker's Creek on the land owned by Hugh and Charles Kelso (Goodspeed 1887b). On September 14, 1814, Hugh and his son, Charles Kelso, proprietors of the lands where the town of Morganton was laid out, sold the 31 acres which contained the town to the commissioners for \$10,000

(Blount Co. Court Minutes 1773-1804). Kelso had paid \$600 for the full 640 acres in 1800.

Morganton had been established as a post town. In 1834, the town contained 18 dwelling houses, one hatter's shop, one cabinet shop, one smith's shop, one silversmith, one gunsmith, one merchant gristmill, sawmill, hemp factory for making rope and bagging, one physician and 70 inhabitants (Morris 1834).

Hugh and Charles Kelso moved from Morganton to Monroe County by 1821 (Alexander 1979). Charles continued the family's milling tradition near Lenior City where he operated a mill. He also operated Eve mill in Loudon County for a time.

According to information on photographs of the mill in the McClung Collection in Lawson-McGhee Library in Knoxville, Kelso sold the mill to persons named Cobb and Pain. In Blount County Deed Book 2 (p.208), there is an entry for 576 acres of land on the Tennessee River and Baker's Creek sold by Hugh Kelso to Archibald Cobb and Thomas Pain. The price was \$2,000, and the date was May 26, 1818. In March, 1819, Hugh and Charles Kelso sold an additional 160 acres to Thomas Pain for \$1,500. Cobb became the sole owner of the mill and the site passed from him to an Abernathy and then to the Heiskells around 1855.

Archaeological Investigations at Kelso's Mill.

Baker's Creek at the mill site had an elevation of 765 feet, and the mill site had a maximum elevation of 781 feet. The dam for the mill was located c. 1,700 feet upstream from the mill. The race cut off the bend of the creek below the dam but, in general, followed the contours of the creek. The race was 11 feet deep in places, and as much as 26 feet wide. While excavations were not undertaken in the race, sections of what appeared to be timber lining were visible in portions of the race.

The mill was originally an overshot wheel and was later converted to a turbine wheel. The head at the top of the flume, measured in 1942, was 17 feet. The distance from the base of the sluice gate to the surface of the water in 1979 was 13.61 feet.

The concrete dam recorded was apparently upstream from a previous dam. This newer dam directed water down a new race that connected with what was probably the original race. The near 90 degree angle at which the new race connected to the old would probably have caused considerable drag at the junction. A concrete wall permanently cut off the old race at the junction (Figure 8).

Artifact recovery by UTC was limited to those recovered in the tailrace. Metal artifacts were located with the use of a magnet. Broken gear pieces, nails, and a

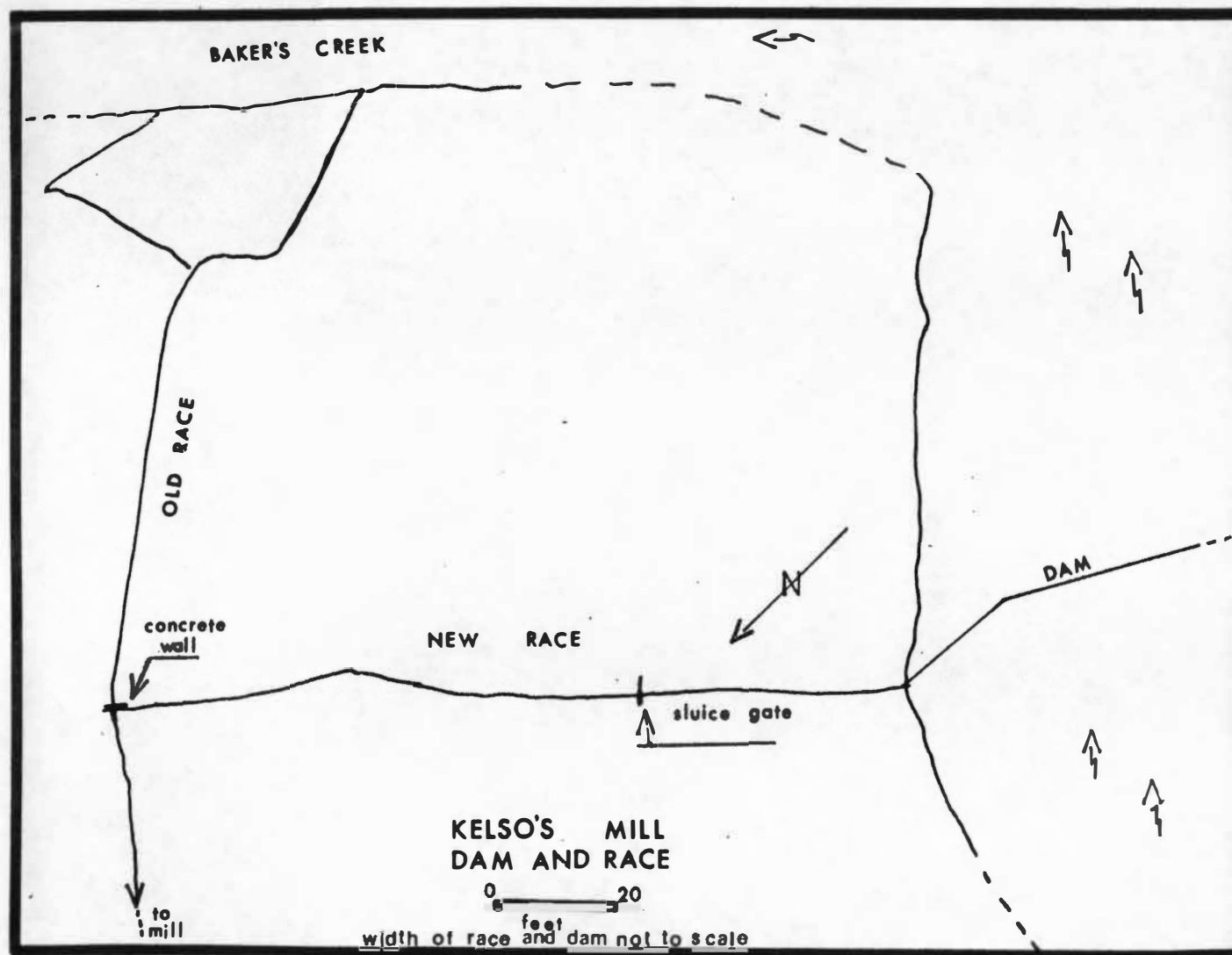


Figure 8. Kelso's Mill Dam and Race.

broken pitchfork comprised the majority of the recovered artifacts (Appendix I, p. 154). The artifacts, while few in number, are very similiar to those recovered from the tailrace at the site of Brainerd mill in Hamilton County, Tennessee.

Trigonia Mill

Location. Trigonia mill was located on Nine Mile Creek at the junction of Blount, Monroe, and Loudon counties. The mill had originally been in Blount County, but the creation of later counties split the property. Loudon County was created by an act of the Tennessee Legislature in 1870. The first name of the new county was Christiana and was changed to Loudon a few weeks later. The county was created out of portions of Roane, Monroe, and Blount counties (Tenn. Hist. Records Survey 1941). At the time of the archaeological investigations, the mill dam was in Monroe, the pond in Blount, and the majority of the mill structures were in Loudon County.

History. The Trigonia mill was supposedly built by George, Ike and Jim Swaney about 1850 (Burns 1957), although it could not have been known by that name at the time. Tindell (1973) indicates that the Trigonia Community was not named until 1888, reflecting its location at the junction of three counties. Tindell (1973) and Montgomery

(1981) both indicate that Isaiah Leonard was the first operator of the mill with the Swaney Brothers taking over later.

B.F. Baskor installed some of the equipment in the mill after the Civil War. He had learned the trade of mill wrighting from his father in Washington County. His descendants still live in the Greenback area (Montgomery 1981).

John Cook operated the mill from 1915 to 1930 (Burns 1957). Cook purchased a portion of the Swaney property in 1905 (Loudon Co.), but it has not been determined if this was the mill plot. The mill was owned by a Mr. Brown from 1930-1951, and then by Pearlie White until it burned in 1954 (Burns 1957).

The Hartsell Longs, who operated the mill for John Cook, claim that their little house near the mill was situated so that the sitting room was in one county, the kitchen in another, and the bedroom was in a third (Montgomery 1981).

Archaeological Investigations at Trigonía Mill.

Archaeological investigations at Trigonía Mill were undertaken for two days in early December, 1979. At the time of the recording, the mill dam was intact, as were portions of the stone walls of the mill. The investigations consisted of recording the structural

elements of the mill complex and recording the turbines in place (Figure 9). Excavations were limited to uncovering the turbines to record them. In the 25 years since the mill had burned, the turbines had been completely silted over and only the shafts were visible.

No attempts were made to recover artifacts other than the turbines. The impoundment of Tellico Lake began during these investigations, and rising water levels prohibited the exploration of the tailrace.

The dam at Trigonía was concrete with an opening for the flume. The flume opening was 6.4 feet high and 5.25 feet wide. The distance from the top of the dam to the forebay floor in the penstock was 13.6 feet, giving a head of at least 13 feet. The flume was 75 feet long from the dam to the main turbines.

A small turbine was located outside the mill structure 30 feet from the dam. This turbine was in its own small penstock, but no other structural elements were in association with it (Figure 10).

Trigonía Turbines. There were three turbines recovered from Trigonía (Figure 11). The small turbine is 2.2 feet in diameter with six gates. This turbine is probably a wicket gate and is similar to a Wellman-Seaver model. This turbine operated at high speed and probably was used to generate electricity for the mill (LaForest

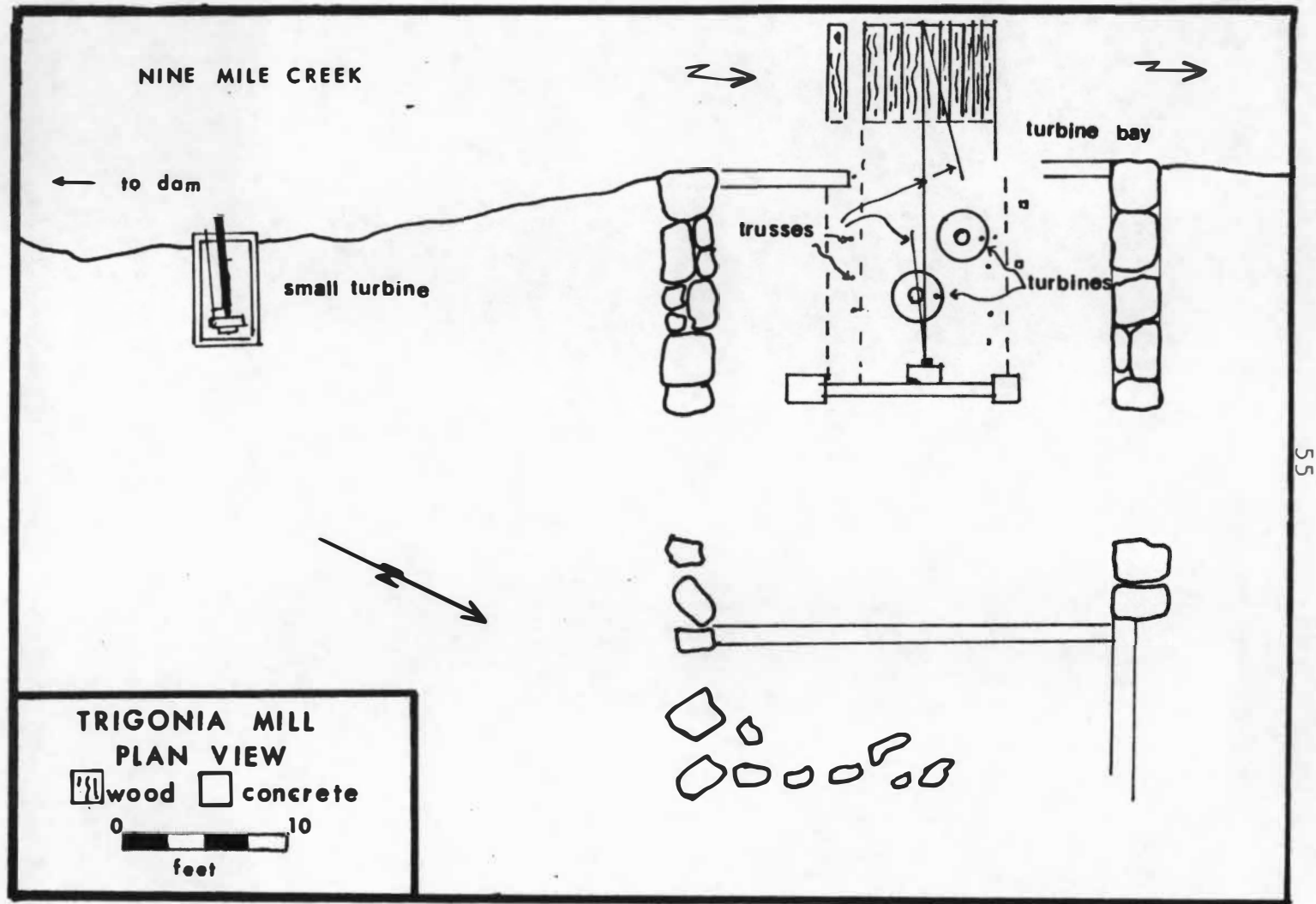


Figure 9. Trigonia Mill Site Plan.

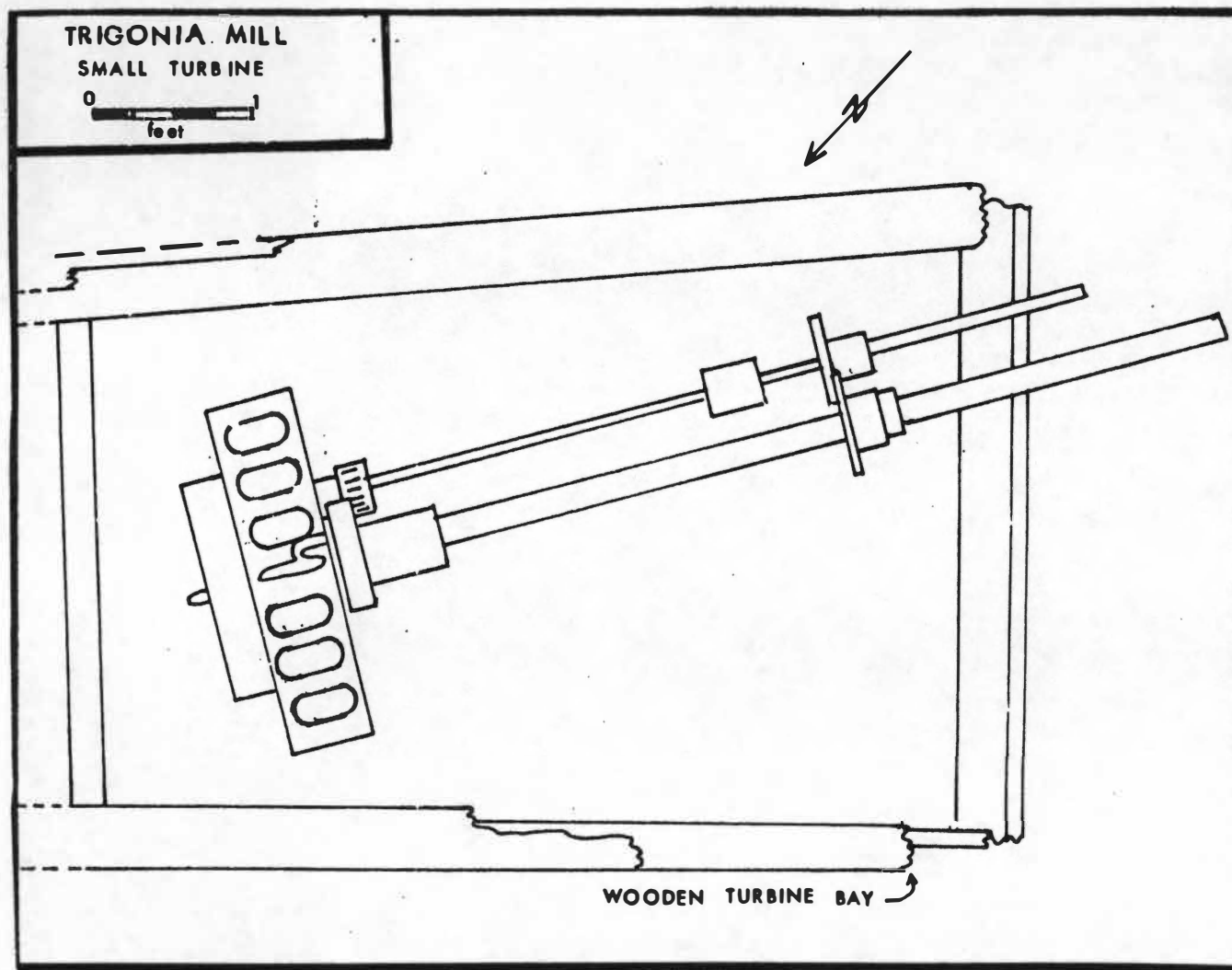


Figure 10. Small Turbine From Trigonía Mill.

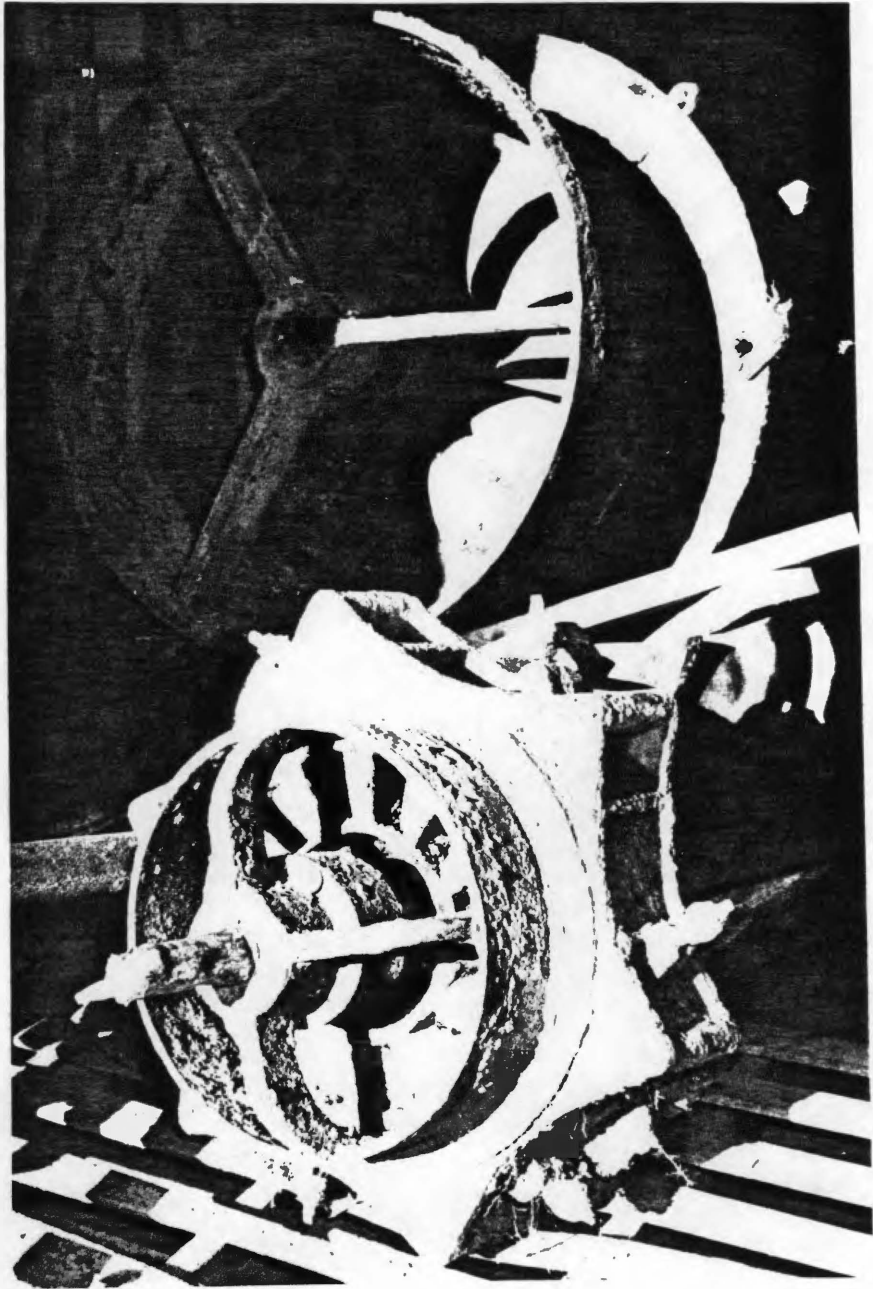


Figure 11. Trigonía Turbines, View of Bases. Upper Turbine is One of the 32 Inch Leffel Sampsons. Lower Turbine is 26 inch Wicket Gate Model.

1982). This turbine was in line with the main flume, and probably operated from a diversion of it.

The two main turbines are Leffel Sampson turbines. These turbines have 12 runner vanes or buckets. The base of the draft tube is 2 feet 9.5 inches in diameter and the main diameter is 32 inches (Figure 12).

The Leffel Sampson has, according to the manufacturer, a lignum vitae bottom step bearing. According to Ketner (1981), lignum vitae bearings were usually replaced with osage orange when they wore out, as lignum vitae is an imported wood (Figure 13). Limited tests by TVA on the bearing for the Trigon turbines indicated that the wood was lignum vitae. This would indicate that the bearings were original.

Shadden Mill. The mill at Shadden was originally operated by Silas Pearson as a sawmill and gristmill. It ground only corn (Montgomery 1981). It was later operated by Frank Shadden and in more recent years was known as the Skeen mill.

Miss Esther Montgomery lived just down the road from Shadden mill and shares this reminiscence:

Corn bread was a regular part of our food supply. In my home, we nearly always had biscuits for breakfast followed by corn bread for dinner and supper.

When the supply of corn meal was getting low, Daddy would bring corn to the house, and we would enjoy an evening sitting before

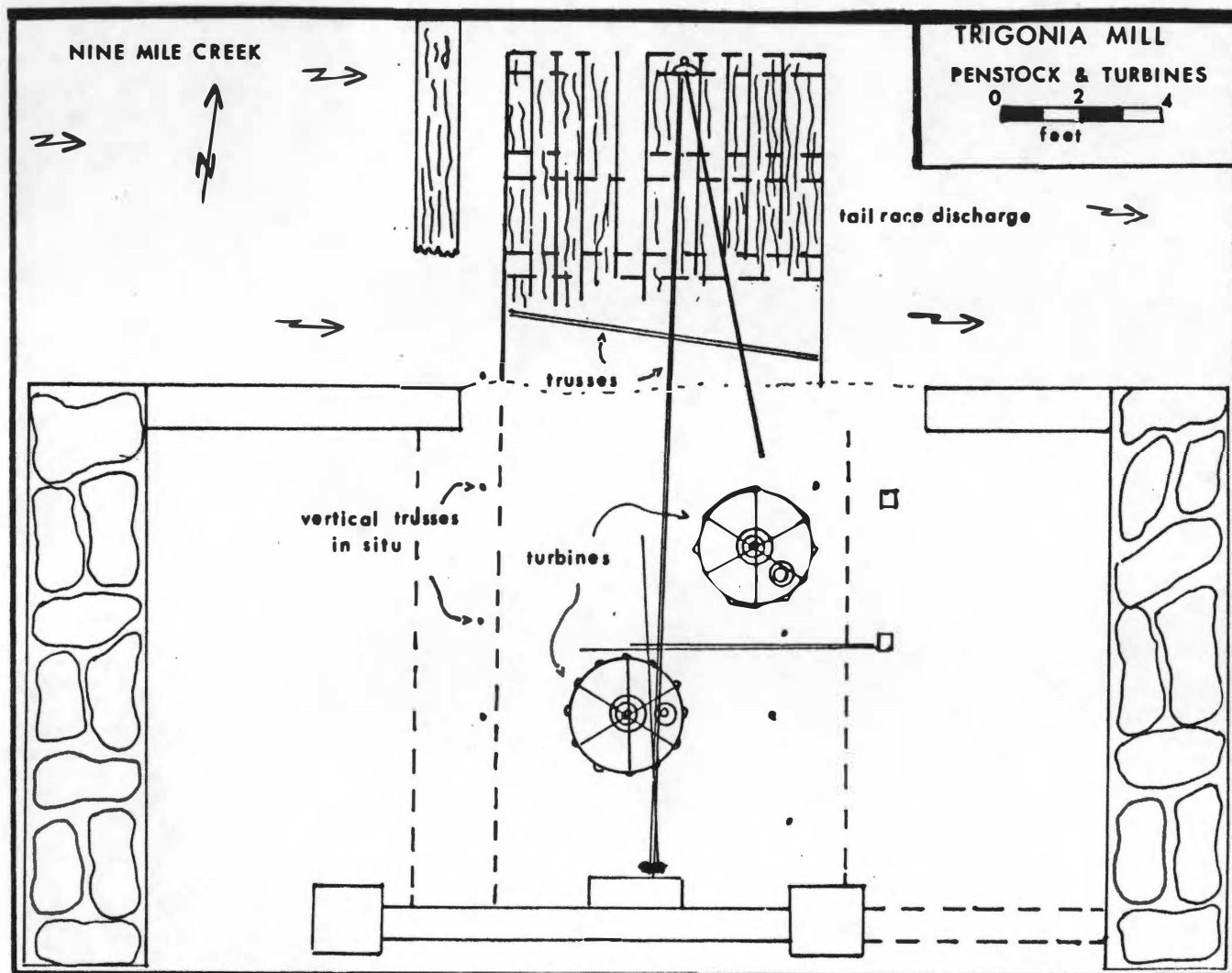
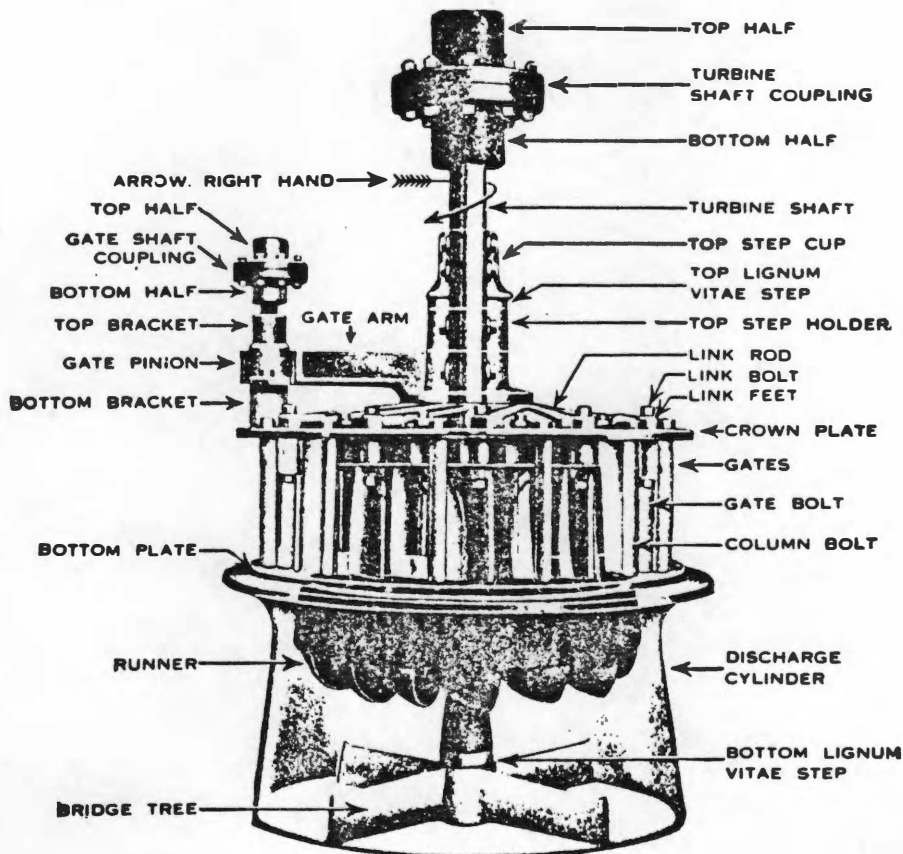


Figure 12. Trigonía Mill, Penstock and Turbines.

THE JAMES LEFFEL & CO.

Improved Vertical Samson Turbines

These turbines are built strong and substantial, and equipped with our exclusive design double steel bucket runners fitted on steel shafts. Large top and bottom lignumvitae step bearings for carrying the revolving parts of these turbines, including the weight of extra upright shafting and gearing. Also, balanced swing-type gates with separate adjustable steel connections. Each gate removable independently. All bearings of large dimensions and special material. Bolted couplings.



The above illustration shows the design and construction of our Improved Vertical SAMSON Turbines and gives the names of each of the various parts.

The arrow on Turbine Shaft shows Right Hand Rotation.

We bore and keyseat the top halves of Couplings to suit your requirements.

For dimensions of SAMSON Turbines in Open Flume Setting, see Page 3.

For dimensions of Steel Flumes for SAMSON Turbines, see Page 4.

Figure 13. Leffel Turbine Showing Lignum Vitae Bearings.

the open fire shelling the ears of dried corn and pouring it into the "meal sack". A grist of corn filled this sack about 2/3 full so it could be carried comfortably on the horse, behind the saddle. It was a special sack of closely woven cotton material that would not allow the finely ground meal to sift through. The miller who ground the corn would keep a portion of the meal to pay him for his work. The meal always had to be sifted to remove the coarse bran before it was used in making bread. Our corn was always leavened with soda and mixed with buttermilk. To this day I believe corn bread is better baked in an iron skillet.

Investigations at Shadden Mill were limited to recovery of the turbine. The masonry dam at the site was in reasonably good condition, and the mill foundations were probably in fair condition. Because the mill site would not be inundated, no archaeological work was undertaken.

The turbine at Shadden was very large, 54 inches in diameter (Figure 14). The wheel was made by Fitz-Burnham Water Wheel Company in Hanover, Pennsylvania (LaForest 1982).

Summary

The impressive size of the mill race at Kelso's mill attests to the effort a miller might have to expend to develop a mill seat. The long race would have been necessary to provide sufficient head for the operation of an overshot wheel. When the mill was converted to a turbine wheel at some later date, the race appears to have continued in use.

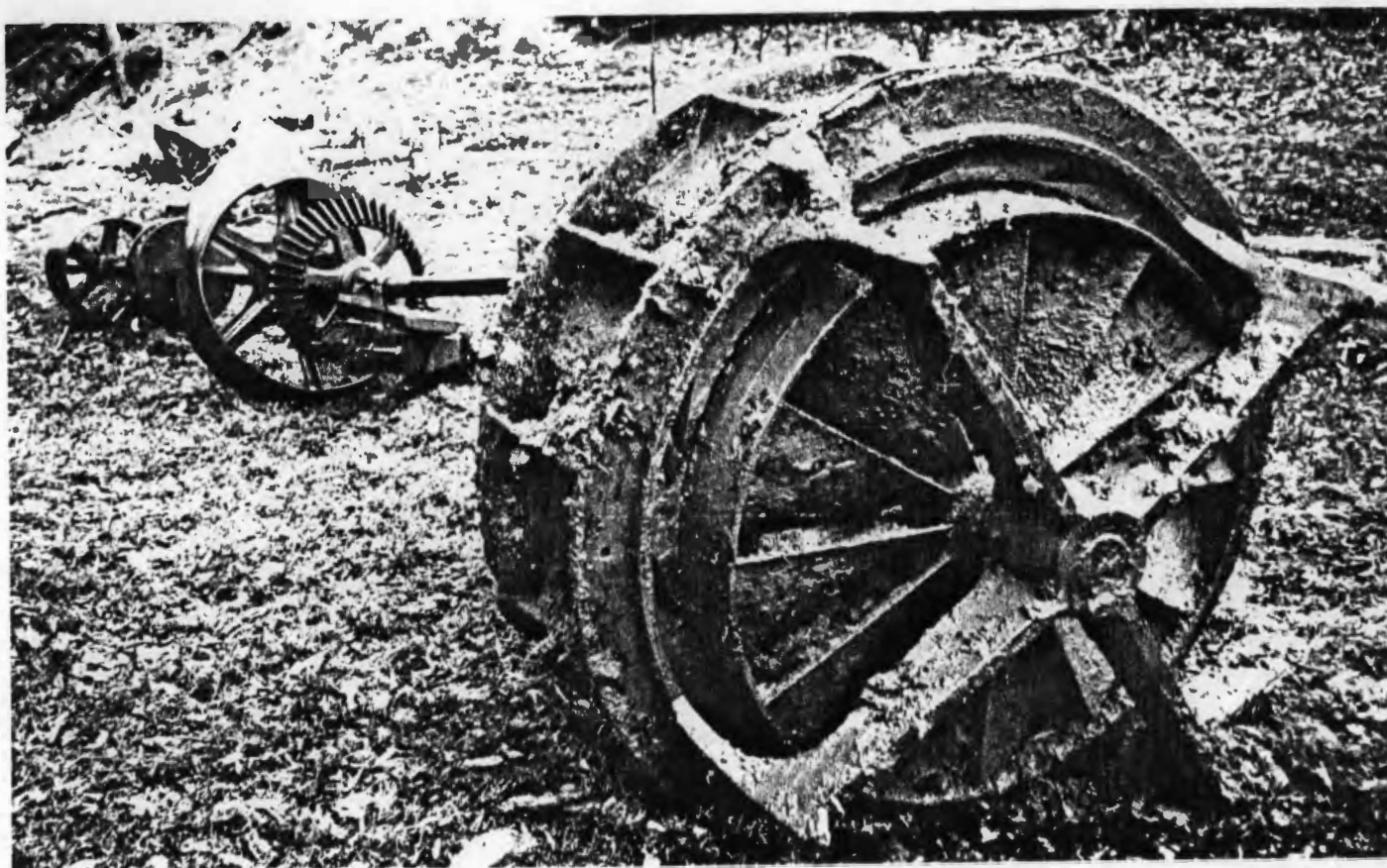


Figure 14. Fitz-Burnham Turbine from Shadden Mill, Main Drive Shaft Still Attached.

The mill at Trigonía, which was probably not built until the 1850s, may have operated as a turbine mill from the beginning. The mill postdated the development of the turbine and was close to its dam with no race involved. Mills with long races were frequently operated by exterior wheels, and those with original or replacement dams at the site of the mill were generally operated by turbines (LaForest 1982).

Newell (1978) has stated that examination of industrial sites can offer insights into the levels of technological sophistication and how the technology is diffused. At Trigonía, the 1850s date would be fairly early for the use of a turbine, since it was not introduced into the United States until 1842. Since the limited archaeological evidence indicates that the mill was originally a turbine mill, it would appear that parts of East Tennessee had access to the new technology only a short time after the industrial centers of the East.

While the Tellico mills were not extensively studied, they still are important to the understanding of the social and industrial development of the Blount County area.

CHAPTER V

THE BRAINERD MILL

Introduction

The Brainerd mill site is a portion of the Mission to the Cherokees established by the American Board of Commissioners for Foreign Missions (ABCFM) in 1817.

Construction of Brainerd Village Shopping Center and the adjacent Eastgate Mall destroyed most remnants of the Brainerd Mission except for the cemetery and the mill site. At the time of investigations at the mill in 1979, the lower portions of a log crib dam, a mill foundation and a possible race were visible.

The construction of a flood relief program for the South Chickamauga Creek watershed was proposed in the late 1960s by TVA. The project consisted of a levee, generally of earth fill, about 3.9 miles long. Levees on low-lying land were to be about 30 feet high, with an average of about 23 feet in height. The levee was designed with a top width of 14 feet and side slopes of 2.5:1.0. The channel of South Chickamauga Creek would be widened and relocated to restore flood capacity lost by leveeing the west flood plain, and old channels would be refilled. The proposed realignment of the sharp turn in the creek at the

site of the mill would directly impact the archaeological remains (TVA 1967).

In 1973, a surface survey, performed by TVA, failed to locate any prehistoric sites along the affected waterway. Remains of the mill were visible at that time, but were not included in the archaeological survey. In February of 1979, the existence of the site was called to the attention of TVA by Mr. Thomas Williams, a local historian. At that time construction on the flood relief plan was well underway, and The Institute of Archaeology at UTC was contacted to perform salvage data recording at the site. Excavation and salvage recording of the site was undertaken from July 18 to August 17, 1979 under the supervision of Dr. Jeffrey L. Brown, director of the Institute of Archaeology.

Throughout this paper, and the Brainerd history section in particular, quotations are used. In all cases spelling and punctuation are as in the original.

Location

The mill site is located on the west bank of South Chickamauga Creek. The site lies approximately 800 feet south of Lee Highway (U.S. 11) and 2100 feet north of Interstate 75. Brainerd Village Shopping Center lies directly to the west of the site (Figure 15).

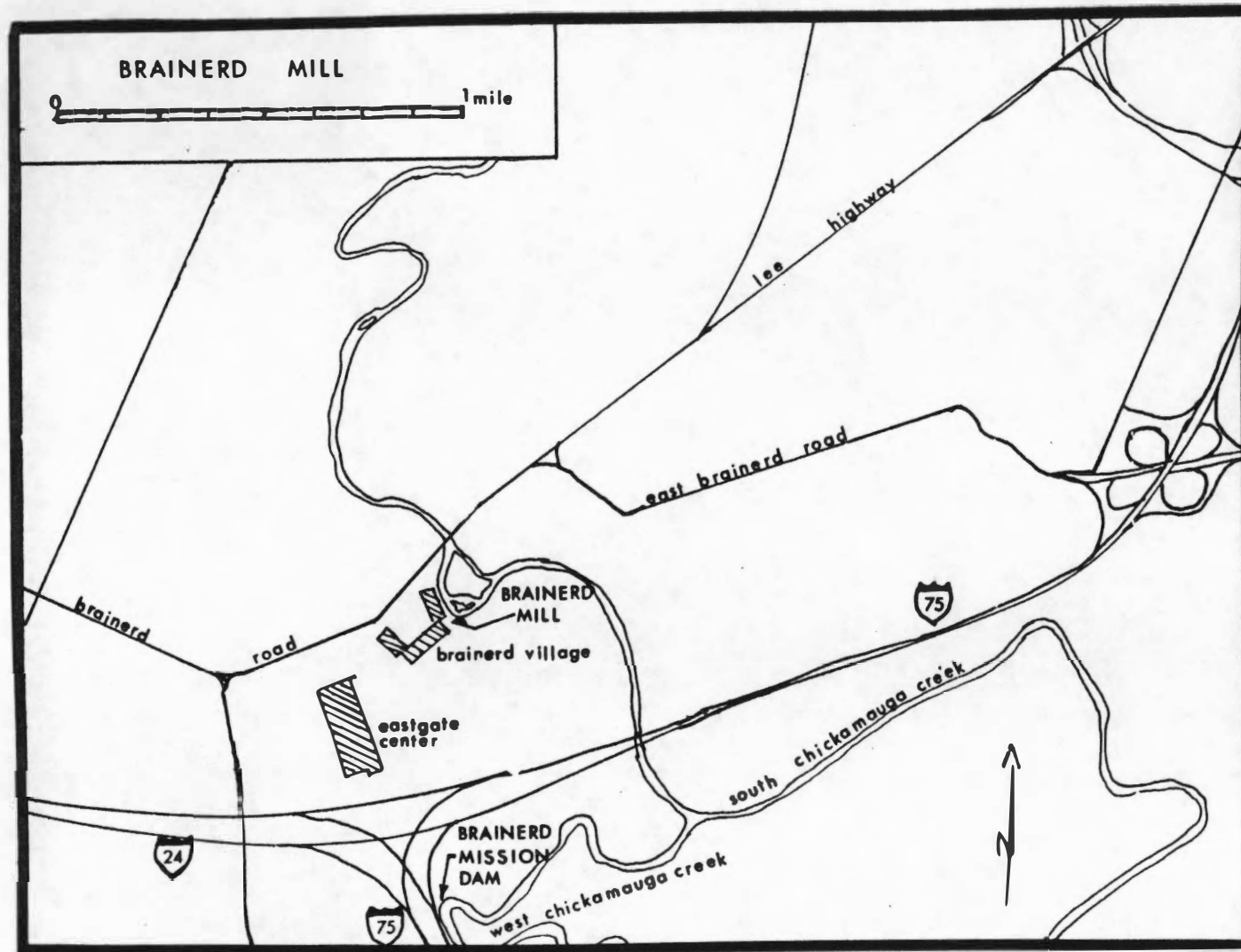


Figure 15. Location of Brainerd Mill and Mission Dam.

The South Chickamauga Creek watershed lies in the Ridge and Valley Physiographic Province. This drainage basin occupies 464 square miles and drains all of Catoosa County and parts of Walker and Whitfield counties in Georgia, and part of Hamilton County, Tennessee (TVA 1967). The primary drainage feature, South Chickamauga Creek, flows in a northerly direction for approximately 30 miles emptying into the Tennessee River at mile 468.2 (TVA 1967) near Chattanooga, Tennessee. There is considerable fluctuation in the size of the creek, which ranges from a sluggish, slow moving stream in late summer to a raging torrent capable of inundating hundreds of square acres in the spring (Brown and Evans 1977). At maximum flow, the creek is larger than several of the streams designated as rivers in lower Georgia, and several early writers refer to it as the Chickamauga River (Haywood 1825).

South Chickamauga Creek is subject to heavy flooding which had an influence on the operation of the mills at the Mission site, and, as well, on the overall operation of the Mission. Flooding on South Chickamauga Creek can come from headwater floods or from backwater from the Tennessee River. Backwater flooding has been reduced since 1936 by the construction of reservoirs on the Tennessee River by TVA. Headwater floods remain a serious problem, and in the period 1928-1958, occurred an average of five times a year (TVA 1958).

The highest recorded headwater flood was at 20.73 feet on March 30, 1951. Bankfull stage is 10 feet on South Chickamauga Creek. Records of the 1867 flood indicate that it was the highest known backwater flood with an approximate level of 30 feet. This flood occurred on March 11, 1867 (TVA 1958). The Brainerd Levee project was designed to reduce the danger of headwater flooding on the creek.

South Chickamauga Creek has a slope of 1.9 feet per mile between miles 8 and 14, 3.8 feet per mile from mile 14 to mile 20 (at Graysville), and 5.0 feet per mile from Graysville to Ringgold. Spring Creek, where the original Mission dam was located, has a slope of 3.9 feet per mile in the 6.5 mile reach above its junction with South Chickamauga Creek (TVA 1958).

History of Brainerd Mill

Mission Period. The Cherokee nation in 1809 was located primarily in northwest Georgia, southeast Tennessee and northeast Alabama. The area they occupied encompassed 24,000 square miles, "generally of an excellent soil, in a fine healthy climate, variegated with mountains and plains, watered by the Tennessee" (Morse 1822:152).

As a condition of the Treaty of Tellico in 1805, parts of the lands ceded to the United States by the

Cherokees were set aside as "school reserves". These reserves or tracts of twelve square miles were to be sold by the United States, and the proceeds were to be used by the President in the manner he judged to be the best way to provide for education among the Cherokees east of the Mississippi River (Morse 1822).

In light of this interest in educating the Native Americans, the American Board of Commissioners for Foreign Missions (ABCFM) associated with the Congregational Church established its first mission to the Cherokees in 1817 in the Chickamauga District. A Cherokee Mission had previously been established at Spring Place, Georgia, in 1801 by the Moravian Brethern; and in 1803 the Rev. Gideon Blackburn had established a school which served as a forerunner to later, more permanent establishments (Morse 1822).

The ABCFM had been organized in 1810 to provide Christian missionaries abroad. When the Board was criticized for sending missionaries to India when there were "thousands of heathen people near its door," the Board took the criticism to heart and sent Cyrus Kingsbury to investigate the prospects of opening a school for the Cherokees (Walker 1931).

The Rev. Mr. Kingsbury was present at the Council Meeting at Turkeytown in September of 1816, at which time boundary lines were settled and a treaty was ratified.

After the business between the Indians and the government was completed, General Andrew Jackson introduced Reverend Kingsbury who spoke about the need for schools. He outlined the plan for a boarding school where the children would be taught "their duty to parents, to their fellow creatures, and to the Great Spirit, the Father of us all" (ABCFM Oct. 15, 1816).

After hearing the presentation, the Council voted to accept the offer and hoped to see the school established. Kingsbury wrote to the Board (1816) that:

At first it will be expensive but the prime articles of living can be raised in this fine country with the greatest ease, and I am confident that in a few years if things are managed properly, the school may be supported at comparatively small expense.

(Walker 1931:19)

In travelling to the Council meeting, Kingsbury passed through country that was:

...one of the finest by Nature that I have ever seen. But its rude inhabitants appeared hardly to have felt the genial influence of civilization though their situation is said to be much better than was formerly. It was truly affecting to see so many people and large families of children entirely destitute of instruction, and living without hope and without God in the world.

(Walker 1931:17-18)

The missionaries apparently felt they could, through their missions, change the "hopeless" condition of the Cherokees. The Mission at Brainerd, named after the missionary David Brainerd, was on the south side of the

Tennessee River, and 15 miles upstream on the Chickamauga Creek (six miles in a straight line). The creek was navigable to the Mission (Morse 1822).

The Mission was founded near the old Cherokee town of Chickamauga (Goodspeed 1887a). Chickamauga had been established by Chief Dragging-canoe and his followers who were dissatisfied with the treaties of peace they had been forced to sign in 1777. In 1779, Colonel Evan Shelby and Colonel Montgomery were sent to Chickamauga when word came that the Cherokees from Chickamauga were starting on a march against the North Carolina border settlements (Walker 1931). The town was surprised and burned to the ground.

The Mission area was purchased from a Scotsman, MacDonald, who had married into the Cherokee nation and established a plantation. He offered his holdings which included buildings, improvements and 25 acres of cleared land for five hundred dollars. The plantation was said to be convenient to a mill and water course (Walker 1931). The MacDonald plantation had been shown to the Moravian missionaries 16 years earlier, but they had rejected it as having the reputation of being unhealthy (Walker 1931).

The South Chickamauga Creek area, while having been the site of a large Late Mississippian Dallas Phase population, did not appear to have been otherwise heavily

populated in prehistoric times (Brown and Evans 1977). While many historians say that the town was abandoned due to Shelby's raid, other towns in the area which had also been burned were reoccupied shortly thereafter. The Cherokee themselves said they left Chickamauga due to the many witches in the area. Crawfish Spring in the historic town of Chickamauga was reportedly called by the Cherokees "Spring of Dead-man's Land". In 1849, a writer reported that "chills and fever prevail on the waters of the Chickamauga" (DeSelm and Brown 1977).

The location may have been chosen less with a regard for its past history than because it was convenient to a population of Indians but not near a Cherokee town. The prevailing thinking at the time was that the towns were a bad influence on the Indians. The Moravians wrote that:

At present only that portion of the Cherokee nation, which is confessedly the most indigent and degraded, continues to live in towns. The greater and more respectable part live on their plantations, and thus acquire those habits of industry and sobriety, which are uniformly countered by their congregating together. Hence it has become a principle of sound policy in the government of the United States, to employ all its influence to wean them from that habit, and to encourage the plantation system.

(Morse 1822:155)

Kingsbury also wrote to the ABCFM in 1816 that:

The children should be removed as much as possible from the society of the natives, and placed where they would have the influence of example, as well as precept. This can be done only by forming the school into one

great missionary family where they would be boarded by the missionaries and teachers, be entirely under their direction and have their pious, orderly and industrious example constantly before them.

(Walker 1931:22-23)

Despite the attitude that the Cherokees were not capable of managing either themselves or their children, by the time the Mission was established the Cherokees were a united nation with laws and organization. The Laws of the Cherokee Nation, passed in 1820 (Morse 1822), provided for eight districts with a Council House in each District. There was a judge and marshal in each District, with a Circuit Judge presiding over every two Districts.

Other acts provided for poll taxes which would defray the cost of Council business. Storekeepers were required to obtain a license from the National Council, and the sale of liquor was strictly forbidden, Cherokee slave owners being required to see that their slaves did not obtain liquors. It was further decreed that any white man who took a Cherokee wife had to marry her legally, and could not gain rights to her property.

The Council also took pains to guarantee that the parents of students attending the Mission schools would reimburse the missionaries if the children ran away from the school.

The first missionaries to arrive, in addition to Cyrus Kingsbury, were A.E. Blunt and John Vail. They

began clearing ground for the Mission in January, 1817 (Morse 1822). Loring Williams and Moody Hall arrived in March, 1817, shortly after the others (Goodspeed 1887a).

The Secretary of War had been authorized by President Madison to instruct the Indian agent to erect a school house and a house for the teachers. The Government contractor failed to build the houses and soon the missionaries were making brick, burning lime, digging cellars and a well, and conveying corn 40 miles to be ground (Goodspeed 1887a).

By May, 1818, the school consisted of 47 students. The buildings erected at government expense prior to 1819 were the Mission-house, a school-house, dining hall and kitchen, several smaller buildings and a grist-mill (Morse 1822). In a letter from the missionaries in July, 1818, they listed expenses for some of the building:

To pay the two men who are hired by the year...	320
To pay laborers for digging well, building dam, finishing houses...	250
To purchase articles of food for the ensuing year...	
100 bushels wheat @ 1.00	100
150 bushels rye @.75	112.50
1000 bushels corn @.50	500
7000 lb pork @.06	220

(ABCFM 1818)

By 1819 there were about one hundred Cherokee children of both sexes lodged, fed, instructed and largely clothed at the expense of the Mission (Morse 1822). On May 27 of that year, during a tour of the area, President Monroe appeared unannounced at the door of the Mission. He apparently liked what he saw and ordered a school-house built for the girls at government expense (Goodspeed 1887a).

In December of 1819, Ard Hoyt, the new superintendant of the Mission, wrote to the Board requesting that they hurry and build the planned mill and saw mill which would help defray their heavy expenses (BML 1819). Added to the need for income was the problem that the corn had to be carried 40 miles to be ground. While at that time in the Cherokee Nation there were six grist and two saw mills owned by natives, and 14 or 15 grist and two saw mills owned by white men who had married into native families (Morse 1822), the large amount of grain purchased in 1818 is an indication of the need for a mill close by.

Not everyone saw the necessity of establishing a mill, however. A Mr. Friderici, a Seventh Day Baptist living with the Cherokees near the Hiwassee Town said of the proposed mill of Mr. Hildebrand to be built near the town:

The mill about to be built nearby is unnecessary, mills only served to make people live more comfortably to themselves

and not to the Lord; each one could pound his grain or grind it in a hand mill.
(Williams 1928:483)

Perhaps Mr. Friderici felt that mills were unnecessary, but the people who depended on them felt otherwise. Entries in the Journal of the Moravian Mission at Spring Place show the importance of mills to the local people:

May 21, 1802 A millwright was at Vann's to help Vann look for a place for building a mill. They located several places, but finally settled on a place a half mile from the Vann place. The millwright agreed to build the mill for \$133.50, if the Negroes would build the dam and the house under his supervision. Vann had already engaged someone, but should he fail him the latter would be permitted to build it. He decided to begin its construction in June for at that time the Negroes would be the least busy and would be able to bring the millstones from Tellico. We have the prospect of a mill less than 3 miles from our place...

July 29, 1802 Vann brought two millstones from Tellico. When they were being loaded into canoes one of them overturned the canoe and fell into the river. It is likely to remain there, and now the whiskey which more than likely contributed toward the accident has to contribute toward relieving the shock.

August 1, 1803 Steiner rode 20 miles to speak to Chas. Hicks about serving as an interpreter for him...He recently returned from Philadelphia...Hicks showed Steiner a hand mill for grinding corn by which two persons could grind as much corn as 20 could do by the conventional method of crushing it by hand. He told about having a mill built which could be operated by a horse. As soon as that was done he would put up a still and that he had already ordered two still kettles...

August 17, 1804 Heavy rains caused the dam at Vann's mill to break in two places.

January 26, 1807 In the afternoon (came) a fairly old man, Thomas Bagley from Tennessee who had resided with Mr. Hicks and built a mill for him. He offered to place his two daughters in our school while he was building a mill for Mr. Vann at Big Water.

October 21, 1807 A number of Indians stopped with us for lodging...Short of meal and unable to grind corn at Vann's mill because of the lack of water some of our guests ground the needed meal by hand.

July 18, 1808 We were glad to hear that Vann's mill was again operating for we had been obliged to grind the corn we needed by hand.

April 3, 1811 We heard that a severe rain had overturned Charles Hicks' mill and washed some of it away, a serious loss to us, for now we will have to grind our grain by hand.

July 16, 1811 Byham and John Gambold (took) part of our wheat by wagon to Mr. Hildebrands' mill to be ground. They returned from Higtwer (Hiwassee) on the 19th.

June 1, 1814 The boys returned from the mill. We were glad because of the broken down mills we were forced to work from early morning until late into the night crushing corn by hand.

December 18, 1814 Because of the severe rain of yesterday and today, we were very much concerned for Br. Crutchfield, who had gone in an open wagon loaded with corn to have it ground at Br. Hicks' mill. We were delighted to see him when he returned this evening with meal for two households. We were glad the tiresome task of the children stomping corn every day had ended.

The April 10, 1820 journal entry for the Brainerd Mission stated that the millwright had examined several places for the mill and decided that there was only one

place where the dam could be built. At that point the creek was not wide and a firm rock extended from bank to bank. The fall at the site of the dam would not be sufficient to locate the mill there as well, necessitating the construction of a race $3/4$ mile long. The race would cut off about 300 acres of good farm land in the bend of the creek (ABCFM). The dam was built, or in the process of being built when one end of the dam gave way (July 5, 1820). The millwright had supposed he had driven the timbers to the rock, but it was gravel instead (ABCFM).

By October of that year the mill was still not completed. In an inventory of the Mission reported to the Secretary of the War Department on October 1, 1820, there was listed a fish-trap, well, and garden valued at \$200.00; a bridge over an arm of the mill pond and canoes valued at \$55.00; and the mill which was valued in its unfinished state at \$3000.00. The mill was both a "gristmill and a saw mill turned by a canal $3/4$ mile in length, which conducts the water from a branch of the creek in the neighborhood..." (ABCFM).

A letter from Ard Hoyt to Evarts on October 17, 1821, reveals that expenses were running high at the Mission, in spite of an entreaty from the Commissioners to watch expenditures carefully. The missionaries had reviewed the areas of expense and felt that work on the mills should

not be stopped. There had already been a good deal of money expended on the grist mill and it was felt that the old grist mill would not be likely to be sufficient for the needs of the mission much longer. (Whether this mill was a new structure or just the milling apparatus itself is not known. It may have been a new structure as the foundation of the saw mill failed after only one month and it had to be moved.)

After these mills were moved, "founded on a rock," and operable, the missionaries expected that they would begin to see a return on their investment. Until that time, there would have to be an increase in the stipend from the home office or the support money for the school would have to be diverted. As well as depleting the treasury by paying large amounts on the mills, the money due from the government had not been paid, leaving the choice of either laying in supplies or lessening the support to the school.

By 1823, a blacksmith shop had been established which was finally beginning to pay for itself (BML 93). The same could not be said for the mills, however. Despite considerable expense, the grist mill was still only grinding enough to supply the Mission. The sawmill was apparently also a source of disappointment. The sawmill had been placed in operation on January 5, 1821, and by February 5, 1823, had sawed only 85,125 board feet of

timber. Of this amount only 33,000 feet were sawed after the mill was removed to its new location. The absence of a sawyer to oversee the operation was considered to be the biggest contributing factor in the lack of profit from the sawmill.

An additional expense would also be incurred in the deepening and widening of the race, if sufficient water was to be provided to keep the trip hammer and mills in operation. The present race was providing barely enough water to power one of the mills, and its walls were in need of repair to keep the bank from falling in on the flume (BML 93).

If a reliable miller could be found, it was felt that the problems with the mill would be solved. To that end, the Brothers began searching for someone to fill the post. They wrote to a Mr. Shelton to come and tend the mills. When he did not arrive as expected, it was discovered that he had never received the letter and had made other plans (BML 96).

The Mission was again in need of money when Ard Hoyt sent a report to the Commissioners on May 26, 1823:

But God in his providence does not will upon these exertions. You did not expect the sum of \$3,000 would support the mission with its seven schools, but doubtless looked to the farms, mills, shops and etc, for very considerable aid. I think I may say in the years that these have all failed-yea more, that our very exertions to obtain support

for ourselves have caused a great addition to the expense of the mission--everything we have undertaken has been a bill of expense --even the stock of cattle and hogs from which so much was expected, is likely to do very little--the hogs run wild and we lose them--and the cattle fail for want of food in the winter. The black-smith shop seems likely to do well, but you will see from the monthly report how much profit the funds of the mission have derived from it...We have lately paid \$100 for iron--about \$200 for transportation of iron and etc from Boston and are now called on for \$150 for coal.
(BML 99).

Mr. Shelton, the millwright was finally able to settle his business and arrived at the Mission in June, 1823. He was to deepen the mill race according to the original plans, and as well, build an extensive flume in the race in front of the mills and shop. The cost of this project was estimated at from 75 to 100 dollars (BML 101).

In addition to the continued problems with the mills and dams, the missionaries were finding the area to be an unhealthy place to live. Dean wrote in November of 1824 (BML 299) that he had been afraid that they would never enjoy health at the Mission, blaming the condition on the "effusive" arising from the pond. He later decided that their diseases originated from (unnamed) things around them.

At about this same time, the missionaries hired a Mr. Parker to tend the mills and the ferry (BML 127). Mr. Parker's wife was not well, however, and could provide him no assistance; it was thought that she had consumption.

The litany of dam troubles continued and on February 3, 1825, the mill dam failed again (BML 130). This time the damage appeared worse than usual and the missionaries again wrote for instructions. Meanwhile they expected that they would have to travel 10 miles to a mill.

Mr. Parker, the miller, and his family were forced to move from their assigned cabin, as the dampness from the creek was further deteriorating Mrs. Parker's health, and he had to be away from the mill frequently to nurse her. Due to the unreliability of Mr. Parker's presence (and possibly to unburden themselves of the continued troubles with the mills), the Board was asked to give some definite instructions about renting the mills and dam. The mills were providing enough grain for Mission use, but no excess. The missionaries were anticipating that as soon as the water fell, they would be "destitute". The grist mill was leaking badly and needed a new roof before summer (BML 131).

The construction of a new dam was still of major concern in April of that year when Mr. Elsworth wrote that the question of whether to build a stone or log dam was being debated (BML 132). Mr. Shelton, who helped in building the old dam, thought a stone dam should be built and that the wall should be extended. He felt that a part of the bottom might be a kind of quick-sand. Another

millwright had looked at the dam and recommended logs. The missionaries were afraid that if the new dam was built where the old one had been, that the cracks in the rocks at the bottom would continue to cause trouble, and hoped to find someone who was well acquainted with building dams in the area.

Mr. Elsworth was tied down by the demands of the school, and could not search for someone to examine the creek (BML 132). He had, however, thought that Mr. Dean, who had been the chief mechanic, could be put in charge of the mills and dam and tend the shop at the same time.

By April the race was dry and would continue that way until the rains came. The missionaries were anxious to have the dam built as soon as possible due to the "dangers of fever and ague." They hoped that if Mr. Dean could undertake the job it would be better if -- Mrs. Dean's health permitting--they would live at the mill house. Mr. Elsworth would prefer that they contract out the job and that the person who took it should have no communication with the family at the Mission house "remembering that 'Evil can corrupt good manners' ." He was also reluctant to board the workers, feeling that they already had more people underfoot than they could oversee. Besides "in a job like this some men would prefer throwing up a rough cabin near their work and have a black girl to cook for them" (BML 132).

A postscript to Mr. Elsworth's letter states that Mr. Chamberlain had been to the site and thought that the new dam should be built about 4 or 5 rods below the head of the race. At this point there was solid rock almost all the way across the creek. Mr. Dean had returned and agreed with this decision (BML 132).

Mr. Dean evidently did begin overseeing the construction of the new dam, but was compelled to return north in July due to Mrs. Dean's failing health (Walker 1931). By September the mills were successfully operating, and within two months, 94 bushels of corn had been received in toll (BML 136).

Despite high water in the Spring of 1826 impeding completion of the dam, the missionaries were apparently beginning to have hopes that the mills would finally pay off (BML 138). Mr. Elsworth requested that the Board send a bolt for the mill. About 500 bushels of wheat were in the fields that summer, and more would be raised if there was only some way to sift the flour. He hoped the Board would let him know as soon as possible if one could be supplied before the next growing season so that the farmers could plan to save more seed (BML 140).

Shortly after this letter, on July 14, 1826, Mr. Elsworth again wrote regarding the bolting apparatus. He had in the meantime seen a millwright regarding the expense of installing the bolt. If operated by water the

cost would be \$50.00, but if turned by hand the cost would only be \$10.00. The cloth would not be expensive, so a small handturned bolt was being installed at once. A regular bolt was still requested, but the small bolt would serve for the interim (BML 141).

In December, the blacksmith shop burned and the only thing salvaged was the lower frame. It was hoped that a new shop could be built on the foundations as soon as possible (BML 311).

The estimate of property at Brainerd in 1827 listed the value of the mills and race at \$4,000 (BML 139). The mills were doing well at this time, but little was expected of them in the way of supplies for the coming year (BML 87).

A visit from David Greene of the Board to the Mission in April, 1828, resulted in the following comments in a long report to the Board:

All seem extremely pleased with Mr. Parker's management in the Mills, and he seemed in his element and apparently the busiest man on the grounds. He has sawed from the 20th of Feb. to the close of Dec. 41,351 ft. the value of which is near \$420, while the expense of the Mill in repairs, has been but less than \$90. In the grist mill he has taken more than 610 bushels of toll, in corn and wheat, the value of which here is about \$350 besides what he has ground for the families, the toll of which would have been \$52.80. The repairs on this mill have cost in the time mentioned about \$38.81. The whole income of the Mills has been, then in ten months and a half, about \$815 and deducting the expenses, about \$687,

without taking into view the time of the tender, or the interest in the capitol.

The race must be cleaned, and the banks repaired in one or two places this coming season, Some of the gears also, which though put in new but a short time since, must be renewed again, considering how quickly the timber of this country decays, I suspect there would be a savings of expense in five years by having the gearing of the Mill wholly of cast iron. Mr. E. will ascertain what the expenses of casting will be in Tennessee and communicate it to you for your decision. Perhaps better and cheaper ones might be forwarded from Boston, and Mr. Worcester could easily make drawings to be forwarded as models, if that should be the fact.

Mr. Parker is much embarrassed by the ferry, which often causes the mills to stand still. I have forgotten the numbers of thousands of horses, wagons and men which he has ferried over, while, as all people living in the nation go free, the income has been but little more than nine dollars.

(BML 325)

The mills were finally performing as the missionaries had hoped. The presence of the sawmill, however, may have been the source of unexpected friction. Mr. Greene goes on to say that:

...I think there is danger that the missionaries at the small stations will feel that they must imitate the spacious and commodious buildings at Brainerd. I think I have seen a propensity to do so; and a feeling of being unfairly dealt with, when attempts are made to dissuade them from it. They do not see that the mere fact of having a sawmill is a reason why one family should live in ceiled houses, while they are surrounded by rough logs, battened or daubed with clay (BML 325).

There seems to be a difference in the amounts accounted for from the mills by David Greene and, later in the year by A.E. Blunt. Blunt reports in December:

You probably have the impression the mills are going well, and to considerable profit. I will give you an estimate of what Mr. Parker and myself thought they would bring yearly. The grist of corn 400 bushels worth \$100, wheat 60 worth \$45 added 145 yearly expenses \$25 leaves \$120 profits. Profits of the saw mill \$257 expenses \$116 leaving \$141 which added to that of the grist mill makes \$261, for the support of Mr. P's family and interest of the money they cost-I say nothing of the worth of the corn ground for our family, which if it were tolled at another mill would cost something like \$10. This estimate is as we may expect from the Mills.
(BML 119).

It seems that success with the mills was not to last, however. In 1829, Luke Fernal, the blacksmith, reported to the Board that the blacksmith shop had appeared to be getting lower to the water. It was discovered that the foundations were so decayed that it was feared that the building would fall in. The mills had both begun to break apart and before too much more time had passed, it was felt they would be in four pieces. Mr. Fernal deducted \$150.00 from their value in the Mission accounts (BML 317).

The flume as well was suffering from the "timber-killing influence of the water". As a matter of course, it needed rebuilding every four or five years. The water flow was next to nothing from June to October. The blacksmith finally despaired of using the flume, and had

given up the water blast in the shop the previous year (BML 316).

The usual summer complaint of the millers was that there was no water in the race due to the scarcity of rain. In 1830, the weather turned capricious and pelted the Mission with heavy summer rain. As a consequence of this, not only were crops destroyed in the fields due to high water (BML 80), but the dam broke again (BML 84). By the end of October, the weather was still not favorable for the repairs to be started.

The dam broke again in the fall of 1831 and in February of 1832, requiring the missionaries to go 18 miles to get the grinding done (BML 87). Mr. Elsworth reported that the break was about the same extent both times, but the winter break would be more costly to repair, as more rock must be used. As usual, repairs would be delayed until the weather was warmer.

In late May, the dam had still not been repaired and it was probable that it would be fall before anything would be done (BML 89). The missionaries were finally realizing that the location would never be suitable for their purposes. They were not in the best of health, and the doctor had advised them that if the water stood on the crops again that year as in previous years, they could expect a "Malignant sickness" to follow. Mr. Elsworth felt that while it was important to keep the mills in

operation, it should be accomplished without too much expense of money and health and perhaps even their lives.

The repair of the dam was now considered of doubtful effect. The creek was cutting away the bank and the channel was changing and undermining the wing of the dam. Mr. Elsworth, despairing of the permanence of any repairs, wrote:

Were it possible and would the state of the nation ascent to it, I would heartily advocate the disposal of this whole establishment, and remove to some more retired and healthy spot among the Cherokees, where our strength and labors might be applied solely and directly to the great object for which we came.

(BML 89)

As the summer progressed, Mr. Elsworth advised the Board that if the mills were to be kept in operation, it would be best to operate them at the point where they stood on the creek and remove the old dam (BML 92). This would relieve the expenses of continually repairing the flumes and digging out the race. While they were well aware that it would cost more if this plan was enacted, they also felt that they might at least have some relief from the constant failure of the dam. There was also a rumor that, if the mills could be operated, there might be a person interested in buying them (BML 92).

By the end of summer 1832, rumor was fact, and a Mr. Seales had not only made an offer for the mills, but had also made an offer of \$2500 for all the Mission property

(BML 93). Mr. Elsworth, in reporting this offer to the Board, said that he had told Mr. Seales that the Board should not take less than \$3000. The Board had not yet decided to sell, and were waiting to see what the Cherokees would do (BML 93).

The times were unsettled for the Cherokees and the missionaries as well. Brainerd was the first of the ABCFM Missions and was considered the "mother church" to later missions established in Georgia and Alabama (Walker 1931).

Several of the early missionaries to Brainerd had in fact left to serve these later Missions. Moody Hall left in 1820 to begin the school at Taloney, Georgia, and Samuel A. Worcester, who came to Brainerd in 1825, left in 1827 to go to New Echota in Georgia (Walker 1831).

The missionaries in Georgia were the first to feel the pressure for Indian removal which was pressing in on the Cherokees. On December 20, 1828, the Georgia Legislature had enacted a law extending the sovereignty of the state over all white persons living in Cherokee territory. The law also provided that after June 1, 1830, all resident Indians were subject to Georgia laws and declared that all laws made by the Cherokee Nation were null and void (Phillips 1902). When the Legislature further declared that, after March 1, 1831, all white persons resident in Indian territory must have a license

from the Governor, the missionaries felt that this law had been directed at them (Phillips 1902).

The Cherokee Nation appealed to the Supreme Court for an injunction against the State of Georgia on the grounds that they were protected by the Federal treaties still in effect. Chief Justice John Marshall, in the majority decision, denied the injunction on the grounds that an Indian tribe within the United States was not a foreign state and could not maintain an action in the United States courts, and the case, as presented, merited a denial (Marshall 1830).

The Indians had previously appealed to the Federal government to abide by its own treaties, but were rebuffed. Andrew Jackson was pro-removal and based his refusal to support the Cherokee Nation on the fact that the Cherokees had established an independent government within the State of Georgia (Jackson 1829). He was also encouraging the voluntary removal of the Cherokees to the West. He reasoned that the Indians by "persuasion and force...have been made to retire from river to river and from mountain to mountain". Already numerous tribes had become extinct in the face of civilization, and "that this fate surely awaits them (Cherokees) if they remain within the limits of the States Humanity and national honor demand that every effort should be made to avert so great a calamity".

On December 29, 1830, the missionaries working among the Cherokees met at New Echota and drafted a resolution concerning the Cherokee crisis (Worcester et al 1830). The resolution included the following statement:

RESOLVED, Therefore, that we view the removal of this people to the west of the Mississippi, as an event to be most earnestly deprecated; threatening greatly to retard, if not totally to arrest their progress in religion, civilization, learning, and the useful arts: to involve them in great distress and to bring upon them a complication of evils, for which the prospect before them would offer no compensation.

Shortly after the missionaries drafted this resolution, the Georgia guard arrested several missionaries for residing in Cherokee territory without a permit. Samuel A. Worcester was one of those arrested and convicted.

Worcester appealed to the Supreme Court (Worcester vs The State of Georgia), and the court declared that the acts of the State of Georgia were repugnant to the Constitution, laws and treaties of the United States. The court overturned his conviction (Marshall 1831) and he returned to Brainerd in 1834 (Walker 1931).

Even with the unsettled state of the Cherokee Nation, in February of 1835, a Cherokee inquired about purchasing the mills (BML 105). The Georgia Indians were moving into Tennessee and the missionaries thought they might now have a market for the property.

In the spring of 1835, Br. Blunt requested that he be removed from service to the Board. The missionaries were very reluctant to have him leave as he was the one person who had any skill in repairing the mills (BML 106). Although Blunt did not leave, Worcester left to go west with those Cherokees who had decided to move (Walker 1931).

Ironically the threatened removal of the Cherokees finally brought about the operation of the mills at a profit. The speculators and settlers moving into the former Indian lands in Georgia were keeping the sawmills running behind demand (BML 111).

Even though the Cherokee Nation appealed to the courts to protect their rights, the clamor for removal was increasing. Finally in 1835, a minority faction of the Cherokees, wearied by the constant threats to their lives and property, signed the Treaty of New Echota, and the Cherokees were driven west (Reed 1979). The Indian lands were deeded to the states in return for land in the new territory. On August 19, 1838, the last service was held at the Brainerd Mission (Walker 1931).

John Vail, who had served as a farmer at the mission for 19 years, elected to stay in the area, and purchased the property. At the same time, Thomas Crutchfield had also entered the property. They settled the ownership of the disputed property by entering a deed of agreement in

February, 1842, in which they agreed to hold the property and all improvements in joint ownership (Hamilton County Court Records E-92). Half of the money each had paid to the State of Tennessee was returned. The tract in question held the mill and mill house, and was described as the SW quarter section of Section 21, Range 3, Township 6, Ocoee District.

Vail resided on the property and in March, 1843, used the land as collateral in a transaction with Ainsworth Blunt (Hamilton Co. E-286). Blunt, although no longer in the service of the ABCFM, remained in the area and in 1840, purchased the old Mission cemetery for the Board in order to protect the graves of the missionaries (Walker 1931).

In 1844, Vail sold his half interest in the property along with half of the grist and saw mills and all fixtures to Samuel and George Williams for \$1200 (Hamilton Co. F-46). This sale was apparently invalidated at some later time, as in 1849, Thomas Crutchfield brought a suit against Vail. There was insufficient personal property to satisfy the debt, and a sheriffs' sale was held with Vail's half share of the property sold to the highest bidder, who was, coincidentally, Thomas Crutchfield. Crutchfield paid \$1,030 for the tract (Hamilton County Court Records G-364).

Bird's Period. Crutchfield retained the property until 1852, at which time he sold it to Philemon Bird (Shepherd 1911). Bird built a new dam at the site of the mill structure. He also built a new and larger mill at the site.

Bird had large holdings in Georgia and Alabama, as well as Tennessee. He lived on his Georgia farm with a free black woman who was the mother of his several daughters and one son, Sam. She died before the Civil War, and Bird took as his mistress a mulatto slave girl, Mary Gardenhire, whom he purchased in Harrison, Tennessee. Mary was the mother of Gus, Philemon's second son (Shepherd 1911).

During the war, Bird went south to avoid the hostilities (Shepherd 1911). The mills were operated for some of this period by the Federal government (The Chattanooga Times 1933). After the Battle of Chickamauga, Forrest's Cavalry was ordered into camp at Bird's Mill on September 23, 1863. On the following day, Forrest had his troops prepare for their action by shoeing horses, checking equipment and cooking rations. This rest stop was of short duration, as on Friday the 25th, the cavalry was ordered out to Harrison (Henry 1944).

The mill evidently survived the war with little damage. J.T. Trowbridge (1866) on a tour of the South to describe the battlefields, ruined cities, and to give an

account of "Confederate misrule", visited the Federal commander at Chattanooga. On a ride to Lookout Mountain, he met a farmer and his son who were laboring to get their wagon over the rough road at the base of the mountain. The farmer had one bag of grist in the wagon which he had gone 12 miles to have ground at the mill "away beyant Missionary Ridge". Although there was a mill on Wahatchie Crick (sic), it was a "powerful bad hill to pull up", and he preferred the 24 mile round trip to Bird's Mill.

Philemon Bird died in 1871 and left the mills to his sons, Sam and Gus (Bird 1871). A guardian was later appointed for Gus Bird (Hamilton County Court Records B 29-458), as a lease filed in September, 1876, lists Samuel A. Conner as his guardian.

The lease was a rental agreement between Sam and Gus Bird and J.J. Bryan. The three year lease provided that Bryan would pay \$600 per annum for the 70 acre tract which contained the corn mill, flouring mill and saw mill. These mills were all contained in one structure.

Mr. Bryan was also to make repairs on the sawmill which would enable it to have a cutting speed equal to that when it was new. He was also to put a new bolting cloth in the old flouring mill and construct a new water wheel for that mill.

In 1880, flour-milling was the leading industry in the state (Goodspeed 1887a). There were 990 flour

and grist mills with an annual product worth \$10,784,804, making Tennessee the leading milling state in the south.

Bird's mill, during Bryan's tenacy, shared in that milling boom. The 1880 manufacturing census listed the mill as having four turbines developing 36 horsepower, operating with a six foot fall. The mill capacity was 210 bushels a day, with a yearly revenue of \$13,206.

The mill in 1887 (Goodspeed 1887a) had three run of burrs, a bolting apparatus and a sawmill. The water wheel capacity was equal to 75 horse power.

Gus and Sam attempted to carry on the milling and farming business, but apparently were not successful, even with (or perhaps because of) the advice of an estate trustee and Gus's guardian. They sold off the farm lands in an attempt to keep the mills, beginning with the property across the creek from the mill (Hamilton County Court Records B 29-458). They also borrowed money and mortgaged the property (Shepherd 1911).

The brothers built a dance hall at the mill, which was the scene of a killing in which one of the brothers took part (Scott 1979). This scandal, coupled with foreclosure of the mortgage (Shepherd 1911) caused them to lose the estate.

Records documenting the final years of the mill's existence are unfortunately very sparse, due to the

burning of the Hamilton County courthouse early in the twentieth century. It is known that the heirs of E.E. Hampton purchased the mills and operated them profitably (Shepherd 1911). The mills then passed to a Mr. Plemons and finally to Joe Walters (Scott 1979) before being torn down in 1921 (Hyde 1944).

Archaeological Procedures

Excavation procedures. Test excavations at Brainerd mill were undertaken from July 18 to August 17, 1979. Because the mill site was not reported until construction work was well underway, investigations at the mill assumed the character of salvage archaeology. When archaeological work began, the lower portions of a log crib dam, mill foundation, and canal were visible. The canal, which could have been a raceway, appeared to have emptied into South Chickamauga Creek approximately 100 feet north of the visible mill foundations. If this canal was indeed the race, it would indicate that the original missionary mill was located at the canal mouth rather than at the foundation ruins.

Archival research revealed that there had been at least two major periods of operation of the mill, the Mission period and Bird's tenancy. Therefore, the main research objective was to test the proposition that there were two separate mills at different locations, and

to obtain data regarding mill construction and operation.

Specific objectives as outlined by Brown (1979) were:

1. To excavate at the assumed site of the Missionary mill in order to locate structural features.
2. To excavate in the canal bed to determine dimensions and other characteristics of this structure, and to locate artifacts associated with the Mission mill or other aspects of Mission life.
3. To conduct intensive mapping and photographing of visible Bird's mill remains to determine structural data.
4. To excavate selected areas of Bird's mill to further define structural data; in particular, to note construction details of the dam site and possible connections between the canal and mill site.

Results. While it was hoped that excavations at the mill site would uncover remains of the Mission mill, evidence of this structure was not obtained. It is more likely that the remains examined were those of Bird's mill. Test pits were placed along the dam and mill sills, and the mill walls to determine construction sequences (Brown 1979).

Preliminary results of these procedures were reported by Brown (1979:2-3):

1. Construction sequence: As the dam was known to have been constructed c. 1852, it was possible to trace inter-connecting members in order to date other structural remains. As a result of these investigations, it can be stated with a high degree of certainty that all remaining portions of the mill date from 1852 and later. No certain evidence of

the original mill was recovered other than a millstone fragment contained within the fill of the 1852 dam. Excavations along the stone walls of the mill also confirmed a mid-nineteenth century construction date.

2. "Canal excavations": Excavations of the "canal" revealed a modern concrete-lined drainage ditch. Historic photographs and documents obtained during the period of investigations eliminated the "canal" as a historic feature.
3. Tail race explorations: The discharge of a mill is known as the tail race. In the case of Bird's mill, the tail race consists of those portions of the creekbed once beneath the mill. As this area was under water at the time of the investigations, it was necessary to retrieve artifacts with a magnet. Low visibility, silt and modern rubbish compounded the difficulties of this operation. However, several hundred artifacts relating to the generation of power, the mechanical transmission of power, sawing, milling, and miscellaneous mill-related activities were recovered.

Mission dam. As stated, the canal was thought to be the location of the race serving the Mission mill. The testing of this feature ruled out this possibility, leaving the question of the location of the race unanswered.

The missionaries' letters discussed the construction of a three quarter mile long race from the dam to the Mission mill site. There was no evidence of an earlier dam in the immediate vicinity of the mill and all visible traces of the race had been obliterated by the construction of Brainerd Village and Eastgate shopping

centers. The mention of a flume system to feed the mills from the race also indicated that the raceway terminated some distance from the mill.

In December 1979, the presence of a stone dam at the junction of Spring Creek and West Chickamauga Creek was reported to Dr. Jeffrey Brown by Mr. Donovan Boutz, a local hunter. The structure was investigated, although high water on West Chickamauga Creek prevented recording of the entire structure. The visible remains, which were felt to represent the majority of the surviving structure, were a limestone dam or wall 34 by 6.5 feet.

The dam may have originally been on the smaller Spring Creek. The combination of the mill dam and a current beaver dam, has resulted in the silting in of the mill pond. Spring Creek appears to have sought a new channel, now entering West Chickamauga Creek several hundred feet upstream from the dam (Figure 15 page 66).

It is very probable that the creek did indeed change course. As early as 1832, it was felt that the creek was cutting away the bank and the channel was changing and undermining the wing of the dam. The missionaries were afraid that any repairs to the dam would not be permanent, and that moving the dam would be the only solution (BML 89).

Stone dams could be praised for their strength and ability to withstand the heaviest floods, saving outlays

from repairs and making them less expensive in the long run (Leffel 1881). This is only true, however, if the dam is not built on a soft bottomed stream, and is properly constructed to protect the foundations from being underwashed.

It is apparent from the continual references to the dam breaking, that the seemingly impervious stone dam was either improperly constructed or poorly suited to the type of creek it was on. While it was not possible to examine the dam, the archaeological investigations at Fryar Branch revealed that the stream bottom was soft with gravel levels rather than providing a firm foundation. The examination of the dam at Bird's mill revealed that the wooden crib dam was still functioning. It can be inferred that the Mission dam was both in the wrong place and built of the wrong materials.

Interstate construction in the area immediately to the head of the race has left some confusion as to the original bed of Spring Creek and to the direction of the race. Available topographic maps indicate that there are two possible routes for the race to have taken. One route would follow the curve of the creek, and the other would follow a more direct route, running almost due north to the mill site. The more direct route would come closer to being the 3/4 mile that the missionaries described. With the exception of a small area near its head at the mill

pond, the race is now under Interstate 75, Eastgate Mall and Brainerd Village Shopping Center.

Bird's mill dam. The dam which was visible at the site of Bird's mill was apparently the one built by Bird in 1852 to replace the Mission dam. The stone Mission dam had provided water to the mill by means of a three quarter mile race. When Bird replaced the dam, he moved it to the site of the mill itself.

The elevation of the top of the dam was 656.35 feet and the step bearing for the turbine was at an elevation of 650.65 feet. The step bearing, the seat for the turbine, would represent the maximum head under which the turbine would operate. This six foot head corresponds with the information in the 1880 manufacturing census.

Bird's dam was of timber crib type construction, similiar to that in Figure 6 (page 31). In constructing such a dam, a timber or log foundation is laid down on the bottom, and the superstructure of the dam is constructed to the desired height. Cribs are built into the banks to anchor the dam. Bird's dam was a full crib dam with rubble filled crib units composing nearly the entire structure.

The dam extended 97 feet across the creek. From the south bank, the dam extended 29 feet before encountering a stone construction, possibly a foundation (Figure 16). This area of the dam was broken down to a great extent,

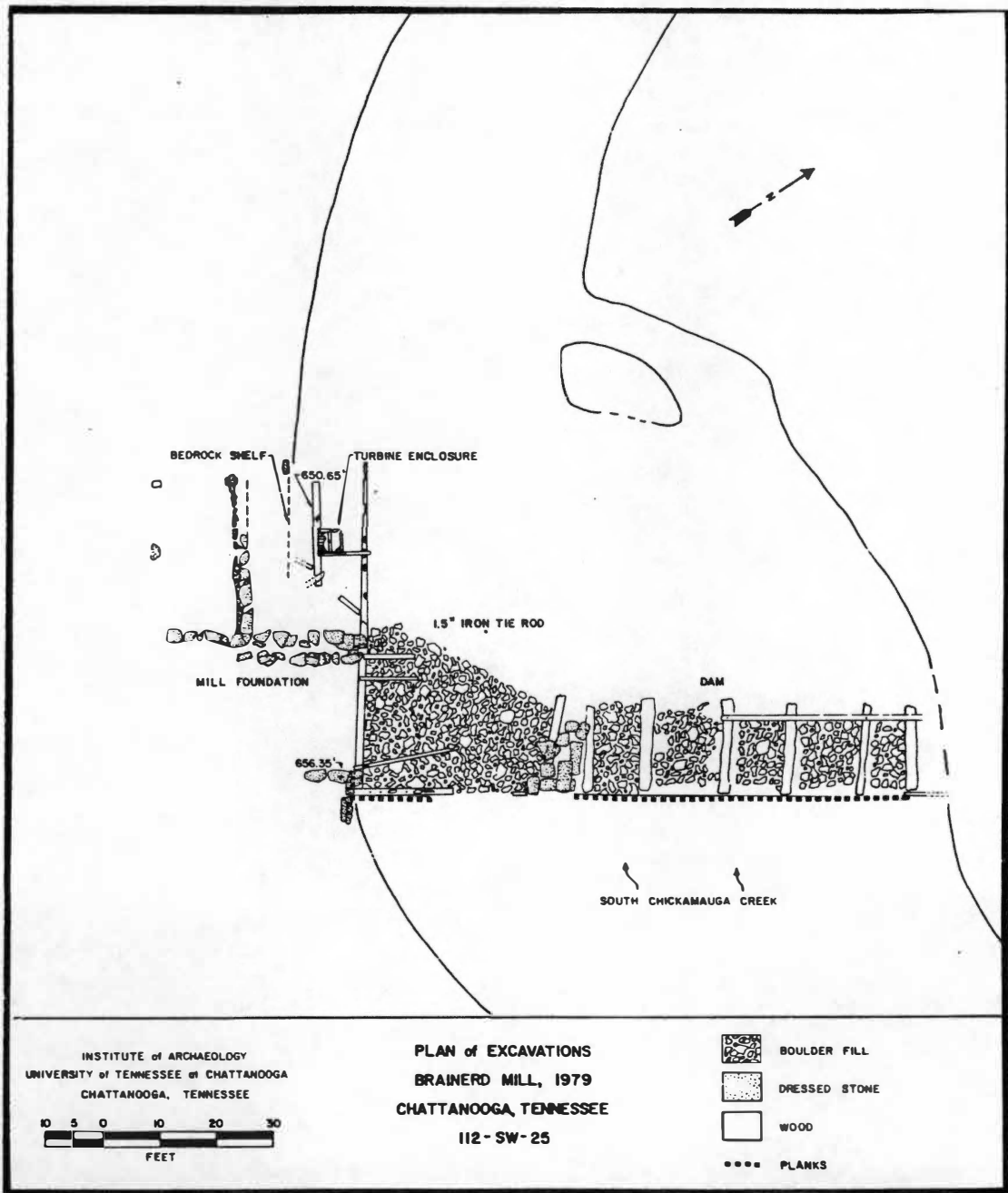


Figure 16. Brainerd Mill, Plan of Excavations.

and the presence of crib walls was not noted in the upper levels. Beyond the stone foundation, six cribs comprised the remainder of the dam. These cribs varied from 8 to 12 feet long along the north-south axis. The three cribs at the north bank were the best preserved of the dam cribs, with both upstream and downstream limits definable. The top of the dam was 13 feet wide at these three cribs, and it is assumed that the remainder of the dam was also 13 feet wide.

As can be seen in Figure 16, planking was placed on the upstream side as a solid sheathing against the dam. This corresponds to the construction procedure defined by Leffel (1881). While Bird's dam itself was not documented, the construction techniques used indicate a familiarity with ideal standards of the day.

Due to high water, the dam was not excavated, but was cleaned to determine the construction mode. With the exception of the mill stone fragment which was found as a component of the rubble fill, the majority of the items recovered from the clean-up of the dam were of modern origin.

Analysis

Mill stone fragment. The fragment of mill stone recovered from the excavation is thought to be the one artifact which can reasonably be associated with the

Mission mill rather than Bird's mill. The stone was recovered from the rubble fill of the 1852 mill dam.

The stone fragment is 6.5 inches thick, and from the edge of the eye to the outer edge measures 1.6 feet. Allowing approximately 4 inches for the eye, the stone could have had a diameter of 3.5 feet. The fragment was dressed in the straight quarter dress style (Grimshaw 1882). Origin of the stone is not known, but it is probably granite.

Early mill stones relied on the porous texture of the stone to provide a cutting edge for grain; the job of the stones being not to crush or rub the grain, but to cut it. As the supply of good quality stones diminished, a means to provide poorer stones with a cutting surface was needed, and the practice of dressing or furrowing stones was developed.

Furrows were cut into the stone in a set pattern, providing a cutting surface and allowing air to the grain to cool it. They also distributed the chopped grain between the faces of the stone and carried it out. The pattern of the dress depended on the speed, direction and material of the stone, as well as the nature of the grain and the milling method to be employed (Grimshaw 1882).

The straight quarter dress used on the Brainerd mill fragment was one of the earlier styles, and Grimshaw (1882) refers to it as a "barbarism". He felt that the

quarter dress should be eliminated but it was still at that time in use in the southeastern United States and Great Britain.

The stones which were in use at Bird's mill were reportedly gold or yellow in color (Scott 1979). According to Scott, these stones were hard granite and supposedly good stones, so it is assumed that they were native stones rather than the worthless imported Fox-buhrs.

Turbine bay. Three excavated areas, I, II and III, comprise the turbine bay on the west bank of the creek below the dam. The turbine bay was an enclosure 18 feet on the south or bank side and 28 feet on the creek side where the bay was connected to the dam (Figure 16 p.104).

Area I, the unit upstream nearest the dam, was the least productive of the units in terms of artifacts recovered. This unit contained four wire nails, seven cut nails, one brick fragment, ten window glass fragments, and four unidentified metal objects. The majority of all three units was underwater, and the items recovered from Unit I were mainly recovered from the bank. The proximity of this unit to the mill house could possibly account for the presence of these structural remains.

Unit II was the enclosure for the turbine recovered from the excavation. The turbine will be described

separately. In addition to the turbine, Unit II contained two saw mill rollers.

Except for the tailrace, Unit III was the unit farthest downstream, and, again excluding the tailrace, contained the largest number of artifacts. The artifacts at the site appeared to cluster around the downstream areas of the tailrace and turbine bay.

Unit III contained 84 cut nails, 14 wire nails, and five bottles plus four bottle fragments. In addition, this unit contained 62 metal artifacts. While many of these were assorted nuts, bolts, and unidentifiable metal fragments, several other items were definable pieces of mill equipment.

A babbited thrust-top bearing to fit over a shaft end (Ketner 1981) was recovered from Unit III as was a bearing backing plate for a quarter box bearing. A shaker bit for a bolting mill (Robert Johnson, personal communication) provides direct evidence that flour was being ground and processed at the mill.

Babbit is a soft metal which is used in bearings to reduce friction. According to Ketner (1981), babbit was not always easy to obtain, and frequently bearings were packed instead with corn-cobs and tallow or lard.

Unit III also contained six fragments of turbine vanes and what was possibly a portion of a metal turbine housing.

Glass. The glass artifacts recovered from the mill site consisted of bottles (whole and fragments) and window glass fragments. Unit III contained five intact bottles and fragments from two others. The intact bottles included two clear glass bottles; one small (4.5 inches high) bottle with a threaded top and a flask-shaped blown-in-mold bottle with no identifiable markings. Two brown bottles were recovered, one of which was from E.R. Betterton and Co Distillers, Chattanooga, TN, dated c. 1880 (Norwood and Kline 1881). The last bottle from Unit III was a straight sided Mason jar. This name on canning jars had become generic, with jars bearing this designation dating from the 1880s to the 1900s (Toulouse 1971).

Several bottles and fragments were recovered from the dam during clean-up; a brown "Coke" bottle, a La Roma soft drink bottle from Chattanooga, Tennessee, which was undated, and a "Chattanooga Milk Bottle" from c. 1915 (Connelly 1915).

The glass artifacts are all from the period 1880-1920. They can all be located horizontally, but due to the recovery techniques in the underwater areas, none can be ascribed to a controlled vertical context. For this reason, the glass artifacts were felt to be of little value in analysis.

Turbines. The major artifact recovered from the Brainerd mill was a simple reaction wheel of a previously unreported type (Figures 17 and 18). This wheel, and a shaft for a second wheel, combine features of the traditional tub wheel and the turbine (Figure 19). The wheel consists of a central drive shaft 1.4 feet in diameter made of southern pine (Figure 20). Nine cast iron buckets or vanes are attached to the drive shaft by means of slots or mortises (Figure 21). The mortises for these vanes are 0.5 inches in depth and are 0.473 inches wide. The buckets are attached to an outer tub made of white pine. The tub is composed of curved sections which are grooved to receive the blades. They are also recessed at the top and bottom where wrought iron hoops held the tub together. The slats of the tub are c. 8 inches by 8 inches. Five of these sections survived.

The entire assembly is 2.8 feet in diameter. This turbine bears a superficial resemblance to a traditional Appalachian tub wheel (see Wigginton 1973), but the turbine recovered from Bird's mill operated in a submerged enclosure as is true of all turbines (Brown 1979).

The upper portion of each bucket is curved in an opposite direction than the lower portion (Brown 1979). The presence of this reverse curve is a curious aspect of the wheel. Robert Vogel (1979) feels that the forward curve at the top would do nothing but reduce the



Figure 17. Recovery of Brainerd Turbine. Wooden Sill at Right Extends to Dam. Large Spur Gear in situ.

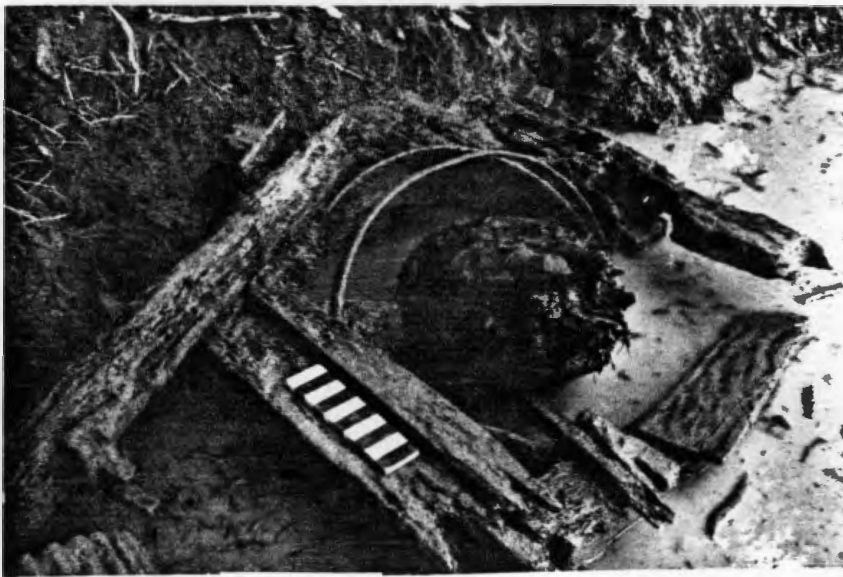


Figure 18. Turbine and Enclosure.

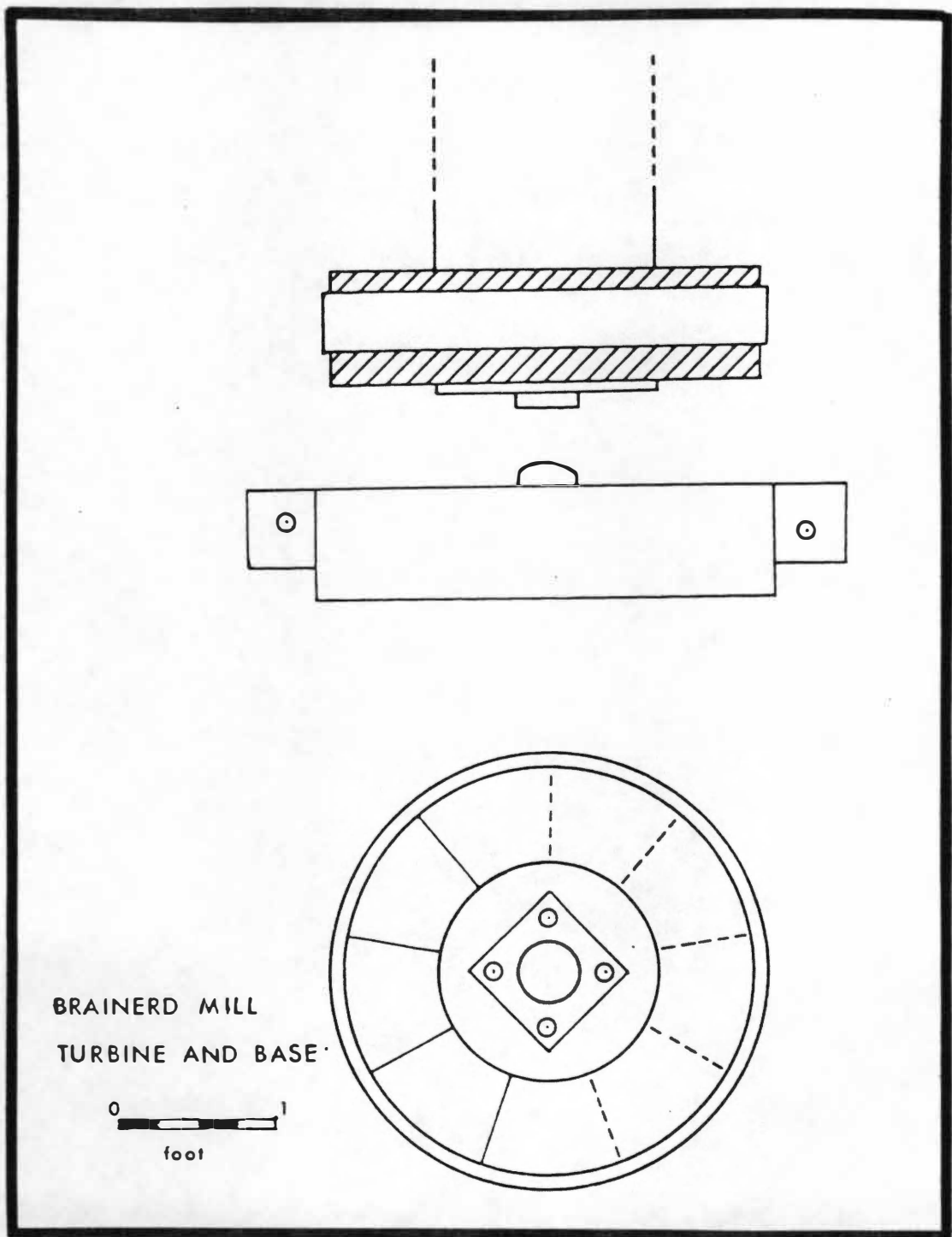


Figure 19. Brainerd Mill Turbine and Base.

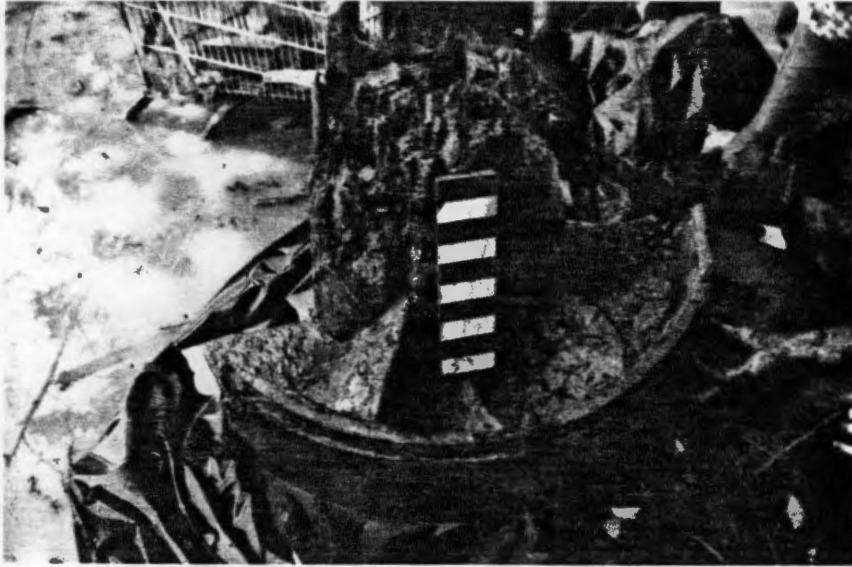


Figure 20. Turbine with Iron Vanes and Wooden Tub Exposed.

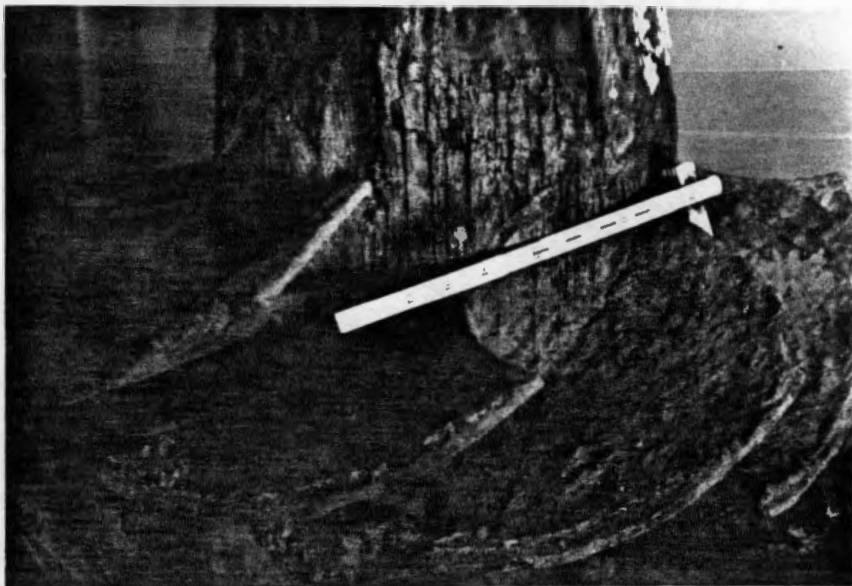


Figure 21. Close-up of Turbine Showing Vanes Mortised to Wooden Shaft.

efficiency considerably. The curve in the operating direction, however, is far greater than that in the negative direction, so the wheel would certainly have rotated.

The buckets are interesting in that they are made of cast iron. It is possible that they were the products of an iron foundry rather than a local blacksmith. Since a foundry is a rather complex operation beyond the scope of most blacksmiths, it is likely that the buckets were prepared for wider use than one turbine (Brown 1979). Ketner (1981) states that several companies in the late nineteenth and early twentieth centuries did provide turbine "kits", where the runner assembly could be ordered separately and later, money permitting, the cast iron shafting could be added. None of the turbines he described, however, contained only the buckets; most were entire turbines requiring only a shaft.

Turbines for low heads were usually of cast iron or cast iron with steel buckets, while high head wheels could be of cast iron, cast bronze or cast steel. It is possible to obtain a higher surface finish of the bucket when it is cast separately, but such separate cast iron buckets must be strongly banded, since there is a tendency for the buckets to work loose. Such buckets were only satisfactory under low heads and where the vibration was not great (Mead 1915). The condition of low head was

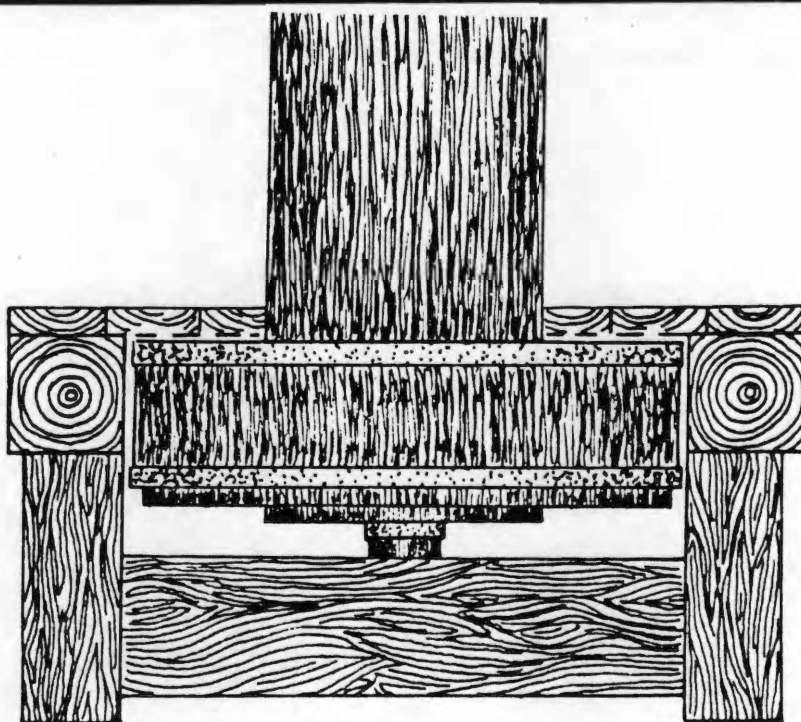
certainly met at Brainerd with a 6 foot head supplying the turbines.

Turbine runners were abraded by the action of sand or other material carried in the water. Cast iron and cast steel resisted this action better than other materials (Mead 1915). Perhaps this helps account for the hybrid nature of the Brainerd turbine.

The turbine shaft is very large in relation to the tub diameter. Vogel (1979) feels that two possible reasons could be given for this; either a mechanical one of providing more area at the hub, or the realization that very little of the wheel's effect came from the section at the center, so why not make it as strong as possible (Figure 22).

Penn (1979) would not expect a wheel like this to be installed in any New England mill as late as the 1850s. The possibility exists that the wheel, or one like it was installed when Bird rebuilt the mill, in which case the wheel would probably reflect frontier mill-wrighting. If the wheel had been installed during the Mission period, it would have represented a very advanced form of turbine.

The turbine sat in an enclosure (Figure 23) roughly 4 feet square, abutted on the east by a beam or sill 9 feet long. This enclosure, designated Area II, was part of a larger enclosure or turbine bay 18 feet on the west (bank)



BRAINERD MILL TURBINE AND ENCLOSURE
ARTIST'S RECONSTRUCTION

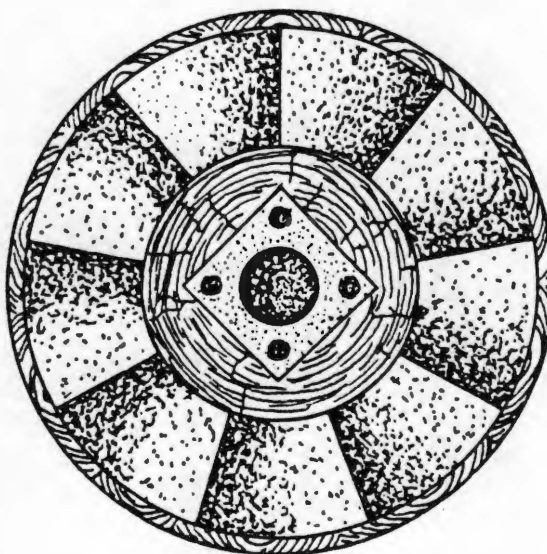


Figure 22. Brainerd Mill Turbine and Enclosure (Artist's Reconstruction).

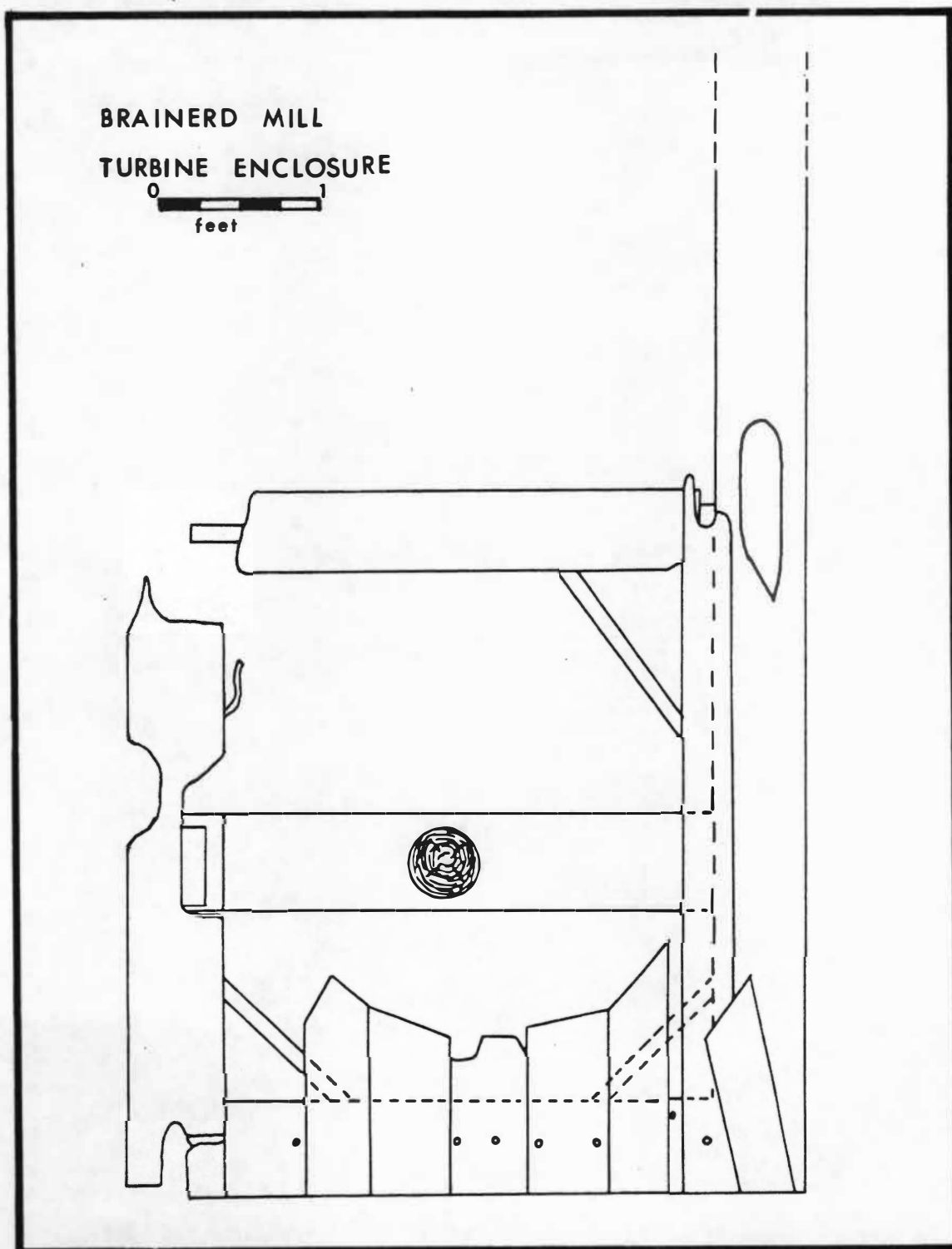


Figure 23. Brainerd Mill Turbine Enclosure.

side and 28 feet on the east or creek side where the bay was connected to the dam. The bay was 8 feet wide.

A bay of this size could have held more than one turbine, and in fact, the wooden shaft for another, similar turbine was found in the bay.

Tailrace. The tailrace is the area where the water is discharged after powering the wheel, and is generally deeper than the surrounding stream. Items which are deposited in the tailrace are subjected to the current of the stream and of the discharged water; many lighter objects would probably have been moved downstream by this water action. Artifacts were located in the tailrace by use of a magnet and by "feel". The water had not been diverted prior to the excavation, and was also quite murky. These conditions dictated the mode of retrieval.

Excluding nails, 212 artifacts were recovered from the tailrace. Of this total, only nine items were non-metal; seven window glass fragments, one stoneware sherd, and one bottle. The remainder of the artifacts (96%) were of metal. The tailrace was the area of greatest concentration of artifacts, even allowing for the skewing in favor of metal items. The artifacts in the race tended to be portions of gearing, shafting and assorted mill machinery.

A. Mill Pick. A mill pick 0.4 foot by 0.12 foot recovered from the tailrace was identified by Mr. Scott

(1979), a former miller at Bird's mill in its later years, as similiar to the one which he had used to dress the stones at the mill.

Mill picks or pickhammers were of cast steel, and were of necessity quite hard. The stones were redressed or sharpened periodically depending on the type of stone, whether they were being run close together, and the type of grain being ground. If the stones were being run daily, they might be dressed every month. Clyde Ketner of Ketner's mill dresses his stones every six months; the job taking him about a week to complete. The stones at Bird's mill required two to three days to sharpen (Scott 1979).

Dressing roughened the stone where the friction of grinding had worn it smooth. It also removed the grain residue which made the stones slick. The feel of the flour or meal is the determinant in deciding when to dress the stones (Ketner 1981).

The quality of the steel pick was most important in dressing the stone. The picks had to hold a good edge to keep them from rapidly becoming dull. The tempering of the pick was all important in determining how fine an edge could be achieved, and recipes for tempering solutions were considered equally important. Hughes (1862) published the following scientific formula for tempering

cast steel mill picks, but it seems that an element of folk-lore has crept in:

3 gallons of water
3 oz spirits of nitre
3 oz spirits of hartshorn
3 oz white vitriol
3 oz sal ammoniac
3 oz alum
6 oz salt
a double handful of hoof-parings.

B. Truss. The truss is an iron rod 9 feet long with a bolt head at one end and screw threads with a nut and washer on the other end. Although this item had been identified as a roof truss (Brown, personal communication) the 9 foot length would perhaps indicate an alternate use. The truss could perhaps have run from an interior wall or beam, but it is unlikely that a work area would have been only 9 feet wide. An alternative use would have been to support the penstock. Trusses ran from the floor timbers below the turbine to the timbers at the top of the penstock (Grimshaw 1882).

Similiar trusses were found in situ in the penstock for two turbines recovered from Trigonía mill along Nine Mile Creek in the Tellico Reservoir.

C. Turbine fragments. In addition to the primitive turbine recovered from the turbine bay, thirteen fragments of one or more cast iron turbines were also recovered. These fragments could represent portions of runners, housing or draft tubes. One fragment of a mixed-flow

turbine runner helps to identify the type of turbines in use at the mill. These turbines probably post-date the hybrid turbine.

D. Gears. With the exception of a large spur gear located in situ in the bank above the turbine bay, all remaining gears and gear fragments were recovered from the tailrace. Two complete gears were recovered; one a spur gear 16.5 inches in diameter, and one a beveled spur gear 21 inches in diameter. Both of these gears were in good condition; however, neither gear was recovered with any portion of shafting. Eleven gear fragments were recovered.

No identifiable shafts were found apart from the one attached to the large spur gear. Six collars or shaft mounts were recovered.

E. Wedges and gear keys. Wedges are metal pieces used to shim the space between the gears and shaft to provide a tight fit and to center the gear. The process of driving iron wedges between the hole in the gear and the shaft was called "staking" (Penn 1981). Seven wedges were recovered from the tailrace.

Gear keys are metal strips used to adjust the gear motion. Gear keys and wedges were found only in the tailrace. Seventeen keys were found in the race, including one which was recovered still attached to the gear. The key slots of some gears were lined with copper.

F. Control gate fork. The water flow to the turbines is regulated by means of a control gate. A portion of this gate, a fork, was recovered. The fork is used in opening and closing the gate.

G. Small tools. A variety of small tools was found in the tailrace and represents all the small tools recovered from the site. In addition to the previously mentioned mill pick, small tools included a chisel, a wood chisel, two files, two rat-tail files and a wrench.

Summary

The selection of a site for the Brainerd Mission appears to have been made on the basis of availability and price, with little regard for the suitability of the site to provide the Mission with a profitable working base. The mills were expected not only to provide for the needs of the Mission, but also supply a surplus which would help defray the costs of running the Mission and eventually place it on a self-supporting basis. It would seem, then, that finding a location with a suitable mill seat would have been an important factor in site selection.

Mill seats are, according to Hunter (1979), more numerous and sharply defined in hilly terrain and the upper portions of a river system than in the lower valleys with their gentler slope and typically sedimentary character. The location of the Mission along the South

Chickamauga Creek was just such a lower valley area and better suited for growing grain than grinding it. The slope of the creek is 3.8 feet per mile from mile 14 to mile 20 (TVA 1958); the Mission is located at approximately mile 15.

From the evidence of the original dam and three quarter mile race, it would seem that the Mission mill was operated by an overshot or breast wheel. The difference in elevation from the Mission dam to the tailrace below the mill is c. 10 feet on current maps. This would provide 10 feet of head to the wheel, adequate but a bit low for an overshot wheel.

The obliteration of the original mill by Bird's rebuilding and the destruction of the race by modern construction, leave unanswered the question of whether or not the grist mill, saw mill and the blacksmithy were operated from one wheel or a combination of wheels and tub wheels.

The original wheel would have been all wood as would most of the gearing. Greene's 1828 letter to the Board requesting iron gears, as the "timber-killing" influence of the water was necessitating frequent replacement of the wooden gearing, indicates that they still had wooden gears at this time.

An earlier letter from Ard Hoyt in 1823 detailing the need to import iron at a cost of \$100 plus \$200 for its

transportation indicated that at least some iron products were being used. Unfortunately the type of iron was not specified, but with the blacksmith available, it is possible that pig iron was being imported. The need for \$150 worth of coal in the same letter raises another interesting question. At such a price, and with the abundance of wood for fuel, it is unlikely that coal would be imported for cooking or heating purposes. Rather it can be assumed that the coal was for use in the smithy.

The missionaries were importing this iron and coal for some use. With the smithy, they had the capacity for forging, but it appears from Greene's letter that by 1828 they were not forging mill gears, and indeed hoped to order them from the north. It would seem then that while they could forge some items, the capacity to cast iron was beyond the range of their operation.

The location of the blacksmith shop would have been near the water supply to operate the trip hammer. No recognizable evidence of the blacksmith operation was recovered.

The continual problem with the mill can possibly be attributed partly to the lack of water-milling knowledge by the missionaries and partly to the physical setting of the mill. The siting of the dam appears to have been the foremost problem. A Journal entry for July 5, 1820, describes the dam failing:

One end of the dam gave way. The millwright supposed he had driven the timbers to the rock. It now appears that what he took to be a rock was only gravel. The water found its way under and carried away the bank about a rod wide. This is a painful disappointment, and the repair will necessarily require considerable additional expense.

(ABCFM 1820)

Interestingly, investigations of an interceptor sewer line along South Chickamauga Creek in 1977, had revealed a "buried forest" of water-logged organic material. This material, carbon 14 dated at 10,270, B.P., was theorized to have been deposited during a massive flood, and quickly sealed over with a level of alluvium. This organic level, which occurred at a depth of 14.5 to 17.2 feet, overlay a gravel deposit thought to have resulted from a similiar event (DeSelm and Brown 1977). Since this gravel deposit was discovered in two locations only a few miles downstream from the mill, it can perhaps be inferred that the gravel deposit which caused the downfall of the mill dam was a portion of this same level and a result of a Pleistocene flood.

The insistence of the missionaries on retaining the dam in its original location almost certainly contributed to the nearly continual problems with the mill. Bird's removal of the dam to its present location at the mill ended the problems with dam failures.

The selection of building material also played a large part in the success or failure of the dam. A

significant portion of the original Mission dam is still intact; however, it is that portion of the dam which was not subject to undercutting by the current. The sections of the dam most susceptible to the current have long since washed away, with the creek forming a new channel in the process of finding the weakest foundations.

Bird's dam, which is still in reasonably good condition, was constructed of log rather than stone. This dam is very similiar to the log construction described by Leffel (1881), which was better adapted to a soft bottom.

The retrieval of substantial quantities of gearing indicates that the mill was still using gears rather than belt drives as a mechanism to connect the power source to the machinery. Cast iron gearing and shafting had been introduced to the New England textile industry in about 1830, and were perfected between that date and the Civil War (Penn 1981). This system and the earlier all wooden format both suffered from "vibration and bending at every revolution," causing considerable breakage.

Around 1817, a change in power transmission was pioneered in England by Fairbanks and Lillie, which replaced the cast iron shafting with high-speed shafting of wrought iron (Penn 1981). The new technology required nearly a quarter of a century to be integrated into American factories, too long to have been a factor at the Mission mill. The shaft attached to the large spur gear

recovered from the bank of the turbine bay is cast iron, indicating that high-speed shafting was not used at Bird's mill, either.

Leather belt main drive systems were developed in the second quarter of the nineteenth century (Penn 1981) and were combined with high-speed shafting during the second half of the nineteenth century. High-speed shafting was necessary for the successful operation of the leather belt main drive system. Even though the leather belts and wooden drums on which they turned might not have been preserved, the absence of wrought-iron shafts and the presence of many gear pieces imply that Bird was not taking advantage of the belt drive system.

The fact that Bird succeeded at the site is evident in the reminiscences of William Lightfoot, a miller who operated another mill on North Chickamauga Creek (Wilson 1976). In April, 1886, a flood swept away Bird's mill, and Lightfoot's mill had to work night and day to take care of customers who would have normally gone to Bird's. There was a waiting line of ox teams, horses, mules, wagons and even boats--sometimes a half mile long.

Business was obviously booming, and Bird's location was suitable for his operation. Bird's Mill Road, later renamed Brainerd Road, was a major artery running from Chattanooga to the mill and north to Cleveland, Tennessee.

The fact that this road was a major artery is indicative of the amount of travel to Bird's mill.

The question can be asked, why did the missionaries fail so miserably at their milling attempts, when Bird did so well? Certainly the newer technology available at the time Bird purchased the mill contributed to his success. Turbines, which could operate successfully under low heads made the Brainerd site more workable. Moving the dam and use of a different construction mode contributed to Bird's success.

The missionaries failure is more difficult to explain. The technology of mill operation was certainly available and successfully employed in their native New England. Did they perhaps not come prepared to apply that knowledge to their new home, did their missionary zeal cloud their concepts of reality in attempting the operation of a mill, or did they attempt to impose their techniques on the new environment without taking into account the actual physical properties of the new location?

The turbine recovered from the mill site was of a more primitive design than one would expect to find in a large commercial mill of the late nineteenth century. While the horsepower of this turbine has not been determined at this time, both Penn (1979) and Vogel (1979) feel that the device operated very inefficiently.

The 1880 Manufacturing Census described the mill as having four turbines with a combined horsepower of 36. Goodspeed (1887a) described the mill as having water wheel capacity equal to 75 horsepower. Even if this horsepower level is an exaggerated claim, it was unlikely that four turbines of the type recovered would have provided the mill with 75 horsepower, or even with 36. It should be noted that Goodspeed's 1887 figure could represent rebuilding after the 1886 flood.

Parts of other turbines were recovered from the tailrace, and a metal turbine is pictured in undated historical photographs of the mill (Figures 24 and 25), indicating that at least one other type of turbine was in use. If additional, newer turbines were at the mill, it is likely that they were removed for use elsewhere or later salvaged for scrap.

It is not uncommon for millers even today (Ketner 1981) to allow an unused turbine to remain in situ long after it is no longer used, if the space is not needed for additional turbines. Removing a turbine from a covered turbine bay is not particularly easy, and if there is no need to remove the turbine, it can be left in place. This is possibly what happened to the turbine recovered from Bird's mill; this older turbine was left at the mill, while the newer turbines were removed when the mill closed.

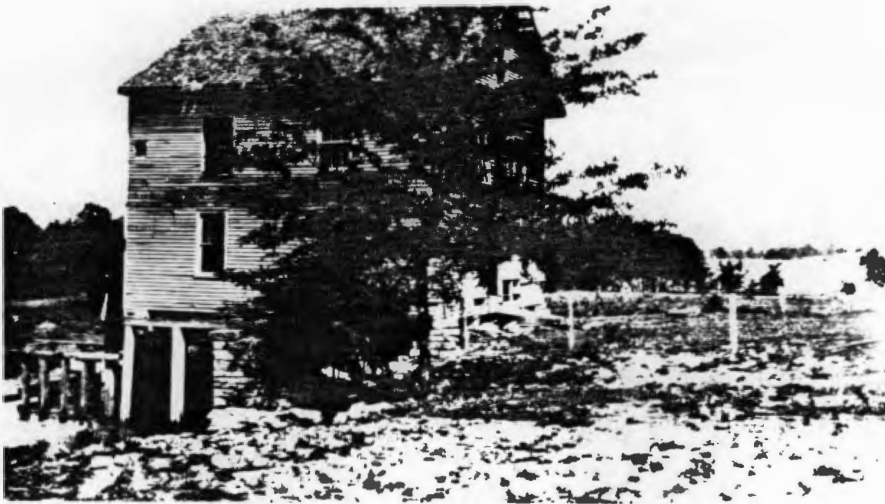


Figure 24. Bird's Mill. A Metal Turbine is Barely Visible in the Uncovered Turbine Bay. Photograph is Undated.



Figure 25. Bird's Mill. Mill is Expanded and the Turbine Bay is Fully Covered. Photograph is Undated.

Historic photographs show a progressive enlargement of Bird's mill. The turbine bay is shown uncovered, and later covered (Figure 25). An older turbine bay is visible in some of the photographs. This area, immediately adjacent to the bank, and corresponding to the location of the excavated turbine bay, may have been abandoned when the new bay was built and the old turbines were left in place.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Indirect Methods.

The investigations at Brainerd mill and the Tellico mills were the first field tests of Brown's theory of indirect methods. The tests were successful in some respects and unsuccessful in others. As in all new techniques, the first tests generally serve to point up weaknesses in the methodology and to provide the beginnings of a data base on which to base refinements.

The basis of indirect methods is the assumption that documents will reflect ideal behavior rather than real events (Brown 1978). To test this assumption, it was important to have the documentation for industry or technological standards, and hopefully, historical documentation for each mill.

A knowledge of water power technology was important to recognize the archaeological remains related to power transmission. At the time of the Mission period at Brainerd, the ideal for mill construction was the work of Oliver Evans. His designs began appearing early in the century, and were published around 1803 as Young Mill-
Wright and Miller's Guide, a text which was continually

re-published and was available during most of the first half of the nineteenth century.

Additional works such as Bennett and Elton's History of Corn Milling (1898,1899,1900), Hughes' Miller and Millwright (1862), Leffel's Construction of Mill Dams (1881), and secondary sources such as Hunter's History of Industrial Power (1979), defined water-power technology in the nineteenth century and the changes associated with the introduction of the turbine to the United States in 1842.

Documentary evidence for each of the mills or even for a regional perspective on water-power was not as easy to obtain. The exception to this was the Brainerd Mission mill. A wealth of documentary data was available for the mill in the form of letters and journals which the missionaries kept for communicating with the home church.

These documents were felt to be adequate to compare the Mission mill workings, as seen through the eyes of the missionaries, with the ideal technological standards of the period and the archaeological evidence. While it was known that the mill had been operated by Philemon Bird after the Mission period, and was operating in the late nineteenth century, it was not until the archaeological evidence was examined that it was apparent that the Mission mill had been virtually destroyed by the construction of Bird's mill on the same spot.

While the documentation of the industry standards of water-milling technology was very complete, it became apparent that regional variations of these standards, especially those arising out of regional adaptations to different physical settings and raw materials, were not usually defined. One of the first texts to deal with regional variations was Leffel's 1881 book on mill dams, which outlined the best type of dam to construct in different geological settings. The contents lists dams suited for soft or sandy bottoms, narrow streams, quick-sand or rock and sand bottoms. There are also dam plans which utilize local materials.

The mill dam at the Mission mill was poorly placed and ill-suited to the terrain. The later Bird's mill dam was better suited to the type of stream bottom. This use of the stone dam by the missionaries might reflect either their lack of milling knowledge or the fact that regional differences had not yet been accounted for in the early nineteenth century.

The dam at Kelso's mill had also been replaced, as evidenced by the 90 degree turn in the race. The earlier dam was not located during the project. It is interesting that Kelso's mill continued to operate with the long race after the installation of a turbine at the mill. There was no evidence either in the documentary record or in the

archaeological data to explain the reason for utilizing the high-maintenance race after the turbine was installed.

The research was disappointing in the ability to compare the documentary data and the archaeological data for the individual mills due to the sparse amount of archaeological data recovered. The ideal standards of waterpower technology were, however, adequate to define the actual mode of power transmission and chart a rough sequence of technological change.

In examining the data for evidence of changes through time, Brainerd mill was shown to be the best example; going from an inefficient mill to a successful commercial complex. The Mission mill, as shown by the missionaries' letters, was never very productive and was a source of continuing problems. The later days of the mill were quite successful, however. Evidence from both the documents, such as the Manufacturing Census, and the retrieval of portions of more advanced turbines indicate the success of the mill. The mill changed from using a vertical wheel, to the "hybrid" turbines, to the "modern" turbine.

Kelso's mill at Morganton also changed from using a vertical, probably overshot, wheel to a turbine. The limited data were insufficient to compare the degree of success through time at this mill.

Limitations of This Study

The major limiting factor in this study was the salvage nature of the archaeological excavations. At Brainerd, construction was already underway on the levee when excavations began at the mill. In addition, much of the South Chickamauga Creek floodplain had been filled and paved over to provide parking for Brainerd Village Shopping Center, possibly covering some components of the mill entirely.

At Tellico, both Kelso's mill and the Trigon mill areas were apparently substantially unaltered from the time the mills had operated. The decision by TVA to close the flood-gates earlier than anticipated left no time to do more than map the mills' components and retrieve the turbines and some artifacts.

The limited archaeological data led to a greater emphasis being placed on the documents, rather than a blending of the two. More time for excavation at each mill could perhaps have revealed additional evidence of expansion of facilities and the changing lay-outs.

The study dealt with some comparisons of "real versus ideal" elements, but these were mainly in auxiliary areas such as the dams and races. I would have preferred to have obtained more archaeological data on the prime movers and their integration within each mill.

Implications For Future Research

Special aspects of mill research. The investigations at these East Tennessee mills, while not extensive, do provide information to guide future research. Ideally some archival research will precede the archaeological examination of any site, and water-mills are certainly no exception. As these investigations have shown, the ideal standards for water-power technology are documented, but regional variations and site-specific information is less available.

Water mills are particularly difficult to deal with due to their complex and geographically dispersed components. Many times one component of the milling complex will not be noted until the project is underway, such as the older dam at Kelso's mill, or will be totally outside of the project area, and not found until much later as was the Mission dam at Brainerd.

Because dams and races were prone to siltation and subsequent replacement, investigators should be aware that earlier components could be present. Mills were also frequently expanded as the technology advanced and the same fall of water could power additional equipment.

An additional concern to the investigations is the fact that complete new mills were frequently built in the same locations as an older mill. Bird, for example, had

to almost totally rebuild his complex. Why then bother to buy the old mill? In locating a mill the primary consideration is the availability of a mill seat. If there is insufficient fall of water to power a mill, other physical and locational factors are immaterial. Another aspect of establishing at the same site is the fact that riparian rights have already been established. There is also usually an access road, and potential customers are used to a mill in that location.

Another problem with water-mills is that the date of the license to build a mill is viewed by many as the date of the actual ruins or structure under investigation. As the evidence in this report details, however, the first date of a mill license is not necessarily the date of the only operating mill at that location. The Brainerd mill saw both a new mill house and dam constructed and the race abandoned when Bird took over the operation. The historic photographs of this mill (Figures 24 and 25, p. 130) show a progressive enlargement of the mill and turbine areas. Kelso's mill saw changes in the location of the dam and possibly a new or expanded building.

One pattern that appeared at both the Brainerd and Kelso's mills was the recovery of the large number of artifacts from the tailrace. This distribution reflects the probable location of equipment, gears, shafts, and etc. over the turbine bay. The main drive shafts and spur

gears are generally located under the mill, connecting the powering mechanism with the milling equipment. Sometimes these gears as well as the turbines were left in place when a mill burned or was dismantled. An abandoned mill which had been vandalized would also show this distribution pattern, as the easiest method of destruction of heavy gears and shafts would be to roll them down the bank to the tailrace. Even large gears and shafts could be rolled downhill with relative ease, but retrieval would be more arduous, and certainly less satisfying.

Future research questions. Investigations of industrial sites can tell us something of the resource base when the site was developed (Newell 1978). We also have the opportunity to examine the impact of the exploitation of the resource base. Examination of residues of industrial processes can give us information on the long-term environmental impact of these materials.

In the case of water mills, the presence of dams, head races and tail races change the hydrology of a particular area. At the Brainerd mill, for example, the creek sought a new channel at the Mission dam location.

A number of mill sites would have to be investigated to determine the long-term effects of these hydrologic changes. Did a drained pond regain its former state? What effect did leaving a dam in place have on the long-

term environment? In eastern North Carolina, for example, mill ponds develop into pocosins, or swamps, creating an entirely new environment. Did the clogging of these ponds with swamp vegetation have an impact on the workings of the mills?

During the analysis another aspect of the data became evident; the question of regional access to state-of-the-art technology in frontier settlements. As small town dwellers can attest even today, all aspects of high-tech equipment and services are not available. The knowledge of the technology is usually available, however, leading to folk-tech adaptations.

The wooden reaction turbine at Brainerd may be such an example of folk-tech at work. Perhaps the perplexing question of the cast-iron blades in the wooden shaft can be explained as an adaptation of available components into something that looked like a turbine, and ran like a turbine, therefore it was a turbine. The level of inefficiency of the turbine was probably recognized, but it was probably developed in the time honored tradition of "make do with what you have".

During the course of future research on mills or other industrial sites it would be informative to note other examples of folk-tech handiwork. Was the transportation system the limiting factor on accessibility to state-of-the-art technology? Do we see fewer of these

adaptations in areas when a market develops for the technology? Is there a likelihood that these folk-tech adaptations are most common when the technology is in a state of rapid change, as it was in the mid-nineteenth century when the Brainerd turbine possibly was installed?

The position of mills in the social fabric is not extensively addressed in this investigation, but many questions can be addressed in future studies. Did, for instance, mills serve as a rural substitute for the court house as a gathering place? Pond Creek Mill in Loudon County, for example, maintained a grinding wheel operated from the belt drive system whereby customers could sharpen their knives and axes while they waited for the grain to be ground. They also used this occasion to catch up on the local news. This grinder now sits idle as the mill rarely does custom grinding. The Eve Mill in Loudon County was one of several mills that served as post offices. Other questions could deal with whether the mills were used as gathering places for social events, and the use of mill ponds for swimming holes.

These four mills are located in the same region, but show a wide range of diversity in equipment, layout and history. The basic essentials of water source, race-flume system, wheels and gears are all present, but are arranged in a variety of ways to fit the needs of each mill. Only by documenting a number of mills can we hope to address

such questions as topographic restriction on ideal mill layouts, regional access to state-of-the-art technology, the place of mills in the social fabric, and the archaeological methods best suited to investigating mill remains.

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APPENDIXES

APPENDIX I

ARTIFACTS RECOVERED FROM MILLS IN THE TELlico RESERVOIR

<u>Accession #</u>	<u>Number</u>	<u>Description</u>
<u>KELSO'S MILL</u>		
1	20	Modern nails 2--5 inches 13--4 " 2--3 " 1--2.75 " 2--2.5 "
2	1	Bent metal piece
3	1	Corroded metal strap 3 inches long
4	1	Wire
5	1	Unidentified metal object
6	7	Square nails 1--5 inches 1--4.5 " 3--3 " 2 fragments
7		
8	1	Sluice gate--wooden
9	1	Spike, 5 inches long
10	1	Section of gear (?)
11	1	Half of a horse shoe
12	1	Pitch fork, one tine broken
13	1	Gear hub; key way visible but very corroded; fragment of gear hub
14	1	Bolt with square head, 2 washers and square nut; 1.3 foot long, 1.25 inch square head
15	8	Broken gear pieces; probably from same gear

* All Kelso's mill artifacts were found in the tail race

Trigonia Mill

1	1	Iron bar with threaded end, hook on other end; one inch diameter, 2 feet long
2	1	Section of scale

<u>Accession #</u>	<u>Number</u>	<u>Description</u>
4	1	Section of pliers (handle?)

Hopewell Mill

1	1	Bearing backing plate with number 263 embossed on back, some babbit remaining
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* Hopewell mill is a standing structure in the project area which was not archaeologically investigated.

APPENDIX II

ARTIFACTS RECOVERED FROM BRAINERD MILL

<u>Accession #</u>	<u>Number</u>	<u>Description</u>
<u>Penstock</u>		
1	1	Wooden turbine with cast iron blades
3	1	Wooden saddle bar with wooden bearing for #1.
4	1	Mortised member for penstock
5	2	Wooden members with tenons and and peg holes
<u>Tailrace</u>		
15	1	Crank handle
19	6	Gate or vane fragments
176	1	Sawmill propeller rack 35x2 inches
177	1	Adjustment for mill step bearing
178	1	Runner
179	1	Setworks/hammer dog
180	1	Damsel agitator
181	1	Altrition mill or feed mill grinding plate, double grind
182	1	Setworks actuation lever
183	1	Winged coupling
185	1	Wood chisel
186	22	Fragments of turbine blades or housing
187	1	Carding pick fragment
188	1	Drift-pin
189	1	Mixed-flow turbine runner c. 1870
190	1	Mill pick
191	1	Draft tube
192	1	Fragment from bolter, auger drive or damsel assembly
193	1	Bell-shaped assembly
194	2	Rat-tail files
195	1	Curved wrought iron rod 2 feet long by 1.5 inch diameter
196	2	Railroad spikes
197	2	Wrought iron strapping fragments
198	1	Wood and metal buggy hood support
199	1	Spur gear fragment
200	1	Turbine gate control fork
201	1	Dog(?) fragment
202	1	Gudgeon
203	1	Roof or penstock truss 9 feet

<u>Accession #</u>	<u>Number</u>	<u>Description</u>
<u>Brainerd Mill (cont)</u>		
204	10	Assorted washers
205	1	Probable stove part
206	1	File
207	1	Chisel
208	1	Hook
209	1	Portion of turbine casing (?)
210	1	Unidentified metal object (UMO)
211	2	UMO
212	1	Hook
213	8	Wood screws
214	1	Forged chain
215	1	Kerr "Self-Sealing" jar
216	-	Wire nails
217	1	Brace or Flange
218	6	Nuts
219	1	Possible fragment of wood stove
221	2	Metal bushings or washers, 3.5 and 3"
222	2	Bolt heads
223	2	Metal bands or collars, 2.25", 2.75"
226	2	Metal plate or flange
227	6	Square Headed bolts .375'
228	1	Mount for end of shaft
229	1	Metal frag. possible turbine part
230	1	Screw key .375'
231	2	Wrought iron rod .9' Cast (?) iron rod .8'
232	3	Metal bushings or washers
233		Wire fragments
234		Cut nails
235	1	Gear fragment
236	1	Bushing
237	1	Metal file fragment
238	2	Bolts .55'
239	9	Assorted nut, bolts, spikes
240	6	Bolts and spikes .85' to 1.2'
241	17	Shaft keys
242	1	Large staple or bracket
243	2	Flat spike .5' and .8'
244	2	UMO
245		Nuts and bolts, 0.3'to 0.4'
246	1	Handle
247	1	Wood and metal crank handle
248	1	Metal bracket and screw mount with remains of 4 wood screws
249	3	UMO

Accession #	Number	Description
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Accession #	Number	Description
<u>Brainerd Mill</u>		
<u>Tailrace (cont)</u>		

250	1	Section of collar mount for shaft
251	1	Pitch fork
252	1	Screw bolt 0.45'
253	5	Back plates
255	1	Wrought iron rod 0.025' diameter bent to hook shape
256	1	Fragment of shaft housing
257	1	Metal ring fragment 0.25' diameter 0.125' wide
258	1	Wooden handle fragment
259	2	Collar for shaft
260	1	Flat metal band
261	1	Stoneware sherd
262	7	Glass window pane fragment
263	1	Band or collar for shaft or gear housing
264	1	Section of gear or turbine
265	1	Wrought iron hook 1.5'
268	1	Gear 16.5"
269	1	Babitted top step bearing
270	1	Center of gear or turbine
271	1	Rack 3.5" pitch
272	1	Bevel gear 21" diameter

<u>Unit Three</u>		
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20	2	Bolts
21	1	Metal bar
22	2	Chisel-like bar
23	1	Section of corn sheller
24	5	Fragments of oval shaped bars
25	1	UMO
26	1	Wrought iron bar 10" long, 1.4" diameter short axle or idler pulley
27	1	Thrust-top bearing or over shaft end, bearing plate with babbit
28	1	Hinge with portion of wood screws intact
29	6	Fragments of vanes
30	1	Hook
30a	10	Assorted straps
31	1	Lock Backing plate
32	2	Wood fragment with metal hook
33	1	Shaker bit for bolting mill
34	1	Carriage wheel, probably saw mill or overhead gates.

<u>Accession #</u>	<u>Number</u>	<u>Description</u>
<u>Brainerd Mill Tailrace Unit Three (cont.)</u>		
35	1	Handle or hinge
36	1	Bearing backing plate for quarter box bearing
37	1	Nut
38	2	Metal door, possibly stove
39	1	Metal flange (?)
41	1	Metal timber band, probable gudgeon
42	1	Turbine housing or draft tube housing
43	1	Portion of turbine housing
145	1	Straight side Mason jar c. 1880-1900
157	42	Cut nails 2" and shorter
158	14	Wire nails
159	1	Wood screw 1.5"
160	2	Round head bolts
161	1	Hinge 1.5" by 2", 2 holes each side
162	1	Metal bracket or support 2.5"
163	12	2" cut nails
164	24	2-3" cut nails
165	1	Fragment Budweiser can
166	6	4" cut nails
167	6	Asst. metal fragments
169	1	Brown Coke bottle
170	1	Flask shaped bottle
171	1	Straight sided glass bottle threaded top, 2" diameter
172	2	Fragment of brown beer bottle
173	1	Window glass fragment
174	1	Clear glass bottle fragment
273	1	Possible turbine runner or draft tube fragment

Turbine Enclosure

184	2	Sawmill rollers
224	1	Turbine seat-saddle pole with wooden bearing
225	1	Wooden portion of turbine enclosure
174	2	Iron band for turbine

Dam Area I

44	4	Brown glass fragment
45	4	Brick fragment
47	11	Clear window glass fragment
48	2	Lavender glass bottle fragment
49	5	Clear glass bottle fragment

Accession #	Number	Description
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Brainerd Mill Dam Area I (cont)

50	1	Aqua glass bottle fragment
51	5	Wire nails
52	110	Wire nails
53	3	RR spikes
54	1	Wrought iron dam spikes
55	3	Glass bottle fragments
56	2	Wrought iron rods
57	1	Wrought iron bolt
58	7	UMO
59	1	Wrought iron ring
60	1	Wrought iron rod-bent
61	5	Terra-cotta tile fragment
62	1	Wrought iron metal bar
63	1	Wrought iron bolt fragment
64	1	Cut nail with wood attached
65	1	Stoneware sherd
66	9	UMO
67	1	Wrench
86	1	Triangular shaped metal bar with "fins"
270	1	Spike from dam 24" long, bent

Dam Area II

68		Wire nails
69	2	Cut nails
70	1	Base of glass fruit jar (aqua)
71	1	Glass bottle or jar base
72	5	Clear glass bottle fragments
73	6	UMO
220	1	Fragment of mill stone, straight quarter dressed. height 6.5", radius from outer edge of hole 1.6'

Dam Area III

75	3	Brown Coke bottle fragment
76	1	Bolt
77	2	Clear glass bottle fragment
78	1	Metal cap
79	2	Fragment of turbine blades or draft tube
80	1	Spike fragment, wrought iron
81	2	Wire nails
82	1	Cut nails
83	1	Fragment of iron band

<u>Accession #</u>	<u>Number</u>	<u>Description</u>
<u>Brainerd Mill (cont)</u>		
84	1	Metal fragment
85	1	Metal bar with round plate on end
<u>Dam Area IV</u>		
74	100+	Metal plates
146	1	Pint glass milk bottle "Chatt. milk and package exchange"
149	1	Tall clear beer (?) bottle, no marking, mold blown
<u>N-S Trench Level 1</u>		
87	50+	Cut nails
88	5	Brick fragment
89	20+	Wire nails
90	4	Clay pipe fragment
91	4	Screens
92	24	Clear glass fragment, no marking
93	1	Bottle glass fragment, possible medicine bottle
94	1	Top of glass vase or lamp globe
95	1	Saw blade
96	1	Iron rim or hoop
97	2	Iron rod fragment
98	1	Iron rod fragment, possible brace
99	2	Copper rivets
100	1	Shell casing
101	7	Brown bottle glass fragments
102	2	Brass lantern top "E. Miller and Co"
103	1	Iron stove leg(?)
104	1	Half of horse shoe with nail
105	2	Wire fragment and wire staple
106	2	Nuts
107	1	Bolt with nut and 2 washers
108	1	Washer
109	1	Metal fragment
110	1	"
111	1	"
112	1	Furriel
113	1	Shell casing
114	7	Brick fragment, porous
<u>N-S Trench Level 3</u>		
115	1	Metal fragment
116	1	Brick fragment

<u>Accession #</u>	<u>Number</u>	<u>Description</u>
<u>Brainerd Mill N-S Trench Level 3 (cont)</u>		
117	1	Nut
118	20	Cut nails
119	1	Clear glass fragment
120	1	Brown bottle glass fragment
121	1	Metal rod fragment
123	1	Earthenware sherd
124	6	Wire nails
<u>N-S Trench Level 6</u>		
125	3	Earthenware sherds
126	21	Cut nails
127	1	Clear glass fragment
128	1	Spike 3" long
129	2	Wire nails
130	1	Half of horseshoe
<u>E-W Trench</u>		
132	4	Mortar samples
133	37	Window glass fragment
134	4	Brick fragment
135	6	Wire nails
136	1	Nut and bolt
137	1	Earthenware sherd
138	1	Bolt
139	1	Copper washer and rivet back plate
140	41	Cut nails
<u>Unit I</u>		
142	1	Sawmill rack gear 24" x 2"
150	4	Wire nails
151	1	Brick fragment
152	10	Window glass fragment
153	7	Cut nails
154	3	UMO
<u>Unit I-A</u>		
155	7	Clear glass fragment
156	4	Wire nails
<u>Unit 2</u>		
143	1	Round bolt head

Accession #	Number	Description
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Brainerd Mill (cont)Items Recovered From Sandblasting Large Gears

275	1	Brass tack 0.7" x 0.6"
276	1	Slot key
277	1	Lag screw 5.5"
278	3	Lag screws

Misc. Prov.

46	1	Spike from dam
141	1	Wrought iron bar wrapped with fine wire
144	1	Brown bottle, mold blown, "La Roma"
147	3	Window glass fragment
148	1	Wrought iron spike
168	1	Brown bottle 6.5" "E.R. Betterton & Co Distillers Chattanooga, Tenn"
175	1	Metal ring 10.5" dia x 2.25"
266	2	Brown glass bottle fragment
267	1	Clear glass bottle fragment

VITA

Loretta Ettien Lautzenheiser was born in Chattanooga, Tennessee. She attended schools in Tennessee, Alabama, Georgia and Pennsylvania, graduating from Chattanooga Central High School. She entered the University of Chattanooga majoring in chemistry.

After time out to marry and raise two children, she returned to the University of Tennessee at Chattanooga to complete work on an undergraduate degree in anthropology. She received a B.S. degree in 1979.

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