Geologic Resources Inventory Scoping Summary
Fort Donelson National Battlefield, Tennessee

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The Geologic Resources Inventory (GRI) provides each of 270 identified natural area National Park System units with a geologic scoping meeting and summary (this document), a digital geologic map, and a geologic resources inventory report. The purpose of scoping is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and monitoring and research needs. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity to discuss park-specific geologic management issues, and if possible include a site visit with local experts.

The National Park Service held a GRI scoping meeting for Fort Donelson National Battlefield on March 23, 2009 at the Tennessee Division of Geology offices in Nashville, Tennessee. Tim Connors (NPS-GRD) facilitated the discussion of map coverage and Lisa Norby (NPS-GRD) led the discussion regarding geologic processes and features at the military park. Geologists from the Tennessee Division of Geology presented a brief geologic overview of the battlefield and surrounding area. Participants at the meeting included NPS staff from the park, Geologic Resources Division, and Cumberland Piedmont Network, geologists from the Tennessee Division of Geology, and cooperators from Colorado State University (see table 2). This scoping summary highlights the GRI scoping meeting for Fort Donelson National Battlefield including the geologic setting, the plan for providing a digital geologic map, a prioritized list of geologic resource management issues, a description of significant geologic features and processes, lists of recommendations and action items, and a record of the meeting participants.

Park and Geologic Setting

Established on March 26, 1928, Fort Donelson National Battlefield in Stewart County, northwest Tennessee preserves the scene of the American Civil War battle that took place on February 14-16, 1862. The park includes the Civil War era Fort Donelson in Dover, Tennessee, a national cemetery, and the Fort Heiman unit in Calloway County, Kentucky. The NPS manages 407.22 ha (1,006.26 ac) at Fort Donelson. The park is in the process of developing the ≈70-ha (≈180-ac) Fort Heiman unit in Kentucky. The park is in the Land Between the Lakes area between the Cumberland and Tennessee river valleys at the edge of the western Highland Rim Plateau.

Exposed within the Fort Donelson unit are three geologic units: alluvial deposits (Qal), St. Louis Limestone (Msl), and the Warsaw Limestone (Mw). The nearby Fort Heiman area has loess (Ql), alluvium (Qal), continental deposits (QTc), Cretaceous rocks such as the McNairy Formation (Km), the Tuscaloosa Formation (Kt), and the Mississippian Fort Payne Formation (Mfp) and Warsaw Limestone (Mw).

Water and wind deposited the unconsolidated clay, silt, sand, and gravel of the younger formations. Loess is a silty deposit transported by wind and is typically associated with colder climates forming in areas bordering large, continental glaciers. The older, Cretaceous-age units reflect deposition in terrestrial fluvial environments. The McNairy Formation contains sand, clay, and gravel whereas the Tuscaloosa Formation contains gravel, silt, and sand including abundant reworked clasts from

underlying Mississippian formations. The Mississippian Fort Payne Formation, Warsaw Limestone, and St. Louis Limestone were deposited in deep marine environments ranging from open ocean to open shelf shoal depositional environments. Outcrop exposures within the park are weathering deeply (to produce clays and remnant chert clasts) and are limited.

Dissected upland open areas flanked by relatively steep forested slopes define the landscape at the battlefield. The Cumberland and Tennessee Rivers dominate the viewsheds of the park units with smaller streams including Hickman Creek, Indian Creek, and Erin Hollow traversing the landscape.

Geologic Mapping for Fort Donelson National Battlefield

During the scoping meeting, Tim Connors (NPS-GRD) showed some of the main features of the GRI's digital geologic maps, which reproduce all aspects of paper maps, including notes, legend, and cross sections, with the added benefit of being GIS compatible. The NPS GRI Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation for the GRI Program and allows for rigorous quality control. Staff members digitize maps or convert digital data to the GRI digital geologic map model using ESRI ArcGIS software. Final digital geologic map products include data in geodatabase and shapefile format, layer files complete with feature symbology, FGDC-compliant metadata, an Adobe Acrobat PDF help document that captures ancillary map data, and a map document that displays the map, and provides a tool to access the PDF help document directly from the map document. Final data products are posted at http://science.nature.nps.gov/nrdata/. The data model is available at http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm.

When possible, the GRI Program provides large scale (1:24,000) digital geologic map coverage for each park's area of interest, which is often composed of the 7.5-minute quadrangles that contain park lands (fig. 1). Maps of this scale (and larger) are useful to resource managers because they capture most geologic features of interest and are spatially accurate within 12 m (40 ft). The process of selecting maps for management begins with the identification of existing geologic maps (table 1) and mapping needs in the vicinity of the park. Scoping session participants then select appropriate source maps for the digital geologic data or develop a plan to obtain new mapping, if necessary.

Table 1. GRI Mapping Plan for Fort Donelson National Battlefield

Covered Quadrangles	Relationship to park	Citation	Format	Assessment	GRI Action
Dover	Intersects park lands	Marcher, M. V., L. T. Larson, and R. H. Barnes. 1965. Geologic Map and Mineral Resources Summary of the Dover Quadrangle. Scale 1:24,000. Geologic Quadrangle Map 29 NE. Nashville, TN: Tennessee Division of Geology.	digital	The digital map has not been finalized yet, but the digitization is done and available to the GRI.	Obtain GIS shapefiles digitized by the Tennessee Division of Geology and convert to GRI Geology-GIS Geodatabase Data Model.
Bumpus Mills	Just northwest of park boundary, included for buffer area	Marcher, M. V., and L. T. Larson. 1965. Geologic Map and Mineral Resources Summary of the Bumpus Mills Quadrangle (Including the Tennessee Portion of the Hohnson Hollow Quadranglle, Kentucky-Tennessee). Scale 1:24,000. Geologic Quadrangle Map 28 SE. Nashville, TN: Tennessee Division of Geology.	digital	The digital map has not been finalized yet, but the digitization is done and available to the GRI.	Obtain GIS shapefiles digitized by the Tennessee Division of Geology and convert to GRI Geology-GIS Geodatabase Data Model.

Covered Quadrangles	Relationship to park	Citation	Format	Assessment	GRI Action
Standing Rock	Just west of park boundary, included for buffer area	Marcher, M. V., L. T. Larson, and R. H. Barnes. 1965. Geologic Map and Mineral Resources Summary of the Standing Rock Quadrangle. Scale 1:24,000. Geologic Quadrangle Map 29 NW. Nashville, TN: Tennessee Division of Geology.	digital	The digital map has not been finalized yet, but the digitization is done and available to the GRI.	Obtain GIS shapefiles digitized by the Tennessee Division of Geology and convert to GRI Geology-GIS Geodatabase Data Model
Tharpe	Just northwest of park boundary, included for buffer area	Geologic Map and Mineral Resources Summary of the Tharpe Quadrangle. Scale 1:24,000. Geologic Quadrangle Map 28 SW. Nashville, TN: Tennessee Division of Geology.	paper	The paper map has not been digitized yet.	Scan and digitize paper map using GRI Geology-GIS Geodatabase Data Model
Hamlin &Paris Landing, KY	Intersects Fort Heiman unit	Blade, L. V. 1966. Geologic Map of Parts of the Hamlin and Paris Landing Quadrangles, Western Kentucky. Scale 1:24,000. Geologic Quadrangle Map GQ-498. Reston, VA: U.S. Geological Survey in cooperation with the Kentucky Geological Survey	paper	This paper product was digitized by KYGS	Compare paper version to GIS version and assure all features captured in KYGS digital GIS version
Hamlin &Paris Landing, KY	Intersects Fort Heiman unit	Tyra, M.A., 2002, Spatial database of the Hamlin and Paris Landing quadrangles, western Kentucky, Kentucky Geological Survey, Digitally Vectorized Geological Quadrangle DVGQ-12_498, 1:24000 scale	digital	The digital map is available online from the Kentucky Geological Survey website	Obtain the digital geologic map data and convert to GRI Geology-GIS Geodatabase Data Model

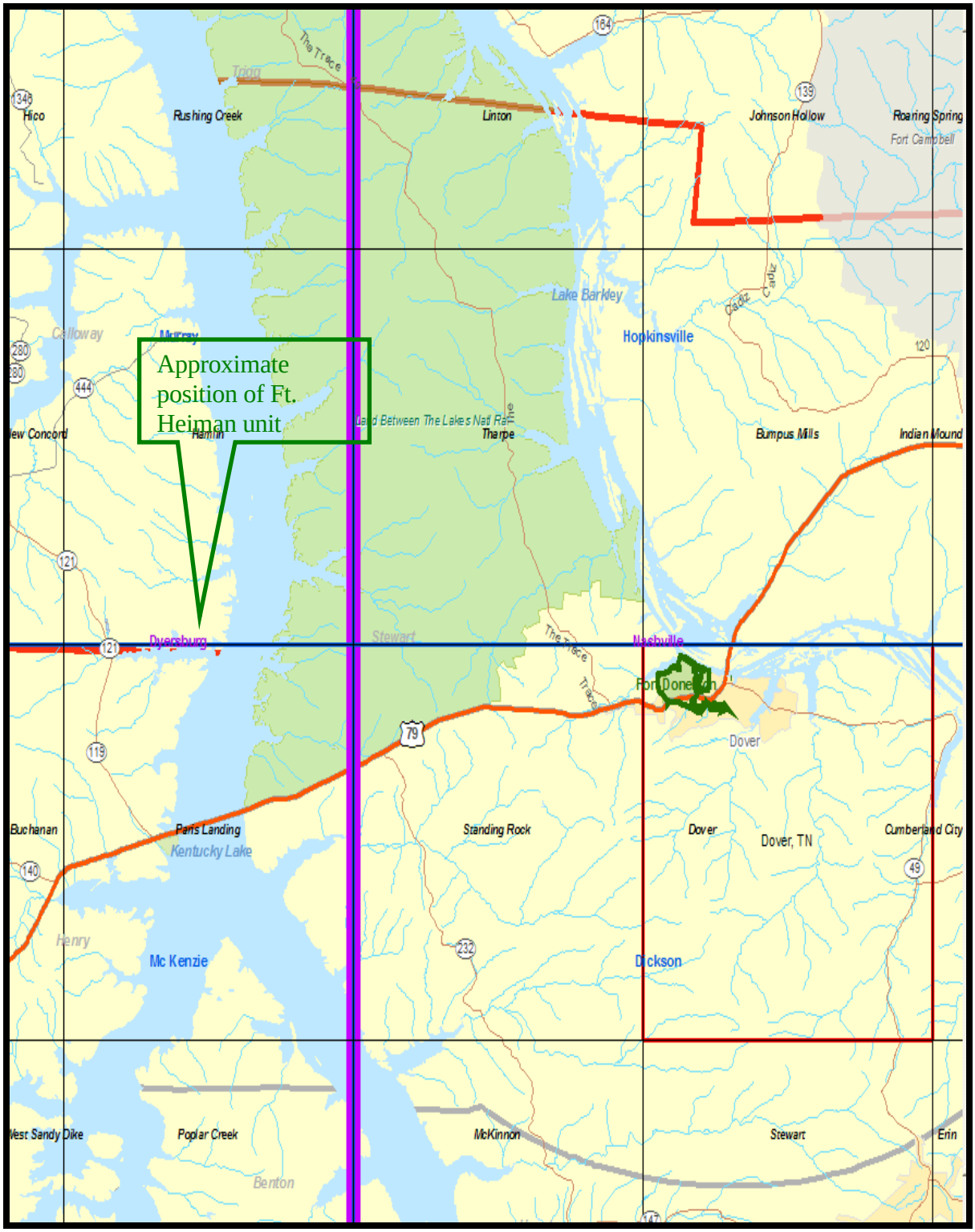

Figure 1. Area of interest for Fort Donelson National Battlefield, Tennessee. The 7.5-minute quadrangles are labeled in black; blue text and boundaries indicate 30-minute by 60-minute quadrangles; purple text and lines indicated 1x2 degree quadrangles. Green outlines indicate monument boundaries. Please note there is no boundary included for the FORT HEIMAN unit, which is present in the south central portion of the Hamlin KY 7.5'.

Map coverage is available at the 1:24,000 scale for all the areas of interest for Fort Donelson National Battlefield. The NPS boundary for the Fort Heiman unit is not yet available from the NPS base cartography or land tracts groups. According to Mike Hoyal of the Tennessee Division of Geology, the quality of the 1960's geologic maps for the area of interest are accurate and of good quality. The park desires at least a 1.6-km (1-mi) buffer of map coverage around the park boundary for resource management purposes over the main FODO unit. This would intersect the Bumpus Mills, Tharpe, Dover, and Standing Rock 7.5' quadrangles, but would preclude GRI staff from having to supply the full extent of these quadrangles.

Geologic Resource Management Issues

The scoping session for Fort Donelson National Battlefield provided the opportunity to develop a list of geologic features and processes, which will be further explained in the final GRI report. During the meeting, participants prioritized the most significant issues as follows:
(1) Flooding and fluvial processes,
(2) Karst hazards, and
(3) Slope processes.

Other geologic resource management issues discussed include seismicity, mineral resource development, and disturbed lands.

Flooding and fluvial processes

The Tennessee and Cumberland rivers and tributaries dominate the fluvial features and processes at Fort Donelson National Battlefield. The park boundary does not touch the rivers. When the Tennessee Valley Authority (TVA) and Army Corps of Engineers built the dams to impound the rivers in the 1960s forming Kentucky Lake and Lake Barkley, respectively, the fluvial processes in the rivers changed dramatically (fig. 2). Areas affected by fluvial changes from the dam include Indian Creek, which periodically floods parts of the Graves battery area. The Army Corps of Engineers stabilized the Cumberland River shoreline with riprap. At Fort Donelson, most of the floodplain of the Cumberland River is on the opposite side of the river and is managed by the Army Corps of Engineers.

Karst hazards

According to the geologic hazards map presented by the Tennessee Division of Geology, the karst features at the battlefield are low density. The Mississippian limestone units (St. Louis Limestone and Warsaw Limestone) are conducive to karst topography on the highland rims (of the Illinois basin) in Tennessee. The St. Louis Limestone is the same unit as that present at Mammoth Cave in Kentucky. The Warsaw Limestone crops out along a maintenance road within the Fort Donelson unit and along the Cumberland riverbank just beyond the park boundary near the lower river battery. A veneer of terrace gravels from the Cumberland and Tennessee rivers mantles other park exposures of limestone.

Slope processes

Most of the landscape within Fort Donelson National Battlefield is of moderate to steep slopes. However, due to thick forests with groundcover, erosion is not a major resource management issue at the park. Historically, the Confederates cleared the landscape to obtain lumber for building

shelters and obstacles, but the park has no plans to remove trees to restore the historic landscape. Preventing erosion from diminishing earthworks is an ongoing management issue. In an attempt to stem erosion, the NPS used sod on some earthworks, but with limited success (fig. 3).

Other geologic resource management issues

Seismicity

According to geologists from the Tennessee Division of Geology, Fort Donelson National Battlefield is within an area of relatively low seismic risk (zone 2). However, there are frequent seismic events in the area possibly associated with the New Madrid seismic zone. Hazards associated with seismicity that could threaten park resources include liquefaction within water-saturated, unconsolidated floodplain deposits; however, given the limited amount of alluvial deposits at the park, this is not a significant resource management issue. Seismic shaking, if strong enough, could damage park infrastructure including buildings, roads, trails, monuments, and bridges.

Historic mineral resource development and disturbed lands

According to park staff, no local limestone quarries exist within the park. Some quarry activity occurred to the south of the battlefield possibly supplying limestone for local structures. Limonite iron ore occurs within Fort Donelson National Battlefield. Iron rich deposits occur in the greater Land Between the Lakes area near the contact between the Mississippian St. Louis Limestone and Warsaw Limestone. Around 1812, the Highland Rim area of Tennessee, including Dover, had a concentration of iron furnace operations that was among the largest in the south. Remnants of these iron operations throughout the region include mines, pits, and furnace sites. Material produced by these furnaces contributed to the War of 1812 effort.

Adjacent development continues to encroach upon park lands. At the national cemetery, a housing development dominates the northeastern viewshed. Because the War Department originally purchased the national battlefield in 1928 to include only the fort and Confederate earthworks, many of the battle sites are not contained within the park boundaries, especially the Confederate escape routes to the southeast. Much of the land now within the park was subject to logging, grazing, and agriculture. These activities certainly degraded the historic landscape. The Civil War Trust organization is attempting to purchase buffers around park lands including Union troop positions and breakout areas.

Historic features and geology

Constructed in 1883, the park administration building at the national cemetery at Fort Donelson contains bricks (possibly locally sourced from clays on the western shore of the Tennessee River), limestone blocks, and a slate roof (imported). River clay supplied material to the Dover Brick Company in the 1930s. Mississippian or Ordovician age limestone has been used for building material in the block walls at the river batteries in the park. The quarry source for this stone is unknown.

Figure 2. View from the river batteries overlooking Lake Barkley on the Cumberland River. Photograph is by Trista L. Thornberry-Ehrlich (Colorado State University).

Figure 3. Sod installed over Confederate earthworks with limited success. Photograph is by Trista L. Thornberry-Ehrlich (Colorado State University).

Features and Processes

Karst features

The Mississippian limestone units at Fort Donelson National Battlefield are prone to karst processes. Karst processes cause dissolution of carbonate-bearing rocks such as limestone. At the battlefield, the limestone units are deeply weathered and do not display distinctive karst features such as caves, sinkholes, and disappearing streams. Hickman Spring on the Circle Loop Trail is a karst feature in the park.

Geologic connections with the battle for Forts Heiman and Donelson

Geology controlled the locations of Forts Heiman and Donelson above the Tennessee and Cumberland riverways during the American Civil War. Both forts are perched on prominent overlooks underlain by Mississippian limestones and capped by terrace gravels. Geology strongly influenced the movements of troops and artillery before and during the battle. The battles followed ridge tops where batteries were strategically located. Steep slopes and eroded areas such as Erin Hollow channeled troop movements and played a role in the escape of some Confederate troops after the surrender of Fort Donelson.

Paleontological resources

According to the NPS Paleontological Inventory for Fort Donelson National Battlefield, fossil resources are not yet documented within the park, but the geologic units present there are fossiliferous elsewhere and future field investigations will likely document fossil resources within the park. Within the surrounding region, the McNairy Formation contains trace fossil tubes and plant microfossils. The Tuscaloosa Gravel contains remains of fossils reworked from older units, and plant microfossils. The St. Louis Limestone contains foraminifera, fossil algae, corals, gastropods, crinoid and echinoid fragments, bryozoans, and brachiopods. The Warsaw Limestone contains crinoid fragments, horn coral, bryozoan fossils, brachiopod shells, echinoid spines and plates, and trilobites. The Fort Payne Chert contains coral, crinoid fragments, brachiopods, and trilobite fossilized remains.

Within the Warsaw Limestone at Fort Donelson, quick field surveys by the Tennessee Division of Geology staff revealed the presence of crinoid segments, and “shell hash” (a mélange of broken chunks of brachiopods and bryozoans). Some coral was present in a gully wash near the Confederate Monument within clasts of clayey, weathered chert. Brachiopods are present in gullies in the park. Devonian shells (possibly from weathered Chattanooga shale) are found nearby in Paris Landing State park.

Unique features

Locally derived, white spotted “Dover chert” from the Fort Payne Formation was prized by Native Americans for making arrowheads and other implements. No known local quarries for this material exist within the park boundary. Chert from the weathered Fort Payne Formation is used as aggregate for local road building.

Action Items

1. GRI mapping coordinator will get an updated boundary layer for Fort Donelson National Battlefield including the incorporation of the Fort Heiman unit in Kentucky.

References

Meiman, J. 2005. Cumberland Piedmont Network Water Quality Report-February 2005, Fort Donelson National Battlefield. Atlanta, GA: National Park Service, Southeast Region.

Meiman, J. 2009. Cumberland Piedmont Network Water Quality Report: Third Serial Fort Donelson National Military Park. Natural Resource Report NPS/SER/CUPN/NRTR—2009/002. Atlanta, GA: National Park Service, Southeast Region.

Hunt Foster, R. and others. 2009 (in prep). Paleontological Inventory of Fort Donelson National Military Park. National Park Service.

Table 2. Scoping Meeting Participants

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