US Army Corps of Engineers
Huntington District

CHERRY RIVER, WV
WATERSHED RECONNAISSANCE STUDY

Richwood, WV, November 2003

SEPTEMBER 2008

U.S. Army Corps of Engineers

Huntington District

Huntington, WV

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CHERRY RIVER BASIN, WV
RECONNAISANCE STUDY ANALYSIS

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1.0 STUDY AUTHORITY

This reconnaissance phase investigation has been authorized by resolution of the committee on Transportation and Infrastructure, U.S. House of Representatives, dated April 2002, and is shown as follows:

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C.

RESOLUTION

Cherry River Basin, West Virginia

Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army review the report of the Chief of Engineers on the Ohio River and tributaries, Pennsylvania, Ohio and West Virginia, published as House document #306, 74th Congress, 1st Session and other pertinent reports to determine whether modifications to the recommendations contained therein are advisable, with particular references toward flood damage and prevention and associated water resources issues in the Cherry River basin at Richwood, West Virginia, and its vicinity**.**

2.0 STUDY PURPOSE

The reconnaissance phase is the first step of a two-step planning process that is required for all Civil Works Water Resources Projects. The reconnaissance phase is financed in total by the Federal government through the Corps of Engineers and no local sponsor funds are required. The primary purpose of the reconnaissance phase is to determine if there is Federal interest in proceeding with the second planning step known as the feasibility phase. The reconnaissance phase accomplishes the following tasks:

- Determine if the identified water resources problem(s) warrant Federal participation in a cost-shared feasibility study or studies;

- Define the Federal interest based on a qualitative appraisal, consistent with Army policies, of the costs, benefits, and environmental impacts of identified potential project alternatives;

- Assess the level of interest and support from non-Federal entities in the identified potential solutions and cost-sharing of the feasibility phase, project design and construction. Obtain a letter of intent (LOI) from the local sponsor stating their willingness to participation in the feasibility study described in the Feasibility Cost Share Agreement (FCSA) and Project Management Plan (PMP), and to share in the costs of construction of any recommended and authorized prospect.

This reconnaissance-level investigation will evaluate a watershed approach for flood damage reduction, water supply needs, recreation potential, ecosystem restoration and associated water resource opportunities on the Cherry River and tributaries in the vicinity of Richwood and Fenwick, WV.

3.0 STUDY AREA LOCATION

The Cherry River Watershed is located in eastern West Virginia and is a major tributary of the Gauley River. Figure 1 shows the location of the watershed with respect to the Gauley River basin and sub-basins of the Cherry River hydrologic complex. The locations of Richwood and Fenwick are shown with stars on Figure 2. The watershed has a drainage area of 167 square miles, and the Cherry River has a total of 43 stream miles. The river flows through the counties of Greenbrier, Pocahontas, and Nicholas including the incorporated communities of Richwood and Fenwick. Much of the Cherry River watershed upstream of Richwood, where the North and South Forks join to form the Cherry River mainstem, is within the boundaries of the Monongahela National Forest. Richwood is located in eastern Nicholas County, 25 road miles from Summersville, which is the county seat. The study area is located in the West Virginia 3rd Congressional District, represented by Congressman Nick J. Rahall.

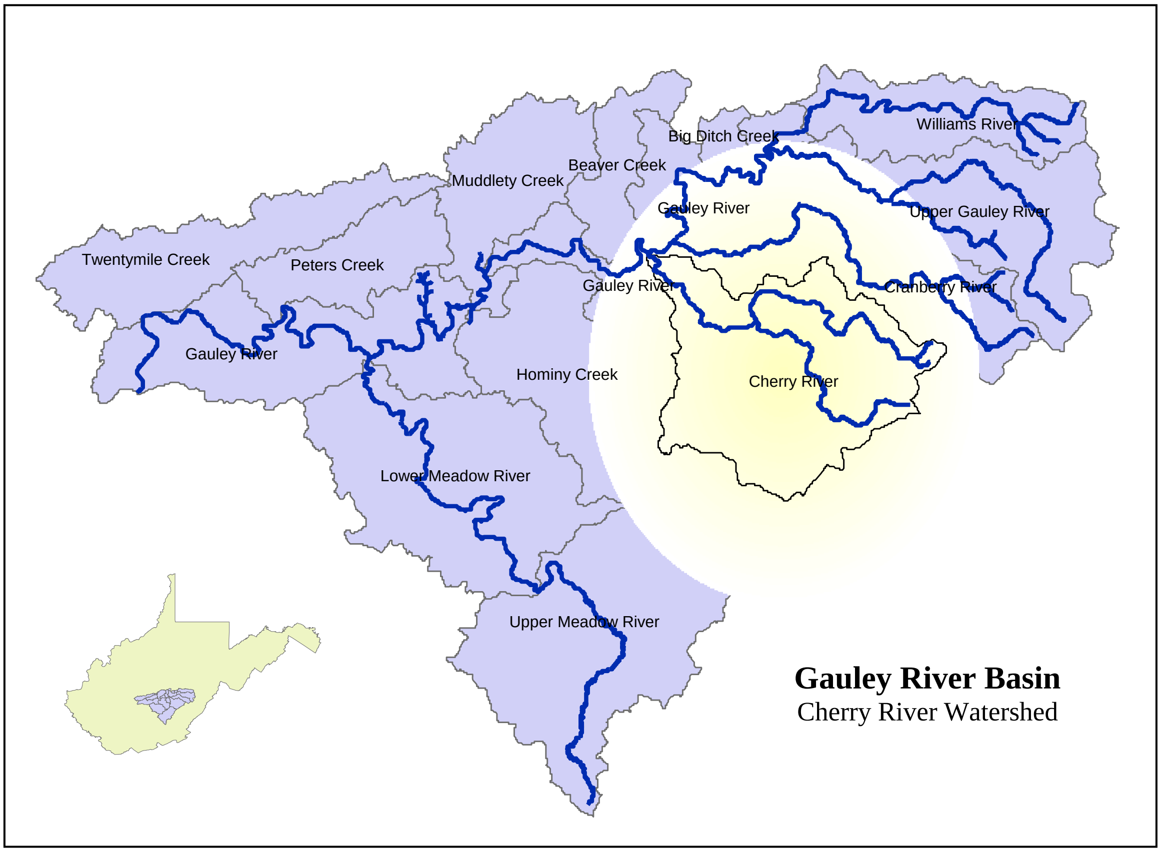


Figure 1. Location Map

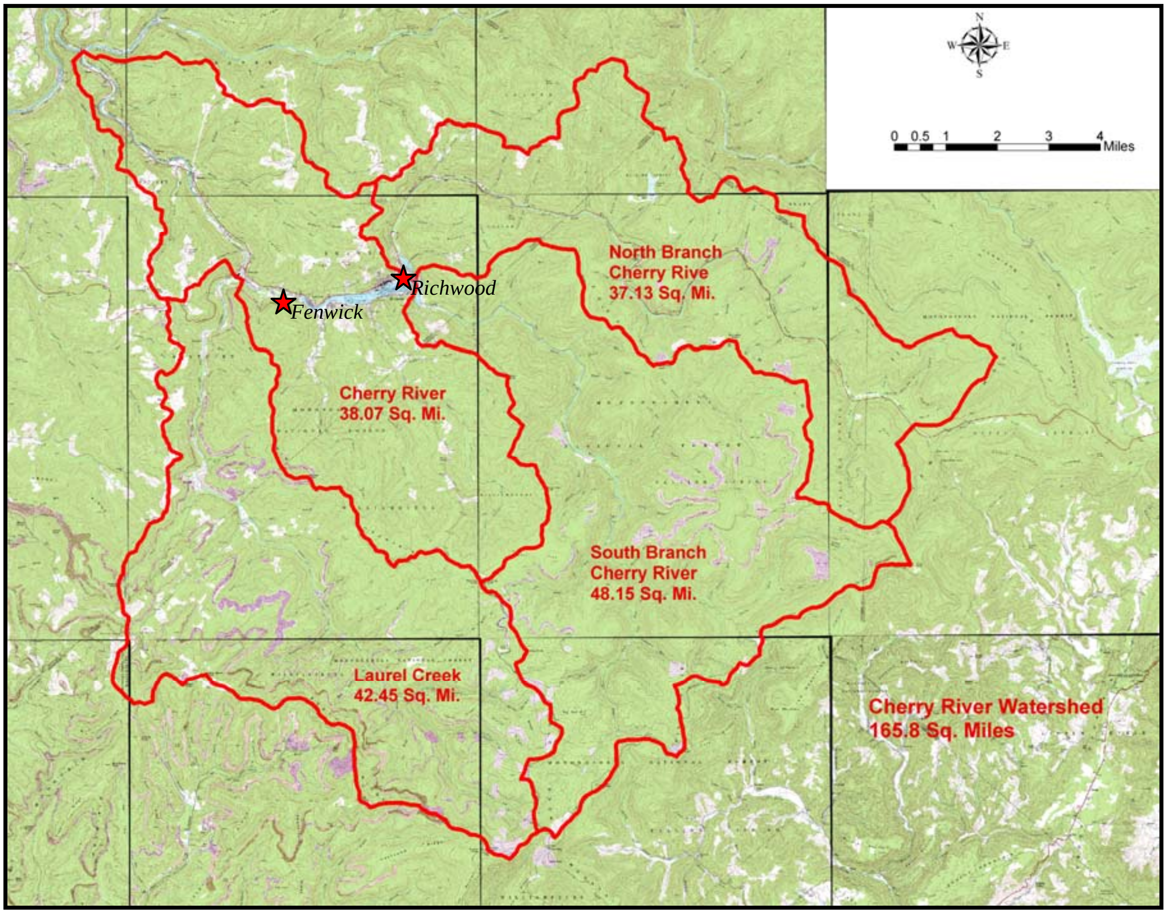


Figure 2. Cherry River Watershed Major Sub-Basins

4.0 PRIOR STUDIES, REPORTS AND COMPLETED PROJECTS

Richwood Snagging and Clearing Project, Huntington District, USACE, 1958. This project was carried out under authority of the Section 208 of the Flood Control Act of 1954, and consisted of debris removal and snagging and clearing the channel of the Cherry River, through Richwood and removing two bars from the channel at Fenwick. Initial construction was carried out in 1955 and an additional section of channel was altered in 1958. This project provided protection against smaller floods but only limited protection against larger floods.

Reconnaissance Report, Huntington District, USACE, July 1972. A reconnaissance investigation and report were completed for Cherry River in July 1972. The report concluded that channel improvement along 2.5 miles of Cherry River downstream from the Corps of Engineers' existing Section 208 Snagging and Clearing project was the most practicable means of providing flood damage reduction for Richwood. The plan was estimated at a benefit-cost ratio of 1.5, excluding redevelopment benefits; therefore, it was recommended that a detailed project report (DPR) be completed for a small, flood protection project in the Richwood-Fenwick area.

Detailed Project Report, Huntington District, USACE, December 1974. A DPR was completed evaluating channel improvement projects along the Cherry River at Richwood, WV in December 1974. The proposed project extended downstream for 2.5 miles from the existing Section 208 Snagging and Clearing Project that was completed by the Corps in 1954. The channel improvement project would have a minimum bottom width of 100 feet with 1 on 3 side slopes, and was estimated to cost $620,000 (October 1971 Price Level). The DPR concluded that neither the selected plan nor any other variation (various lengths and bottom widths) were economically feasible, and it was recommended that further detailed studies be terminated.

Soil Conservation Service Report, November 1989. The Soil Conservation Service (or SCS as they were referred to then, now called Natural Resource Conservation Service or NRCS), initially investigated water resource problems in the Cherry River watershed during 1966-1967, and proposed development of two single purpose dams for flood control and a multi-purpose reservoir for both flood control and water supply on the South Fork of the Cherry River. The projects were not constructed because of marginal feasibility and lack of local/regional support. Following several damaging floods in the late 1970’s and 1980’s, the SCS undertook further investigation in the Cherry River Basin which resulted in the 1989 report. This later investigation concentrated on development of a dam and reservoir on the South Fork 6.2 miles above the confluence of the South with the North Fork of the Cherry River at Richwood. The SCS evaluated five plans for this site, either a single purpose flood control project or a multi-purpose reservoir project with water supply, and recreation lake. Preliminary plans were developed for three lake sizes and differing dam elevations. The SCS report concluded that none of the alternative plans were economically feasible, and therefore, no further investigations were contemplated.

Federal Emergency Management Agency (FEMA) Flood Insurance Study, Richwood WV, September 1991. A study and report were prepared for Richwood under the authority of the National Flood Insurance Act of 1968 and the Flood Disaster Act of 1973. The report provided flood hazard information for the City of Richwood that would enable that community to participate in the National Flood Insurance Program (NFIP). The report contained flood profiles along the Cherry River through Richwood and identified the limits of the base flood (100-year). The report also included maps with the designated floodway and identified various flood zones to be used for a flood insurance program.

US Forest Service (USFS) Cherry River Watershed Assessment, September 2002. The USDA Forest Service Gauley Ranger District of the Monongahela National Forest completed an analysis of the Cherry River watershed in order to identify interactions, processes, functions of resources and human influence on a watershed scale. The document is intended to serve as a foundation of information and data to be used in future decision making. The report characterizes the watershed, identifies issues, describes "reference" conditions as well as existing conditions, interprets changes in the watershed and makes recommendations for management activities. Key issues identified in the study for the Cherry River watershed include some erosion and sedimentation, acid deposition (acid rain), flooding, areas of stream instability, water quality (specifically a few areas of acid mine drainage and sediment), lack of large woody debris in some streams, barriers to aquatic wildlife migration, and lack of quality riparian corridors/buffers. Approximately 15 miles of the North Fork Cherry River were found to be eligible for Wild and Scenic River designation, however, no decision has been made regarding such a designation. The South Fork of the Cherry River was considered also, but it was found to be ineligible at the time of the study

<u>USFS Cherry River Draft Environmental Assessment (2006)</u> The USDA Forest Service Gauley Ranger District prepared a draft Environmental Assessment for their proposed forest plan for the Monongahela National Forest. The document contains information on existing conditions for environmental resources in the watershed, along with an analysis of impacts from the proposed management plan. The environmental analysis determined that no federally listed threatened or endangered species are known to occupy the Cherry River watershed; however there were 11 known Regionally Sensitive Species that occur in the project area. There were three Threatened species (Bald Eagle, Small Whorled Pogonia, Virginia Spirea), two Endangered species (Indiana Bat and Virginia Big-eared Bat), and 21 Regionally Sensitive species that have suitable habitat but are not known to occur in the area. Issues for the Cherry River watershed mentioned in the document include elevated levels of fine sediment in streams, barriers to aquatic migration, reduced stream stability, lack of in-stream habitat, lack of large woody debris, acid deposition and poor riparian habitat. Sampling by the Forest Service determined that water chemistry indicated marginal to poor conditions in terms of aquatic productivity potential, mostly due to acidity and poor acid neutralizing capacity. Benthic macroinvertebrate data collected in three project area streams indicate clean water conditions; however diversity and richness indices indicate reduced health of the aquatic system. This is most likely due to a combination of factors, including excessive fine sediment, low productivity waters and acid deposition.

5.0 DESCRIPTION OF WATERSHED RESOURCES

5.1 General

The Cherry River Watershed comprises 167 square miles in east-central West Virginia within the counties of Greenbrier, Pocahontas and Nicholas. The city of Richwood, which is the main population center in the watershed, is situated at the confluence of the North and South Forks, about 10 miles above the mouth of the Cherry River, which is a major tributary of the Gauley River. Most of the Cherry River Watershed lies within the boundaries of the Monongahela National Forest, and as such comprises the western portion of a large and diverse area with high quality natural resources and numerous recreational facilities and opportunities.

The area around Richwood was initially developed in the late 1800's, when the community was known as Cherry Tree Bottom. The railroad was extended into the area in 1898, and in 1901 the town was incorporated with its present name, Richwood. In the first part of the 20th century, Richwood was a booming community due mostly to coal mining and lumber production. In pre-depression years (prior to 1930) the town had a population of nearly 10,000. Richwood at that time was the economic center for Nicholas County and the largest incorporated town. However, economic conditions eventually changed, as most underground coal mines closed by the mid 1900's, the lumber business declined and the railroad ceased operation upstream and the tracks removed in the 1980's.

5.2 Socio-Economic Resources

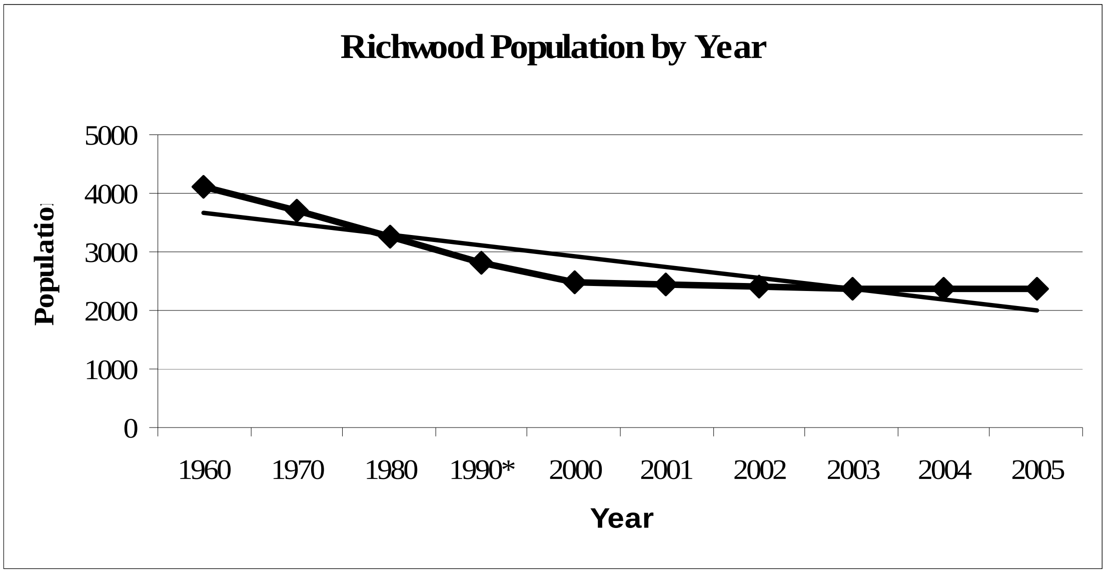
Most of the Cherry River Watershed is a rural, natural area except for the population at Richwood and nearby Fenwick. Richwood was once the economic hub of Nicholas County, but because of the decline in population and downtown commercial establishments, that distinction now belongs to Summersville, the county seat. The population of Richwood, once nearly 10,000 in the early 1900's, declined to about 4,000 in the 1960's and to presently about 2,400 (2005). The Richwood population since 1960 is shown in Table 1, and the population trend is shown on Figure 3. Currently, there are approximately 1,000 households in Richwood, with about 1,200 housing units. The average family includes 2.85 people and the median age is 45 years, with one-fourth of the people 65 years or older. The median household income is $24,423, as compared to $37,227 for West Virginia and $46,071 for the nation.

Table 1 - Richwood Population by Year

1960	4116
1970	3717
1980	3263
1990*	2808
2000	2477
2001	2429
2002	2408
2003	2361
2004	2371
2005	2369

Note: 1990 data extrapolated from previous and following year.

Figure 3 - Richwood Population by Year with Trend line



Richwood once had several large businesses and industries, most centered on lumbering and hardwood products. The wood based industries produced paper and axe handles, and the nation's largest clothespin factory was located in Richwood. Following closure of the coal mines and decline in the hardwood industries, most of the large businesses closed or relocated. The current businesses in Richwood are primarily small stores and specialty shops. These included banks, restaurants, gas stations, and one shopping center with a Foodland, Rite Aid Pharmacy and Dollar General.

There are three schools in Richwood. Richwood High School and Middle School, both near the downtown area, and Cherry River Elementary School, located along the river about one mile downstream.

Highway Transportation through Richwood and the Cherry River Basin is provided by WV 39 and WV 55 which permits access to Summersville and US 19 to the west, and Marlinton and US 219 to the east. West Virginia 39 extends along the North Fork of the Cherry River, thereby providing direct highway access to the Cranberry Glades botanical area, Highland Scenic Highway and the southwestern section of the National Forest. The only vehicular access along the South Fork of the Cherry River is by an unpaved timber haul road which extends along the stream, but is not a through road. The N&W Railway formerly ran through Richwood and provided passengers and freight transportation through the 1970's. Following the decline of businesses and industries, the railroad closed in the 1980's and the track has been removed.

The Richwood Area Community Hospital is the City's primary health care provider. It was formerly known as Sacred Heart Hospital and was administered by the local Catholic Church. Two other major facilities which provide social and/or public service include the Nicholas County Senior Center and the WV National Guard Armory, both located in the southwestern section of Richwood.

5.3 Recreational Resources

Richwood and most of the Cherry River Watershed are within the Monongahela National Forest, consequently there are many recreational facilities in the city and the surrounding area. Richwood has a small city park with a swimming pool, the Pratt Ball Field Complex and the Cherry Hill Golf course. The old railroad bed through Richwood is now a bike and hiking trail having been converted in the “rails to trails” program. Nearby in the National Forest are the Woodbine Recreation area with camping and stream fishing, Northbend Recreation area with camping facilities and Summit Lake Recreation area with a 43 acre lake for boating and fishing. At the eastern boundary of the Cherry River Watershed are the Cranberry Glades Botanical Area, a Canadian type bog, the Hill Creek Falls Scenic Area, and Cranberry Visitor Center.

Summersville Lake on the Gauley River near the city of Summersville, 25 miles west of Richwood, is a major Corps of Engineers reservoir with a 2,700 acre lake, campgrounds, boat ramps, and marina. Special releases from the reservoir in the fall help provide for some of the best whitewater rafting in the eastern United States on the Gauley River below the dam. Although outside of the Cherry River Watershed, Summersville Lake is easily accessible from Richwood by WV 39 and US 19.

Stream fishing in the area is some of the best in West Virginia. Both the North and South Forks of the Cherry River provide good stream fishing, however the Cranberry River and the Williams River, two tributaries of the Gauley River immediately to the north, are considered two of the most outstanding trout streams in the entire National Forest.

5.4 Aquatic Resources

The Cherry River is a free flowing stream with no impoundments on the main channel system. Streams within the Cherry River Watershed are primarily steep gradient mountain streams. The Cherry River main stem is a lower gradient river, beginning at the confluence of the North and South Forks at Richwood and flowing approximately 10 miles to its confluence with the Gauley River. The North Fork of the Cherry River and many of the smaller streams particularly, are high gradient streams, and mostly well entrenched within narrow valley walls.

Approximately 15 miles of the North Fork Cherry River were determined to be eligible for Wild and Scenic River designation, however, no decision has been made regarding such a designation. If it were to be designated, its probable classification would be recreational. The South Fork of the Cherry River also was considered, but it was determined not to be eligible at the time of the study.[1]

The West Virginia Department of Environmental Protection (WVDEP) has designated the Cherry River a high quality stream. The WVCEP uses the West Virginia Stream Condition Index (WVSCI), which uses benthic macro-invertebrates as an indicator of overall stream integrity. The average biological condition for the Cherry River based on

[1] Monongahela National Forest - Cherry River Watershed Assessment, 2002.

the WVSCI score identifies it as the 5th best in the state, bested in quality only by Glady Fork, Cranberry River, Williams River, and Shavers Fork. The reach of the Cherry River with the lowest score is located immediately downstream of the town of Richwood. Habitat values for this reach are considered "sub-optimal" due to lack of riparian vegetation and bank instability.

The WVDEP also has determined that some streams in the watershed do not fully support their aquatic life use designation due to chemical impairment. On the 2006 Section 303(d) list of impaired streams, the entire length of Cherry River was listed for Iron (trout), and the North Fork of the Cherry River was listed for aluminum (trout). Seven tributaries of the North Fork were listed for pH, including Desert Branch, Windy Run, Armstrong Run, Rabbit run. Carpenter Run, Bear Run and Darnell run.

The Draft Total Maximum Daily Load document (June 2007) for the Gauley River Watershed indicated that low pH impairments were associated solely with acid precipitation and low watershed buffering capacity in the Windy Run, Armstrong Run and Carpenter Run watersheds of the Cherry River. For these problems, the TMDL approach captures the watershed dynamics associated with acidic atmospheric deposition and presents the net acidity reductions (and net alkalinity additions) necessary to achieve the pH water quality criteria.

The quality of much of the North Fork Cherry River is being improved by limestone sand additions within the North Fork watershed through the State's stream liming program. Limestone sand added to streams raises the pH and ANC, and adds calcium to improve water quality. According to Monongahela National Forest documentation, water quality and aquatic productivity are being improved in the North Fork, and to a lesser extent downstream in the Cherry River mainstem. [2]

The Cherry River and tributaries reportedly supports 29 species of fish. The majority of fish (21 species) are native species and eight species have been introduced into the watershed. Sport fish community information taken from Monongahela National Forest Fisheries database indicates native brook trout (*Salvelinus fontinalis*) can be found in North Fork Cherry River, Holcomb Run, Morris Creek and Buckheart Run. Electro Fish Surveys were conducted in June of 2005 in Morris Creek, Holcomb Run and Coal Siding Run, with brook trout being reported in all surveyed areas and all life stages. The North Fork of the Cherry also supports a stocked trout fishery (brown trout -*Salmo trutta* and rainbow trout - *Oncorhynchus mykiss*). Other fish species found in the Cherry River watershed include small and largemouth bass, rock bass, stoneroller, suckers, chubs, shiners, several dace species, creek chubsuckers, and Northern Hogsucker. Many of the species in the project study area (e.g. bass, sunfish, suckers, and minnows) are associated with warm to cool water habitats and primarily occur within the mainstem Cherry River. Other species (*e.g.* trout and dace) have a lower tolerance for warmer stream temperatures and are typically found in the smaller, coldwater tributary streams. Brook trout prefer streams with cold, clean water, a high riffle ratio and abundant cover. [3]

[2] Monongahela National Forest - Cherry River Watershed Assessment, 2002.
[3] Monongahela National Forest - Cherry River Watershed Assessment, 2002.

5.5 Geology and Soils

Elevations in the watershed range from about 1,900 feet at the junction of the Cherry River with the Gauley River, to about 4,500 feet near the head of Left Branch. The Monongahela National Forest Cherry River Watershed Assessment (2002), indicated that most of the watershed is underlain by Pennsylvania age bedrock systems. Smaller amounts of Upper Mississippian system bedrock (Mauch Chunk Group) occurs along portions of the North Fork Cherry River, and a few of its headwater tributaries such as Bear Run and Left Branch. The Pennsylvania age bedrock is typically low in calcium carbonate minerals that reduces the acid buffering capacity. These portions of the watershed characteristically have acid-forming rock and acid soils, which make streams slightly too strongly acidic. Primary erosion processes include surface erosion (sheet, rill, and gully) and landslides, which underlie 21 to 50 percent of the landscape. Soils over the Mauch Chunk formation are highly erodible and prone to mass movement. [4]

Two important coal seams in the watershed, Fire Creek and Sewell, have been extensively mined by both deep mining and surface mining methods[5]. There are approximately 3,100 acres or about 2.9 percent of the Cherry River watershed that has been strip mined for coal reserves[6].

Studies by the USFS for the Cherry River watershed identify excess sediment delivery to streams and sediment deposition as key issues, which is partly attributable to soils that commonly occur in riparian areas and have a high component of sand, and partly attributable to past road construction, timber harvesting and other land management practices. The NRCS has identified sediment accumulation as a problem, especially in the previously channelized reach of the Cherry River near Richwood.

Identified point sources of sediment in the area include permitted mining activities, permitted non-mining activities and storm water discharges from construction sites greater than 1 acre. Identified nonpoint sources include abandoned mine lands (AML), bond forfeiture sites, roads, oil and gas operations, timbering sites, agriculture, and urban/residential land disturbance.

Permitted discharges from mining activities are considered the most prevalent point sources throughout the watershed, where streambank erosion has been determined to be a significant nonpoint sediment source. The West Virginia Legislature passed the Logging Sediment Control Act in 1992, which requires the use of Best Management Practices to reduce sediment loads to nearby water bodies.[7]

[4] Monongahela National Forest - Cherry River Watershed Assessment, 2002.
[5] USDA Soil Conservation Service - Cherry River Watershed Preapplication Report, 1989.
[6] Monongahela National Forest - Cherry River Watershed Assessment, 2002.
[7] West Virginia Department of Environmental Protection – Total Maximum Daily Loads for Selected Streams in the Gauley River Watershed, WV Draft Report. June 2007.

While the USFS has identified sediment as an issue in the Cherry River watershed, sampling by the WVDEP did not indicate impaired habitat quality due to sediment. The WVDEP measures habitat quality using the EPA's Rapid Bio-assessment protocols. Of the 31 sites sampled in the watershed, 84% scored as optimal and the remaining 16% as suboptimal based on the average scores of all parameters. Additionally, sampling for sediment deposition showed 52% of sites scored at optimal, 32% as suboptimal, 16% as marginal, and none as poor. Consequently, even though sediment deposition occurs, stream habitat quality in the watershed remains unimpaired from sediment.

5.6 Terrestrial Resources

Typical plant communities in the Cherry River watershed are sugar maple, beech, sugar maple-beech, red oak, sugar maple-basswood, sugar maple – red oak, with cherry and tulip poplar prevalent as well. Red spruce forests are located at elevations greater than 3,800 feet, and at some lower elevations due to forest microclimatic conditions created by aspect, high mountain shading, and cold air drainage.[8]

The USFS's Cherry River Draft Environmental Assessment (2006) detailed that streams within the project area are generally low in large woody debris, which contributes to simplistic in-stream habitat conditions and some channel instability in portions of these streams. They are below their resource potential in this regard, due primarily to early 1900s (and to a lesser extent more recent) timber harvesting within riparian areas. Riparian areas along most of the smaller streams are in good condition and well forested, but are still too young to be fully functioning riparian systems.

According to the Cherry River Watershed Pre-application Report prepared by the USDA SCS (1989), land use in the watershed is naturally controlled by the topography. The majority of the watershed land is forested. A small percentage of the watershed, particularly the narrow valleys and flatter hillsides, is used for agricultural purposes, primarily for hay and pasture. Urban development, such as Richwood, along with major highways, have been confined almost entirely to the level flood plains.

The South Fork is a rugged, mountainous, sparsely populated section of the Cherry River watershed. Forested mountains and the boulder strewn stream make the area attractive; however, scattered mining and logging activities detract somewhat from the scenic qualities. The South Fork watershed is largely undeveloped, but there are several seasonal hunting and fishing camps scattered throughout. Primary access to the area is by a single lane, rocky, private logging road that closely follows the stream.

The South Fork is a put-and-take trout stream which WVDNR regularly stocks for about 9 miles above the mouth. According to DNR, trout cannot reproduce naturally in the stream because the fingerlings are eaten by the indigenous chubs and bass. The area is very popular with hunters and fishermen because of the forested surrounding and the attractive mountain stream.

[8] US Forest Service. Cherry River Watershed Assessment. Sept. 2002.

5.7 Threatened and Endangered Species

An “endangered” species is one that is threatened with extinction throughout all or a significant portion of its range, while a “threatened” species is one that is likely to become endangered within the near future. The USFWS lists federally threatened and endangered species. Table 2 shows five federally listed species that historically or potentially could inhabit the Cherry River basin. However, none are likely to occur within the Richwood area. The table also shows the corresponding State of West Virginia rank for each of the listed species. The State does not designate species as threatened or endangered at the state level. The West Virginia Non-game Wildlife and Natural Heritage Program, part of the WVDNR’s Wildlife Resources Section, tracks federally listed, proposed and candidate species as well as those rare on a state (S1, S2, etc.) or global basis using the methodologies employed nationally by the Natural Heritage Network.

The following are additional endangered and threatened species that are known to or potentially could occur in the Cherry River watershed and the Richwood study area.

- **Shale barren rock cress** - The shale barrens, where this rock cress grows, have soil which contains many hard, small shale fragments. The hillsides typically face the south or the east, so they get very hot during summer days. Shale barrens occur on Devonian-aged shale exclusively in the Valley and Ridge Geographic Province of the Allegheny Mountains. In West Virginia, five shale barrens where the rock cress grows have been partially destroyed by road construction, and a sixth was degraded

- **Virginia spiraea** - Virginia Spiraea is a shrub that primarily grows between forested slopes and the rocky shores of high-energy rivers. The factors that most affect the species are those that either eliminate its habitat altogether, or reduce the moderate level of flood-scouring it seems to require. Streamside habitat has been lost through reservoir construction such as Summersville Lake, which eliminated considerable habitat along the Gauley River. The perpetuation of this species will require streamside habitat with natural flood regimes.

- **Small whorled pogonia -** The principle threat to this species is the cutting of forest habitats and conversion of the landscape to other land uses, such as housing and business developments, and golf courses.

Table 2. Federally Threatened and Endangered Species

Common Name	Scientific Name	Federal Status	WV State Rank	Potential for Occurrence Within Project Area
Indiana bat	*Myotis sodalis*	LE	S1	Caves are important for the Indiana myotis, and during the winter, large numbers of Indiana myotis gather in a few caves which provide suitable conditions for hibernation. Indiana myotis are more sensitive to disturbance than most other bats, and each time the bats awaken during the winter, valuable fat reserves are used up, which could affect their survival.
Running buffalo clover	*Trifolium stoloniferum*	LE	S2	Running buffalo clover is most frequently found in habitats with filtered sunlight that have had some kind of recent disturbance. In West Virginia running buffalo clover has been found on jeep trails, old logging roads, skid roads, and wooded thickets. The greatest threats to this species appear to be major disturbances, such as road construction, that completely destroy the clover's habitat, and the slow maturation of the habitat through succession.
Virginia northern flying squirrel	*Glaucomys sabrinus fuscus*	LE	S2	The northern flying squirrel is typically found in boreal habitats, especially spruce/fir/hemlock and northern hardwood forests. In West Virginia, this squirrel is usually associated with red spruce and northern hardwoods such as sugar maple, black cherry, American beech, black birch, and yellow birch. The main threat to this animal is loss of habitat (high elevation red spruce forest). Most of the known locations of this squirrel are within the Monongahela National Forest.
Bald eagle	*Haliaeetus leucocephalus*	LT	S2B, S2N	The WV Breeding Bird Atlas (Buckelew et al, 1994) has no observations and no confirmed breeding of bald eagles in Cherry River watershed.
Cheat mountain salamander	*Plethodon nettingi*	LT	S2	Threats to the Cheat Mountain Salamander include the degradation of high-elevation red spruce and spruce/northern hardwood forests, and would not likely occur on the Cherry River or its main tributaries.

Federal Status: **WV State Rank:**
LE = Federally listed endangered **S1 = extremely rare/critically imperiled in WV** **B = Breeding populations in WV**
LT = Federally listed threatened **S2 = very rare/imperiled in WV** **N = non-breeding populations in WV**
SC = Federal species of concern **S3 – somewhat vulnerable to extinction in WV**
NR = no WV rank reported

Sources: USFWS 2001a, WVDNR 2001a

6.0 Identified Problems, Needs and Public Concerns

Water resource problems, needs, opportunities and public concerns have been identified in this reconnaissance study through a number of methods and techniques. Field investigations and documentation in published reports have provided an overview of existing conditions as well as background information. Numerous meetings with State and local representatives were held to discuss the water resource problems and gather information on issues that might warrant Federal involvement. Input from the public was obtained through workshops and from various groups and organizations that are focused on specific needs and concerns in the watershed. The following paragraphs summarize the problem, needs, and concerns that form the basis for this reconnaissance investigation.

6.1 Floods and flooding problems.

Flooding is the primary water resource problem for the Cherry River watershed, including mainly the City of Richwood and community of Fenwick. Flooding conditions are worst during major storm events when the mainstem Cherry River overflows its banks and inundates portions of Richwood and Fenwick. Precipitation at Richwood average about 53 inches annually, but the upper and higher portion of the tributary sub-basin may exceed 60 inches per year. Intense summer storms which produce flooding are common, as well as maritime tropical air masses that move through the watershed from the south-east. The mainstem Cherry River below Richwood has a rather low gradient, but the North Fork and South Fork tributaries have their sources in rugged, mountainous areas and the upper reaches of these streams have steep gradients. Consequently, major storms over these sub-basins result is rapid stream flows which provide little warning times to the Richwood and Fenwick areas. Damaging floods have occurred many times in the Richwood area over the last 50 years and as a recent as November 2005. The following paragraphs summarize some of the more recent major floods in the Cherry River watershed, and the flood damages that occurred during these events. Figure 4 shows photographs taken during the 1932 flood, even though details from that flood are not available.

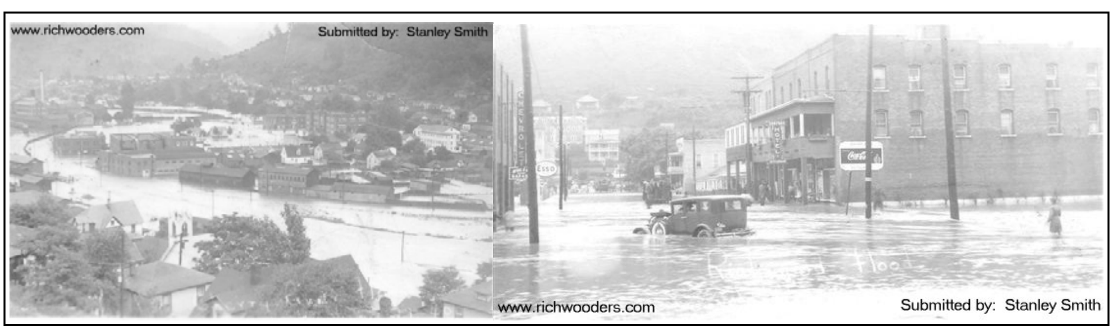


Figure 4. 1932 Flood in Richwood, WV

July 1954. This flood is considered to be the flood of record at Richwood and for most reaches of the Cherry River. Reportedly, over 100 homes and 13 businesses in Richwood were badly damaged and at least 15 homes were totally destroyed. Some structures were inundated up to eight feet deep. Several public facilities, including two hospitals and one school, were damaged, along with three highway bridges, one railroad bridge, and most of the public utilities. At Fenwick, located downstream from Richwood, there were seven homes destroyed and a lumber company badly damaged. Total damages to the Richwood-Fenwick area were estimated to be $3 million (1954 Price Level). Figure 5 below shows flood photographs in Richwood during the 1954 flood, sometimes referred to by residents as the “flood of the century” at the time it occurred.

Figure 5. 1954 Flood in Downtown Richwood

July 1979. This flood damaged 10-15 homes in the Johnstown area of Richwood. Public facilities that were damaged include the City Park and the sewage collection system. Total damage was estimated to be $100,000 (1979 Price Level).

November 1985. This flood was a result of remnants of Hurricane Hugo which devastated much of the watershed just east of the Cherry River basin. City officials reported that there was considerable damage to City property, including the water supply and sewage treatment facilities and city bridges and streets. No data is available for residential and commercial damages. The city property flood damages were estimated to be $50,000 (1985 price level).

November 2003. Richwood was inundated by severe flooding twice during November 2003, due in part to a major storm that occurred throughout central and southern West Virginia and as a result of the wettest November on record for that area. The flooding occurred on November 11^{th} and November 19^{th}. The November 19^{th} flood is considered the second highest on record along the Cherry River at Richwood. Reportedly, 370 residences and 25 businesses were damaged, as well as two schools and the community hospital. Most of the commercial damages occurred in the downtown area between Main Street and the Cherry River and from Commercial Street east to the lumber storage yard. Most residential damages occurred in the area south of the Cherry River between the City Park and the Pratt ball field. Two funeral homes were closed for several days and a center for housing senior citizens had to be evacuated. Damages from the flood were estimated to more than $2 million (2003 price level). Figures 6 and 7 show photographs taken during the flood. *Note the photo in Figure 6 shows the same view as seen in the right half of Figure 4.*

Figure 6. Oakford Avenue during November 2003 flood in Richwood, WV

Figure 7. Hospital Located Just West of Downtown.

November 2005. The most recent flooding in Richwood occurred in November 2005. Damage to structures was relatively minor, but the Cherry River did overflow its banks and inundated several areas in town. Total damage was estimated to be less than $20,000 (2005 price level).

6.2 Environmental Impairments

Review of existing documentation and coordination with resource agencies was used to determine the environmental impairments in the Cherry River watershed.

A. Water quality impairment due to acid mine drainage on the Cherry River and North Fork of the Cherry River. The entire length of the Cherry River has been identified by the WVDEP as impaired from Iron, and the North Fork of the Cherry River has been identified as impaired for excess Aluminum. Where low pH is paired with excess metals, the resulting impairment is generally related to acid mine drainage. Stream restoration opportunities include remediation of abandoned mine drainage and improving the buffering capacity of streams.

   According to the US Forest Service Cherry River Watershed Assessment, mining in the North Fork watershed primarily occurs along Hamrick Run and in the upper part of Bear Run. The Forest Service reports that the only known AMD of any significance is in Bear Run, and the volume is not great (15 to 87 gallons per minute, measured twice). There are four mine locations associated with the Bear Run Mines. Acidic water discharge from these mines ranges from a pH of 3.6 to 3.8. The WVDNR currently treats the stream in two locations using limestone fines.

B. Water quality impairment due to acid deposition and naturally low buffering capacity on Windy, Carpenter and Armstrong Runs, and potentially Desert Branch, Rabbit Run, Bear Run and Darnell Run. The June 2007 Draft Total Maximum Daily Load Document for the Gauley River Watershed determined that the low pH impairments were associated solely with acid precipitation and low watershed buffering capacity in the Windy Run, Armstrong Run and Carpenter Run watersheds. Opportunities to restore the quality of these streams would revolve around limiting acid deposition.

   The US Forest Service Cherry River Watershed Assessment details that acid deposition, and to a lesser extent acid mine discharge, have resulted in streams with pH levels lower than what would be expected naturally, especially in the eastern half of the watershed. Many of these streams can no longer support fish or their productive potential has been reduced due to the acidic conditions. To mitigate the influence of acid deposition, streams in the North Fork Cherry and South Fork Cherry River sub watersheds are treated with limestone sand to neutralize the water and raise the pH level. The streams on NFS lands that receive limestone sand include Left Branch, Bear Run, Hamrick Run, Rabbit Run, Coats Run (above Summit Lake), Hacking Run and the North Fork Cherry River main stem.

C. Sediment and Erosion – Excess stream sediment and erosion have been identified by several sources in the Cherry River Watershed. However, a review of WV Department of Environmental Protection habitat assessment data reveal that the aquatic habitat of the Cherry River watershed does not indicate an impairment resulting from sediment deposition, and no streams in the Cherry River watershed are listed by the state as impaired due to sediment.

   Potential sources of sediment and erosion include permitted mining activities, permitted non-mining activities and storm water discharges from construction sites greater than 1 acre. Nonpoint sources include abandoned mine lands, bond forfeiture sites, roads, oil and gas operations, timbering, agriculture, and urban/residential land disturbance. Opportunities to reduce sediment and erosion could include improved enforcement for construction and resource extraction including mining, oil and gas and timber operations. Sediment from agriculture could be reduced through education and projects to reduce sediment delivery to streams.

   The US Forest Service Cherry River Watershed Assessment states that all sub watersheds within the Forest are impacted by sediment. Both natural conditions as well as past and present land use were identified as potential sources of sediment. Some sediment conditions are a result of natural conditions such as soil and geology type, topography and channel characteristics. The streams in the western portion of the watershed characteristically are dominated by the Buchanan soil type that occupies nearly all of the lower slopes, riparian areas and stream banks. The Buchanan soil is high in sand, and most of these streams are very high in sand sized fine sediment.

D. Channel Alteration on the Cherry River – Approximately 2.5 miles of the Cherry River that flows through the Richwood area was part of a snagging and clearing project completed in the 1950's. This area is not designated as impaired, but does show some of the lowest habitat quality scores in the watershed according to WV Department of Environmental Protection sampling data, and is reported to have excess sediment deposition by the Natural Resource Conservation Service. While the stream could potentially benefit from restoration, efforts would be limited due to the confined nature of the corridor through the Richwood urban area.

6.3 Water Supply Needs

Richwood presently obtains water from a shallow impoundment on the North Fork of the Cherry River just upstream of town. Raw water goes to the treatment plant before distribution. This source generally is sufficient except for a few months in a particularly dry summer such as during the drought of 1988 and recently in the summer of 2007. The NRCS in the study prepared in 1989 estimated Richwood's future water needs to be 1.6 million-gallons-per-day (MGD). This projected need would require augmenting natural flows a maximum of four months in a dry year. Presently it is uncertain as to what the projected water supply needs for Richwood and other communities downstream would be because of population losses and decline in some businesses. Local officials indicate that water is in short supply, and lines cannot be extended to new customers. As a result, some residents must haul water at a great expense, and commerce has been restricted.

6.4 Recreation Needs

Richwood area residents have expressed a desire for additional recreation facilities in the Cherry River basin. They envision a multipurpose reservoir on the South Fork as providing a large lake for boating and fishing as well as augmenting downstream flows perhaps for kayaking and whitewater rafting in the summer, and an area for cross-country skiing and snowshoeing in the winter. Summit Lake on the North Fork just east of Richwood provides for boating and fishing on a 43 acre lake. It has a boat ramp, fishing piers and a campground. Local users would like to see additional facilities and improved access at Summit Lake. Figure 8 shows the environment of Summit Lake. Summersville Lake is just 25 miles west of Richwood on the Gauley River and can be accessed by WV 39 and US 19. This major Corps reservoir has a 2,700 acre lake, campgrounds, fishing access, water-skiing, boating ramps, marina, and provides for some of the best whitewater rafting in the eastern United States by special reservoir releases in the fall. The NRCS concluded in their study in 1989 that available lake fishing exceeded the demand (need) for the activity. However, there may be needs for additional in-stream fishing on the South Fork as data indicates that the North Fork has some acid mine drainage problems.

Figure 8. Summit Lake

6.5 Infrastructure needs

Infrastructure problems and needs in the Richwood area are generally associated with undependable water supply, combined sewers and storm water overflows, deteriorating sewers and septic tanks, and streets and other public facilities which are frequently flooded. The water supplies source for Richwood is a low-head impoundment on the North Fork just upstream from town. This impoundment is not adequate or reliable in dry years, and is frequently damaged during floods. During storm events, the combined sanitary and storm sewers overflow, and the potential for contamination threatens human health in the area. Much of the sewer system and the septic tanks are aged and deteriorating and are in need of replacement. Many significant institutional structures in the downtown area, including two schools, municipal buildings, along with the city streets and bridges are frequently flooded, which not only causes safety and access problems, but results in increased cost to the city and county governments for maintenance and repair of damaged property.

6.6 Economic Development

Richwood was the economic center of Nicholas County in the mid-1900's, with an economy driven by coal mining and the lumber industry. Most coal mines have closed and the hardwood lumber industry has declined, resulting in an economic downturn in Richwood and nearby communities. Most businesses in Richwood today either provide basic economic necessities or are specialty stores or outfitters which cater to recreationists. Richwood seems ideally located as a recreation center between Summersville Lake with boating, fishing and rafting to the west, and the Cherry and Cranberry Rivers with trout fishing to the east.

Local leaders consider Richwood as the getaway to the Cranberry backcountry and the National Forest for travelers coming from the populated areas to the west. They envision a multi-purpose reservoir on the South Fork as providing the necessary stimulus for the local economy. They are convinced that the continued risk of flooding and an unreliable water supply are the two main obstacles to economic growth in Richwood. A reservoir on the South Fork they believe would address both problems – control major floods along the Cherry River mainstem and provide a permanent, dependable impoundment as a source of water supply. Recreational opportunities associated with a multi-purpose reservoir, such as boating, fishing and kayaking in the summer, and skiing in the winter would have both direct and indirect impacts on the local economy. Recreationists would purchase or rent equipment from local outfitters, and would patronize local stores, restaurants and gas stations. Local officials believe that a South Fork Lake with diverse recreation facilities would encourage tourists to consider the Richwood area as a recreation destination rather than merely a supply or refueling stop on the way to other parts of the region.

6.7 Expected Future Conditions

The future without condition is defined as the most likely condition expected to exist in the future without any flood risk management measures or any other water resource projects in the Cherry River watershed. Flood problems would continue at Richwood with no sharing of common goals or no coordinated State and Federal actions to reduce or eliminate the threat of flooding. Abandonment of floodplain properties would continue due to uninsured damages from future flooding, the increasing flood risk, and the rising cost of flood insurance. Aging infrastructure would continue to degrade due to persistent flooding and the lack of repair and reinvestment because of a shrinking tax base.

The problems of an undependable water supply would persist as Richwood must continue to rely on a low head impoundment on the Cherry River as the primary source of water. Richwood's economic base has declined since the mid-1900s, and flood problems and lack of dependable water supply are the two main reasons, and these conditions will continue. The recent growth in Nicholas County has been near the Summersville Lake and along US 19, and unless there is some major economic stimulus near Richwood, this condition will likely continue.

7.0 Plan Formulation

7.1 Planning Objectives

The water and related land resource problems and opportunities previously described in this report are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems, needs and opportunities and represent desired positive changes in the with project conditions. The planning objectives, which would be accomplished over a 50-year period of analysis, are identified as follows:

- Promote harmonious partnerships with other Federal, state, local agencies and groups, and the general public to mutually achieve basin wide study objectives;

- Provide for the comprehensive restoration of aquatic ecosystems of the Cherry River Basin;

- Provide risk-based beneficial flood damage reduction projects, which are acceptable to the local public and include habitat protection, wetland preservation, or ecosystem restoration components that enhance and preserve natural stream characteristics as much as possible;

- Provide reliable recreational opportunities within the Cherry River Basin, which will increase the quality of life and stimulate the economy;

- Conduct comprehensive watershed planning on fish spawning and feeding, water quality, and sediment accretion and movement;

- Promote projects that will provide wetland and other ecosystem restoration benefits;

- Investigate measures that will reduce sediment and contaminant runoff into the Cherry River and tributaries;

- Investigate and evaluate water resource measures that will stimulate economic development within the Cherry River Basin;

- Investigate measures for ecosystem restoration within the Cherry River Watershed; and

- Promote land use practices to sustain the Cherry River Watershed.

7.2 Planning Constraints

Planning Constraints unlike planning objectives that represent desired positive changes, represent regulations and restrictions that should not be violated. The planning constraints identified for this study are as follows:

- *Principles and Guidelines* and all Corps of Engineers regulations and applicable federal laws and executive orders (i.e. Endangered Species Act, Wetlands Protection Act, Archeological Resources Protection Act, Clean Air Act, Clean Water Act, National Environmental Policy Act, National Historic Preservation Act);

- All applicable state laws and policies;

- Existence of Federal lands in the North Fork watershed under the jurisdiction of the National Forest Service;

- Formulating watershed management alternatives in habitat areas of Threatened and Endangered species;

- Economic conditions within communities and counties that might limit their ability to act as local sponsors and/or provide for operation and maintenance of any recommended project.

7.3 Alternative Measures and Concepts Considered

A management measure is a feature or activity at a particular location, which addresses one or more of the defined objectives. A variety of management measures and associated concepts have been considered and preliminarily assessed for their feasibility and ability to implement. Determinations have to be made regarding whether a particular measure should be retained in the formulation of alternative plans. To select alternative courses of action at this time, the entire watershed was considered in devising and assessing conceptual plans to reduce the flood risk, provide public safety and restore the Cherry River Basin.

The quality of life in the Cherry River Basin is, in part, a direct reflection of the environmental quality of its watershed. Improvement measures that generate the most interest are those measures that can be formulated into mutually acceptable plans and that alleviate the water resources problems described earlier in this reconnaissance report. These problems taken separately require specific solutions whose influences and effects on the basin as a whole may not be effective. Simply put, localized plans, devised in isolation, may not be effective in successfully meeting the national and watershed planning objectives previously discussed in this report. Hence, the task of formulating concepts for watershed improvement at this stage requires full integration of the individual concepts that would address these specific problems while simultaneously contributing to other areas of impairments and to the quality of life of the basin residents as a whole. These individual concepts would address problems in the areas of flood damage reduction, water quality, fish and wildlife habitat restoration, pollution source reduction, biological well being of the Cherry River, reduction of soil erosion and sedimentation, wetland restoration, economic development and recreational opportunities.

This reconnaissance analysis encompasses the formulation of conceptual plans, including the "No-Action" alternative, that effectively address the problems and needs previously described paragraphs in the interest of both the federal government and non-Federal sponsors. The following are specific management measures which could be implemented to achieve the planning objective:

- **Reservoirs on the North and South Forks**. Reservoir or watershed impoundments have previously been investigated at several locations on the South Fork. During studies in the 1970's under the Kanawha River Comprehensive authority, the Corps evaluated a dam site at mile 1.2, just upstream from the junction with the North Fork. In 1989, the NRCS investigated several plans for a reservoir at mile 6.2 on the South Fork. The NRCS plans included a single-purpose flood control dam, and multi-purpose reservoirs that included combinations of water supply storage, flow augmentation, and various size recreation lakes. The lower site at mile 1.2 evaluated by the Corps would provide greater flood control storage and produce greater flood damage reduction benefits at Richwood and communities further downstream, but would inundate an additional 5 miles of the South Fork channel. The NRCS site at mile 6.2 appears to be the best location for a dam from a physical standpoint, with steeper rock abutments requiring a smaller footprint for the dam, thus reducing cost, but would have less storage and a smaller recreation lake than at mile 1.2. Reservoirs (dams with a permanent pool behind them) as well as dry dams (dams which do not have a permanent pool behind them) will be investigated for both the North Fork and South Fork.

- **Levees and Floodwalls**. Levees have been investigated at Richwood in the past, but were determined not to be feasible because of the length of the levee/floodwalls required and the location of some structures which might have to be removed to accommodate the project. Based on recent field investigations and available mapping, there are two areas which could be protected from major flooding by levee/floodwalls. One area is near the primary business district between Main Street and Cherry River, and from Commercial Street east to the juncture of the North and South Forks. This area contains a number of businesses including the Cherry River Plaza (Dollar General, Foodland, Rite Aid, etc.), Go Mart, and Highland Corp, plus two large schools (Richwood High and Middle School), a drive-in bank and the empty Cherry Valley Furniture building. Also, several residences which are located in the area between Oakford Ave, Railroad Ave and Valley Ave have been flooded. A levee/floodwall combination to protect this area would extend from just east of the football stadium, downstream along the river, crossing Oakford Ave and tying to high ground near the old Cherry Valley Furniture building. Figure 9 shows the 100-year floodplain for downtown Richwood as described above.

A second area that could be protected is on the south side of the Cherry River extending from the City Park downstream beyond the Pratt Athletic Field. A levee/floodwall could originate at high ground near the City Park, extend around the city pool, downstream along the river bank past Pratt Field to high ground at Bridge Street. This levee/floodwall alignment would provide protection for the City Pool, National Guard Armory, Richwood Hospital, Senior Citizens Center, and at least 60 residences. These potential levee projects will be further evaluated during the feasibility phase. Figure 10 shows the 100-year floodplain for the area described previously.

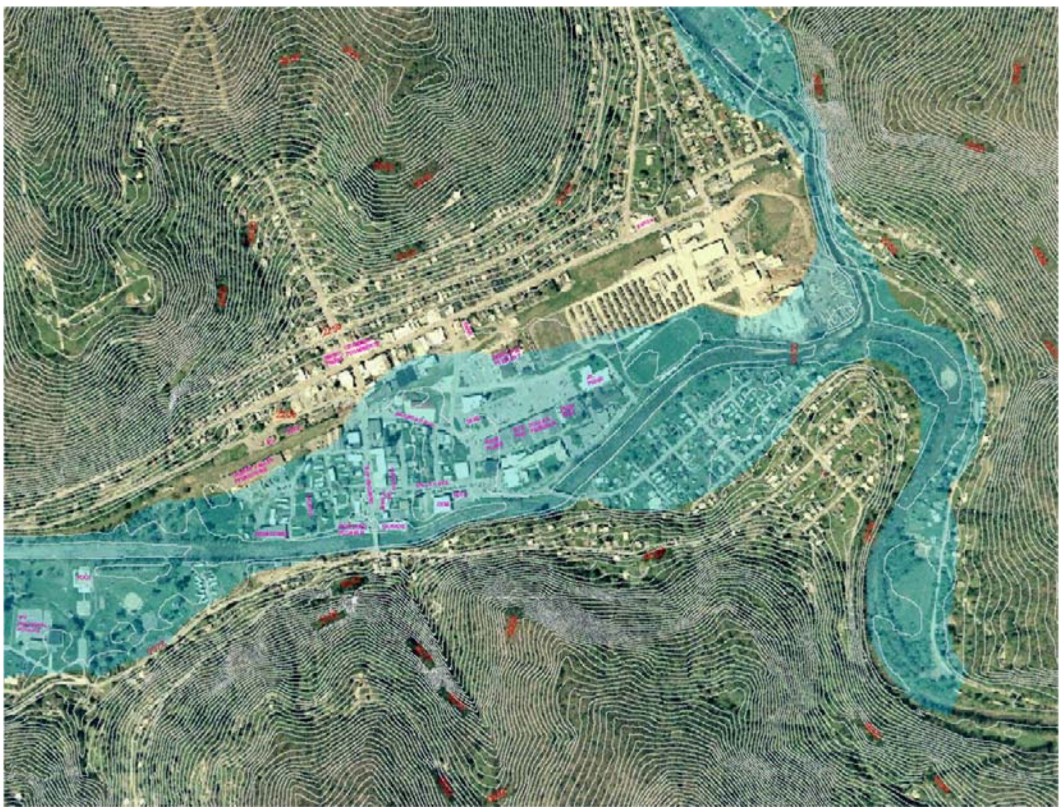


Figure 9. 100-Year Floodplain at Richwood, WV

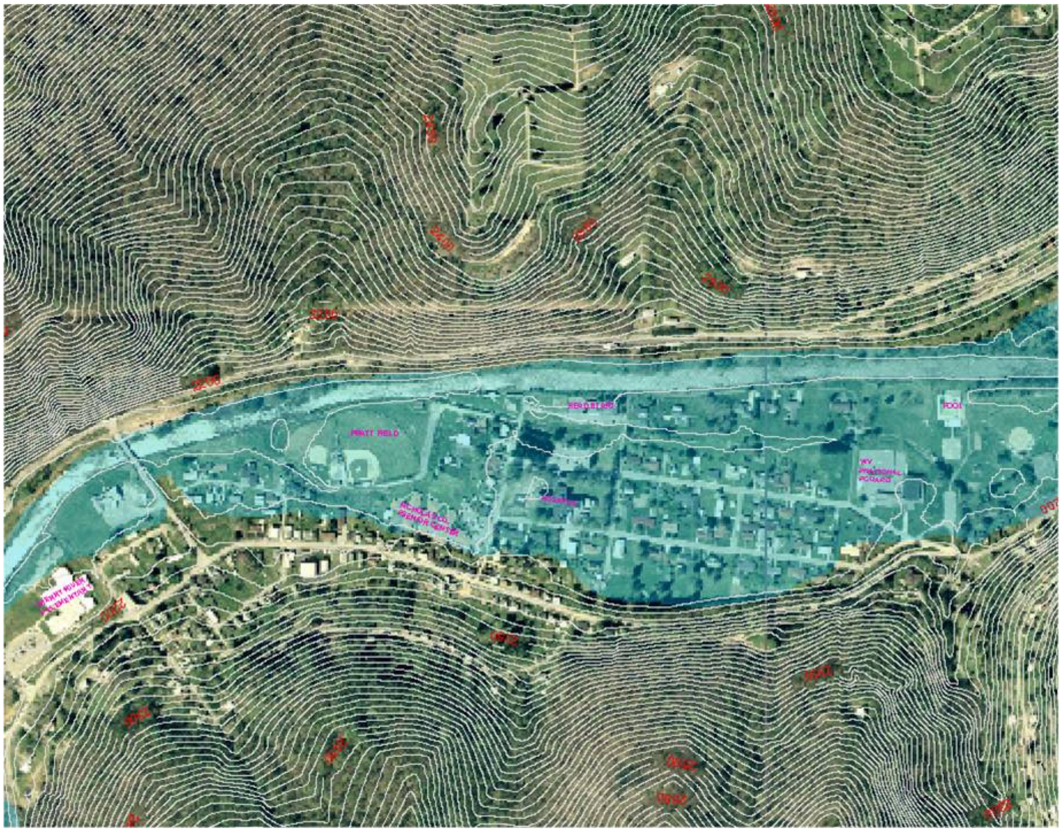


Figure 10. 100-Year Floodplain along Cherry River at Richwood, WV.

- **<u>Channelization</u>**. A snagging and clearing project was completed by the Corps at Richwood in 1954. That project extended along the Cherry River from the junction of the North and South Forks, downstream 2.5 miles, to the location of the sewage treatment plant. In 1974, the Corps evaluated a channel widening project on the Cherry River under the Section 205, Small Flood Control Projects Authority. This project would have a 100-ft wide channel extending an additional 2.5 miles downstream from the existing 1954 project to just below Fenwick. The Corps determined that the cost of the project would exceed the resulting flood damage reduction benefits, consequently the study was terminated. The channel alternative will be re-evaluated during the feasibility phase to determine if any conditions have changed which might result in a feasible channel improvement plan, including the cost of channel widening and benefits that would result based on current development and annual flood damages

- **<u>Nonstructural Measures</u>**. Nonstructural measures are those activities or management actions that modify or remove land uses where overbank flooding results in significant damages to structures or facilities. These measures can include permanent acquisition, floodproofing (wet or dry), floodplain management and zoning, land use zoning, building code enforcement, and flood warning and emergency evacuation. For developed areas that cannot be protected by structural means, nonstructural measures may be suitable. Both Richwood and Fenwick currently participate in the National Flood Insurance Program (NFIP) and have active enforcement of floodplain management ordinances for the mapped areas of the respective municipal areas. Likewise, each of the four counties included within the watershed boundary participate in the NFIP as well. Unfortunately, numerous structures in the areas subject to flooding were “grandfathered” into the NFIP at the time of the enactment of the ordinances and those structures remain at risk from flooding.

Measures such as land use zoning and permanent acquisition have in the past been considered infeasible or unacceptable by local interests. No formal building codes are currently enforced within the municipal or county areas of the watershed. However, the voluntary acquisition of frequently flooded structures or the elevation of structurally sound buildings (floodproofing), such as has been done on small scale project with the FEMA Hazard Mitigation Grant Program (HMGP) or on a large scale as the Huntington District has done in the Tug Fork Valley, may be a viable option if structural measures are not economically feasible. Following the November 2003 flood event, several homes were acquired through the HMGP in conjunction with the Natural Disaster declaration.

Relocation of the entire town or floodproofing large structures may not be feasible or practicable; however, programs for raising structures have been successful in the Tug Fork Valley. The area along the right descending bank of the South Fork and the main Cherry River could be addressed by relocation and acquisition. Many of the homes in this area are located in the floodway and once these homes were acquired and the structures removed, this land would be restricted from any future building and would eventually return to a more natural condition.

A Flood Warning System (FWS) for Richwood and vicinity is now being addressed in the Statewide Plan, which is a comprehensive statewide initiative to upgrade existing rainfall and stream gages, and install new gages and equipment in areas that are deemed deficient. The goal of the program will be to utilize technological advances to maximize the warning time for citizens of the state in order to reduce flood risk and potential loss of life during storm events. The warning system for he Cherry River could be accomplished under Section 205 of the Corps Continuing Authorities Program (CAP) with the West Virginia Office of Homeland Security as the local sponsor. It is anticipated that this work could be done and new equipment in place by FY 2012.

- **Ecosystem Restoration**. Problems and opportunities relating to ecosystem restoration have been identified using existing information from the USFS, NRCS, and the WVDEP, and from site visits to the watershed. There is authority for the Corps to address ecosystem restoration in the Cherry River Watershed. While opportunities for improvement exist, some measures may provide only limited net benefits given the general high quality of the Cherry River, particularly the North and South Forks.

Measures to address impairment or degradation of the aquatic habitat could include treating acid mine drainage from abandoned mine lands and/or direct treatment of stream waters to reduce acidity in the Cherry River and North Fork of the Cherry River. These measures could be implemented under the Corps' ecosystem restoration authorities. This condition also falls under the authority of the Federal Office of Surface Mining, and could be addressed by the Abandoned Mine Land (AML) program administered by the WVDEP.

Other measures to address stream degradation from acid deposition include limiting pollution sources and direct treatment in affected streams that include Desert Branch, Windy Run, Armstrong Run, Rabbit Run, Carpenter Run, Bear Run and Darnell Run. Efforts to limit emissions from electric utility and industry sources required by the 1990 Clean Air Act (as amended) should reduce sulfur dioxide emissions and therefore acid deposition over time. These issues of air and water pollution fall within the scope of the US Environmental Protection Agency (USEPA) and WVDEP.

While excess sediment deposition may be evident and impacts some areas of the watershed, WVDEP habitat quality data does not indicate a level of impact that impairs the aquatic ecosystem in the basin, and no streams in the watershed are listed as impaired due to sediment. Additionally, net improvements in stream or habitat quality would likely be minimal given the general high quality of streams in the Cherry River watershed. Measures to reduce sediment delivery to streams include a reduction in conversion of forested lands to other land uses, and implementation of Best Management Practices for resource extraction and road construction. The issue of sediment delivery to streams falls within the authority of the USDA, NRCS, USFS, WVDEP, WV Division of Forestry, and the WV Conservation Agency (WVCA).

- **Water Supply Options**. Previous studies have identified water needs for the Richwood area during periods of low flow. The City now relies on a low head impoundment (weir) on the North Fork of the Cherry River just upstream from the city limits. A multi-purpose reservoir on the South Fork, which has been proposed by local leaders, could include water supply storage, which would provide a dependable water source throughout the year. A single purpose water supply impoundment also could be constructed on the South Fork, and an even less costly option would be a small impoundment on Little Laurel Creek, which enters the mainstem Cherry River just downstream of Richwood near La Frank. These water supply options will be investigated further in the feasibility phase.

- **Recreation Facilities.** The Cherry River Basin and the surrounding region offer a multitude of recreation opportunities. Although Summit Lake provides the only lake fishing and boating in the Cherry River watershed, nearby Summersville Lake offers all the recreation facilities generally associated with a large, multi-purpose reservoir. A smaller multi-purpose reservoir on the South Fork could provide additional lake boating and fishing within the watershed, all in close proximity to Richwood and the National Forest's Cranberry Glades and backcountry natural areas. Releases from a reservoir could allow some rafting and kayaking on the South Fork and the mainstem Cherry River below Richwood. A multi-purpose lake on the South Fork would not only provide many recreational opportunities for tourists and travelers, but could provide considerable indirect benefits to the local economy. Additionally recreation features could be incorporated into other alternatives; i.e. trails along floodwalls or atop levees, fishing access points and handicap access (piers) along streams, or park areas in vacated floodplain lands. Recreation features are generally cost shared 50% by the local sponsor. A recreation needs analysis would help to determine the best course of action when considering recreation facilities for the watershed.

- **Environmental Infrastructure**. Much of the infrastructure in the Richwood area is outdated and deteriorating, as previously discussed in this report. Problems with water supply are described previously, but there also are problems with the sewer and waste water treatment facilities which frequently flood. The Water Resources Development Act (WRDA) of 1992 provides the Corps authority to assist in the design and construction of water related environmental infrastructure facilities in Southern West Virginia which includes Nicholas and Greenbrier Counties. The Corps in cooperation with the WV Infrastructure and Jobs Development Council (WVIJDC) and a local sponsor can provide funding assistance to design and construct needed infrastructure facilities in the Cherry River watershed. This program and potential infrastructure projects in Richwood and nearby areas will be further explored in the feasibility phase.

8.0 ALTERNATIVE PLANS INVESTIGATED

This section discusses the alternative plans that have been investigated during the reconnaissance study to help reduce the risk of flooding and address other water resource problems and needs in the Cherry River watershed. Some alternatives deal directly with the City of Richwood while others address basin-wide problems and include both structural and nonstructural solutions. Each alternative dealing with flood risk is designed to provide protection against the 1% chance storm (100-yr flood) using the Base Flood Elevation (BFE) shown on the FEMA floodplain maps. Other levels of protection are possible in some areas of the watershed; however, since both of the counties and communities are already in the NFIP which requires the BFE minimum level of protection, the 100-year flood has been used for analysis purposes. The investigations described in this section are preliminary and based on available information without the benefit of detailed mapping. More detailed information on the evaluated alternative plans, including preliminary design and cost estimates, are provided in Appendix A.

8.1 Reservoirs on the North and South Forks

Reservoir sites have been located and evaluated for effectiveness in reducing flood damages in the Cherry River watershed. Typical dam sites have been identified on both the North Fork and South Fork, and have been evaluated based on consideration of topography and maximum storage retention capacity for the 100-year storm. Both reservoirs (with permanent pools) and dry dams (no pools) have been evaluated on the North and South Forks of the Cherry River in order to provide maximum flood damage reduction for Richwood, located at the confluence of the North and South Forks. Figure 11 shows the location of the typical dam sites which have been investigated during the reconnaissance phase.

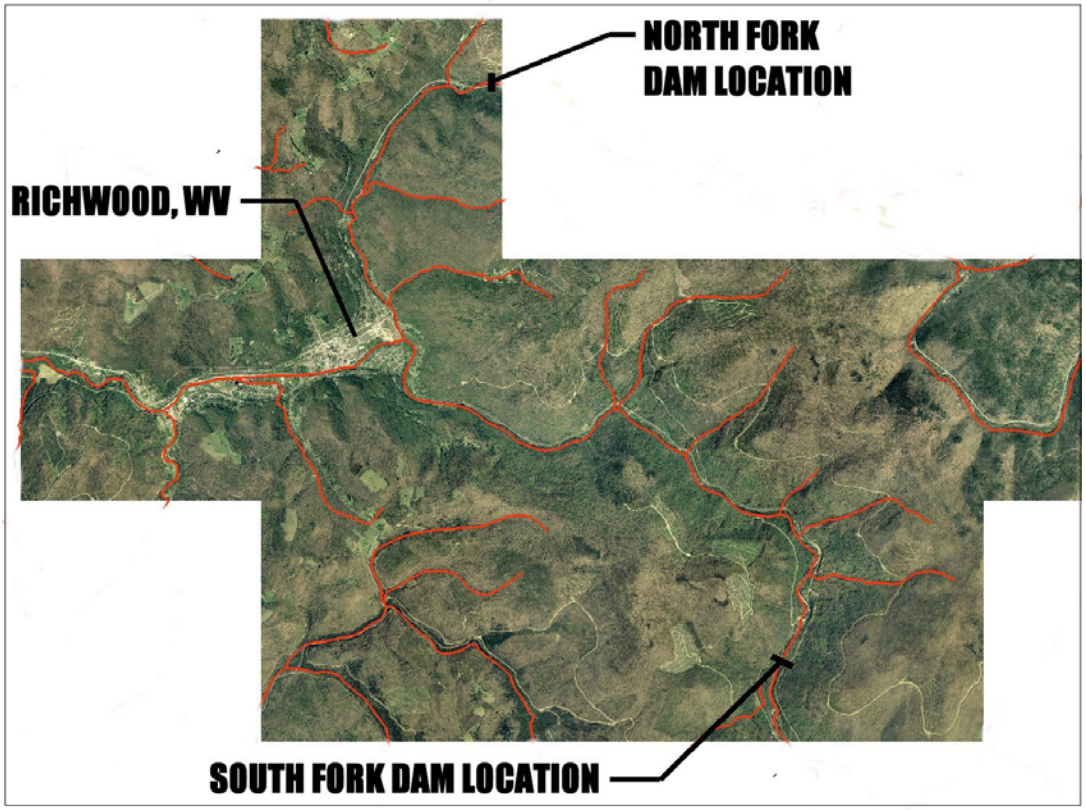


Figure 11. Locations of Dam Sites.

- **South Fork Reservoir.** During studies in the 1970's by the Corps and in the late 1980's by the NRCS (then SCS), two reservoir sites were identified. The Corps investigated a site at RM 1.2 during the Kanawha River Comprehensive Studies in the 1970's, and the SCS selected a site at RM 6.2 as the best location for a dam and reservoir. For this reconnaissance investigation, the site at RM 6.2 has been evaluated as providing the best overall location for a reservoir. The project would include a rock fill dam with clay core over 100 feet high and 1,000 feet in length, with other features such as outlet works, spillway and operation facilities. Most of the dam would be constructed of rock fill excavated within a 5-mile radius of the dam site, including material from the spillway cut. The core of the dam would be constructed of impervious clay fill. Construction of the dam would require the relocation of about 2 miles of Johnstown Road, a secondary gravel road extending along the stream. This project would provide for flood reduction at Richwood, and along the mainstem Cherry River, would have a permanent summer pool (lake) for recreation use, and could include lake storage for water supply needs. More details for this alternative plan are provided in Appendix A.

- **<u>South Fork Dry Dam</u>.** This alternative would include a rock filled dam constructed at RM 6.2, the same location as the South Fork reservoir. The size, project features and construction techniques would be the same as for the reservoir. This project would have the same flood control storage, which would provide significant flood level reduction at Richwood. However, this alternative would have no permanent pool, which means no lake for recreation use in the summer and no storage for water supply or stream flow augmentation. It would be a single-purpose flood control dam and all project benefits would accrue from flood damage reduction along the South Fork and mainstem Cherry River. More details for alternatives are provided in Appendix A.

- **<u>North Fork Dry Dam.</u>** This alternative entails constructing a dam on the North Fork of the Cherry River about three miles upstream from Richwood. The project would not have a permanent pool, therefore, it is described as a dry dam. The dam would be more than 100 feet high and approximately 650 feet long. The dam structure would be rock-filled with a clay core, and other project features would include the outlet works, spillway and operations buildings. Construction of the project would require the relocation of 4 miles of WV 39 which extends along the North Fork. The project would provide flood damage reduction at Richwood and along the mainstem Cherry River. There would be no permanent pool, therefore, no recreation lake or water supply storage. All project benefits would accrue from the reduction of flood risk at Richwood and Fenwick. More data on this alternative is provided in Appendix A.

8.2 Levees and Floodwalls

Levees and floodwalls provide barriers that prevent flood water from reaching damageable property or larger communities such as Richwood. Earthen levees are less costly than concrete walls, and where construction areas permit, they are the first consideration. However, where homes and other structures are located near the streams, floodwalls minimized the space required and the number of structures that would need to be removed. During feasibility studies both types of barriers will be investigated.

- **<u>Upstream Levee/Floodwall.</u>** This alternative entails placing a combination of floodwall and levees along the right bank of the Cherry River in downtown Richwood. The project begins at high ground east of the Richwood High School athletic field and follows along the Cherry River past the High School and the Oakland Avenue bridge to high ground just west of Commercial Avenue. Most of the protection works would be concrete floodwalls, because of the numerous public and commercial structures located near the river. The length of the project would be about 4,500 feet, with two vehicular gate closures (Oakland and Dyer Avenue Bridges). The project would require a storm drainage system and a pump station to discharge interior drainage. For protection against the 100-year flood, the levee/floodwall project would average about 12 feet high. The location of the upstream project is shown on Figure 12, and additional data is provided in Appendix A.

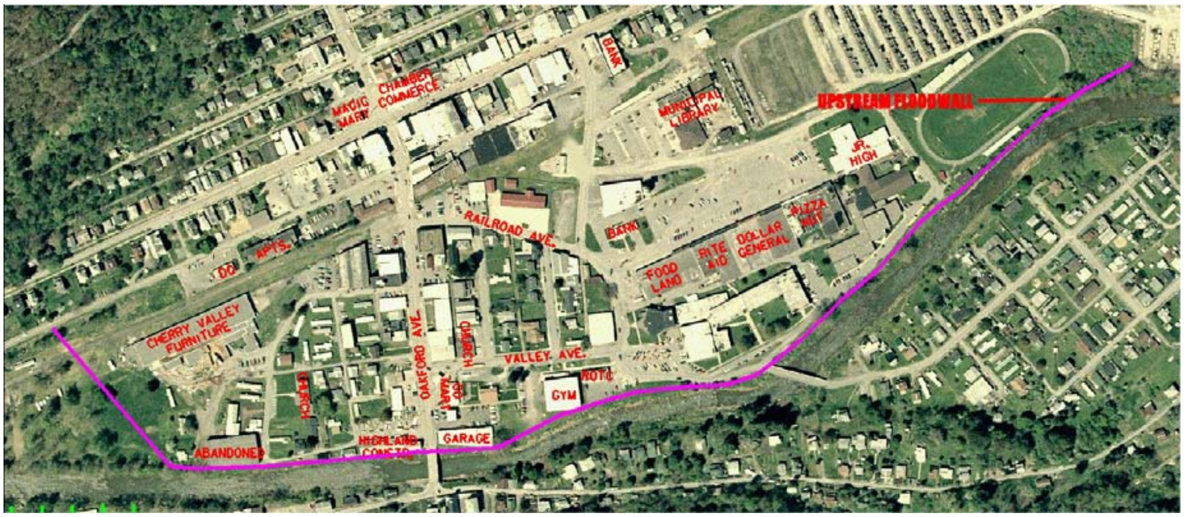


Figure 12. Upstream Floodwall

- **<u>Downstream Levee/Floodwall</u>.** This alternative includes a combination of levee and floodwalls in a downstream area of Richwood along the left bank of the Cherry River. Most of the project would be concrete floodwalls, but there are areas downstream of the city pool and around the ball fields where earlier levees can be accommodated. The levee/floodwall would be about 3,200 feet in length, and would average about 14 feet high for 100-year flood protection. The project would begin at high ground near Greenbrier Road, extend around the city pool complex, and downstream along Cherry River to high ground near Bridge Avenue. The project includes an internal drainage system with a pump station to remove interior drainage. No vehicular gate closures would be required as the project alignment does not cross any city streets. The location and general alignment of the downstream project are shown on Figure 13, and additional details for this alternative are provided in Appendix A.

Figure 13. Downstream Floodwall

8.3 Small Levees and Ringwalls

Ringwalls or ring levees are often referred to as dry floodproofing, measures which prevent floodwater from reaching a structure. They are in fact small, individual flood projects which can protect one large structure such as a high school or a cluster of several smaller structures such as a shopping center. Several such examples in the Richwood area are described in the following paragraphs.

- **High School/ Middle School/Shopping Center Ringwall.** This alternative includes a concrete floodwall which would completely encircle the Richwood High School, Middle School, fire station, bank and shopping center with several stores and businesses. The floodwall would have a total length of approximately 3,000 feet, and an average height of 10 feet. Four vehicular gate closures along with six pedestrian openings would be required. A storm drainage system including catch basins, head walls and pumps also would be required. The general alignment for this ringwall alternative is shown in Figure 14.

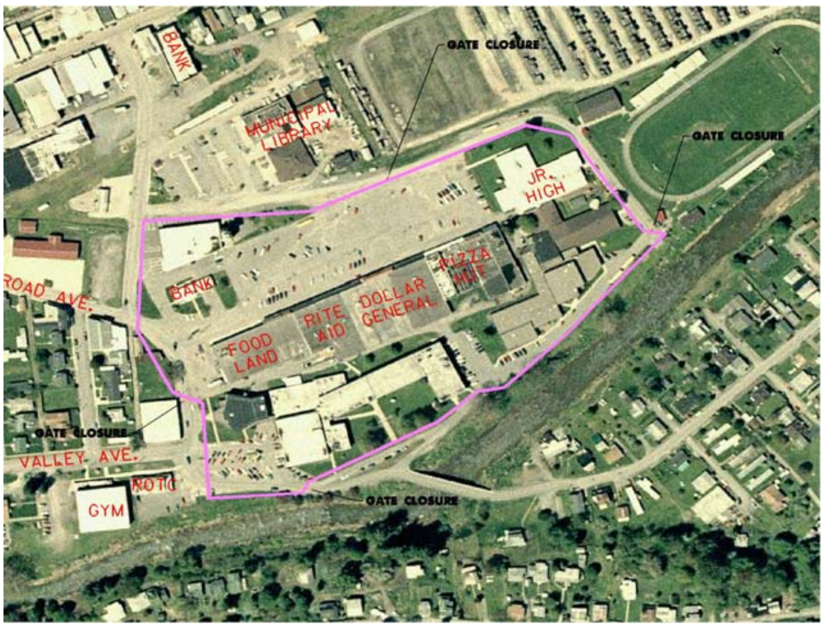


Figure 14. Ringwall for High School and Commercial Plaza

- **Cherry River School Ring Levee.** This alternative involves constructing a small, earthen levee adjacent to the elementary school located on the left bank of Cherry River. The levee would be approximately 75 feet long and average 2 feet high. The project would require a storm drainage system including catch basin, piping and pumps. Figure 15 shows the general alignment of the elementary school ring levee.

Figure 15. Elementary School Levee

- **<u>Senior Center Ringwall.</u>** This alternative involves constructing a floodwall completely around the Nicholas County Senior Citizen Center located on the left bank of the Cherry River. The wall would have an approximate length of 760 feet and average height of 4 feet. A storm drainage system including catch basin, collecting pipes and pumps would be required. The general alignment of the Senior Center floodwall is shown on Figure 16.

Figure 16. Ringwall for Senior Citizen's Center

- **<u>National Guard Amory Ringwall</u>**. This alternative entails constructing a concrete floodwall completely around the Guard Amory building. The floodwall would be approximately 950 feet in length and average 6 feet in height. No pedestrian or vehicular openings would be required since the wall does not block access to the building. An interior storm drainage system with catch basins and pumps would be required. Figure 17 shows the general alignment of the ringwall.

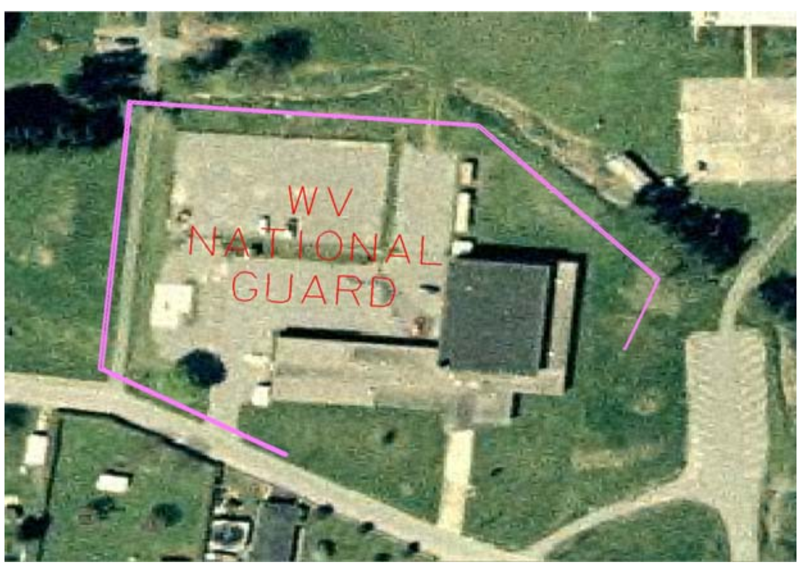


Figure 17. National Guard Ringwall

8.4 Floodproofing

Floodproofing involves measures and techniques which elevate a structure above the flood level, or prevent flood waters from damaging a structure. The most common techniques are raising residential structures above a designated flood level or attaching veneer walls to a large structure to prevent water damage. Floodproofing generally is not a mandatory program, and success depends on owners volunteering to enter the program. There are approximately 725 residential structures along the streams in the Cherry River basin, most of which are located in Richwood that would be damaged by the 100-year flood. It is possible that many of the residences would not be structurally sound enough to floodproof. Most large commercial structures cannot be elevated and must be individually floodproofed with veneer walls. Three examples of floodproofing with veneer walls are described below.

- **Hospital Veneer Wall.** About 900 feet of veneer wall would be required to completely surround the hospital's exterior walls. The veneer wall would average about 3.5 feet high and would require stop log closures at the entrance. The conceptual plan for the hospital is shown on Figure 18.

Figure 18. Hospital Veneer Wall

- **Municipal Building Veneer Wall.** A veneer wall approximately 350 feet in length and 2 feet high would be required to floodproof the Richwood Municipal Building. Two stop log closures would be required at the entrances.

- **Library Veneer Wall.** Approximately 350 feet of veneer wall with average height of 1.5 feet would be required to floodproof the library building. Two stop log closures would be required at the building entrances. Figure 19 shows the conceptual floodproofing schemes for the Library and Municipal buildings.

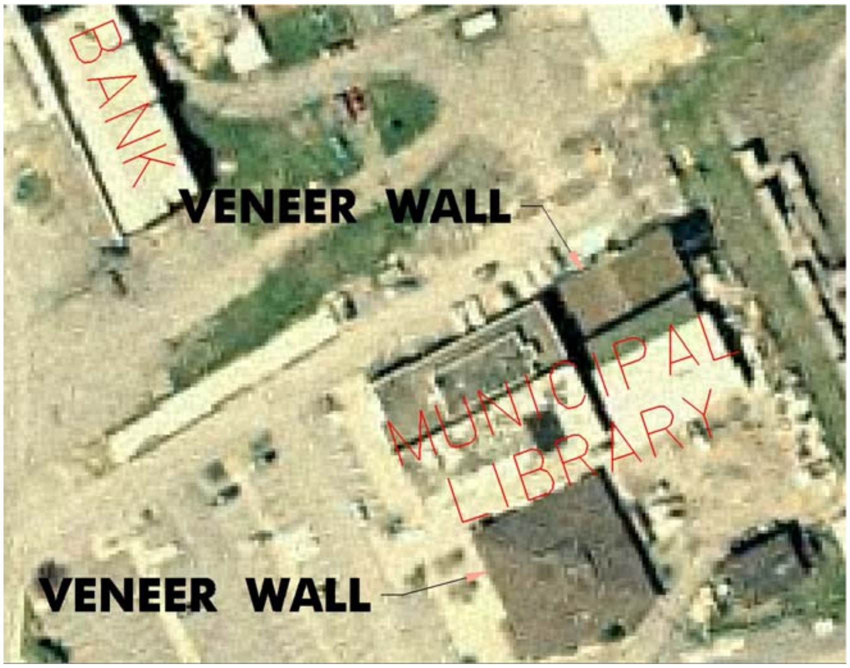


Figure 19. Library Veneer Wall

8.5 Flood Warning System (FWS)

A flood warning system could be installed that would provide two to three hours advanced flood warning time for communities along the Cherry River such as Richwood and Fenwick. A flood warning system would improve the capability for accurate and timely forecasts of severe floods. The purpose of the flood warning system is to reduce the potential loss of life, social disruption, health hazards, disruption of services and the amount of clean-up costs. The FWS would provide enough time for people of the local community to get personal belongings to higher ground and out of danger. A number of stream gauges (at least three) would be necessary upstream of the damage center of Richwood to provide valuable information about the potential danger of flooding. Along with the stream gauges, a computer system with software would be installed to provide necessary information about the impending flood. Existing rain gauges could also be tied into the system.

8.6 Impacts of Alternatives

The following section is a summary of the preliminary impact assessment of the various alterations both positive and negative. The impact assessments are qualitative at the reconnaissance stage; however, during the feasibility phase all final alternatives will be evaluated in more detail in terms of engineering, economic and environmental data.

Reservoir and Dry Dams

Two dam sites have been evaluated during the reconnaissance level studies, at mile 3.0 on the North Fork and mile 6.2 on the South Fork. Whether a reservoir with a pool or a dry dam, these projects have been similarly sized to store the runoff from a 100-year storm over the entire watershed. Either as a system with two impoundments or as a single impoundment on either the North or South Forks, these projects would result in significant reduction in flood levels and risk to citizens in Richwood.

Reconnaissance level data indicated that there are about 735 residents and 125 commercial buildings in the Richwood study area (North and South Forks of Cherry River). These include a number of government and other public structures which are subject to flooding.

Potential environmental impacts of these alternatives include a wide range of effects, many of which could be significant. Construction of the dam would impact the terrestrial and aquatic habitat, water quality, noise and air quality levels, fish and wildlife, hydrology, wetlands, aesthetics, transportation, archaeological resources and socioeconomic resources. This alternative would also have potential effects to Threatened or Endangered Species including the Indiana Bat, West Virginia Northern Flying Squirrel, Running Buffalo Clover, Virginia Spiraea, Small Whorled Pogonia and the Cheat Mountain Salamander.

In general, dams alter, fragment and degrade the aquatic ecosystem of the river. Dams alter the flow regime, downstream morphology, habitat type and quality of the river. Dams fragment the river system by forming a barrier to the transportation of sediment, organic material and the movement of aquatic species. Additionally, the implementation of a reservoir alternative would result in the loss of terrestrial and aquatic habitat of the area designated for the reservoir pool.

The impacts of dams can also extend to water quality, by affecting the water temperature, nutrient load, turbidity, dissolved oxygen, and the concentration of heavy metals and minerals. These impacts are lessened with a dry dam which does not hold a reservoir, and most impacts are associated with the footprint of the structure.

Given the high quality of the Cherry River watershed and the scope of the impacts, there would not be significant mitigative measures available to offset environmental effects of a dam with a reservoir. For a dry dam, measures in the design and operation of the structure could be implemented to reduce the impacts on the passage of aquatic species, sediment and organic material. Additionally, there would be less habitat loss associate with a dry dam, as the area designated for storage would only be utilized during high flow events.

- **North Fork Dry Dam.** A dam at mile 3 on the North Fork, sized to control runoff from the 100-year storm, would reduce the stage of the 100-year flood by three feet at Richwood. Structures located within this zone of reduction would no longer be damaged and flood risk would be greatly reduced. Since this is a single purpose flood control project, all project benefits would accrue to flood damage reduction. The negative impacts to the aquatic and terrestrial resources would be less with a dry dam because the stream would not be replaced with a permanent reservoir pool, and flood storage behind the dam would only be for a limited time during the flood event.

The construction of the North Fork dry dam would require acquisition of approximately 105 acres of pool clearing and 11 acres at the dam site for clearing and grubbing. Additional acquisition and/or easements would likely be required, especially in the case of severed properties or where a permanent or temporary right to flood would be necessary. Construction would also require relocation of 4 miles of WV 39.

- **South Fork Dry Dam.** A satisfactory dam site has been identified at mile 6.2 on the South Fork Cherry River. Either a dry dam or a reservoir with permanent pool can be constructed at this site, and both projects would control runoff from the 100-year storm. The South Fork dry dam would reduce the stage of the 100-year flood by four feet at Richwood. This reduction in flood levels would not only protect existing structures, but it would increase the potential for development on lands now subject to frequent flooding. The potential risks to residents including possible loss of life also would be greatly diminished with this project.

  Construction of the South Fork dam would require a similar acquisition plan as described for the dry dam. There would be no highway relocations required with this project, as there is now only an unpaved logging road extending up the valley but an access road to the dam site would be necessary.

- **South Fork Reservoir.** The dam site for this reservoir project is at mile 6.2 on the South Fork, the same as the dry dam. The dam for the reservoir would be the same size and have the same flood storage capacity as that for the dry dam. The flood damage risk reduction at Richwood would be the same. A multi-purpose reservoir project, however, would result in more positive impacts to Richwood and the Cherry River watershed than would the dry dam. The reservoir would have a permanent pool which would accommodate summer recreation uses such as boating, picnicking and swimming, and also could include storage for water supply. The reservoir recreation use would bring tourists to the area, which would have a positive impact on the local economy. Water supply storage in the reservoir could provide a dependable source of water even in dry years, which should have a positive effect on existing water uses as well as the potential for new development.

  No highway relocation would be necessary with the South Fork reservoir, but an access road to the dam site would be constructed along the lower 6 miles of the stream.

Levees and Floodwalls

Potential environmental affects resulting from levees or floodwalls include loss of terrestrial/riparian vegetation and habitat, disconnection of the stream with the floodplain, alteration of aesthetic resources, disturbance of wetlands, reduction in recreation opportunities, and impacts to threatened/endangered species, as well as social, historical, and cultural resources. Typically, construction of levees and floodwalls could impact air quality, water quality, noise, and transportation, and result in potential human health and safety concerns from hazardous, toxic and radioactive waste. This alternative would also have potential effects to Threatened or Endangered Species including the Indiana Bat, West Virginia Northern Flying Squirrel, Running Buffalo Clover, Virginia Spiraea, Small Whorled Pogonia and the Cheat Mountain Salamander. Since the protective walls and levees would average about 12 feet in height, alterations in aesthetic resources including visual impacts would be unavoidable.

- **Upstream Levee and Floodwall.** This flood protection project would be approximately 4500 feet in length and mostly floodwall with some earthen levee at the upstream and downstream ends. The combination levee/floodwall project would protect all the residences and businesses located in the 100-year floodplain. A few structures located very near the river bank would be acquired and removed to accommodate construction activities. In addition to the existing structures, vacant real estate would be available for development in a flood free area near downtown. This project would protect two large schools and their athletic facilities, several public buildings including the library and city hall, a small shopping center, as well as a number of other businesses and several residences.

  Transportation access through the construction work area would be restricted at certain times in certain locations, including temporary closure of the bridges over the Cherry River. Access to the river would be somewhat restricted by the walls and levee, but the area between the structures and the riverbank could be maintained in a more natural condition.

- **Downstream Levee and Floodwall.** The downstream levee/floodwall alternative would extend about 3200 feet along the left bank of the Cherry River from near Greenbrier Road downstream to Bridge Street. This project would provide 100-year flood protection for structures in the floodplain, including the city pool, hospital, senior citizens center, National Guard Armory, and the existing residences in that area. The reduced flood risk would greatly increase the quality of life for residents using the hospital, Armory and senior citizens center. The protective structures would be mostly floodwalls, however, in some areas there may be sufficient space for levee construction. A few residences located near the river bank may need to be acquired and relocated to accommodate project construction.

Nonstructural measures

These measures generally involve raising or relocating residences or floodproofing larger structures, such as businesses or public buildings by installing veneer walls on or around the structures. For buildings that are structurally sound, such measures can provide protection up to the 100-year flood level. Terrestrial and aquatic impacts generally are minor with such measures, but elevating structures will significantly alter the visual appearance of residential or commercial areas.

Potential environmental affects from nonstructural measures would include impacts to the social community, along with some impacts associated with construction/demolition activities to air quality, traffic, noise, etc. There would be no negative impacts for installing a flood warning system.

- **High School, Middle School, Shopping Plaza Ringwall.** This ringwall alternative would completely encircle the two schools, shopping plaza and several public buildings. The concrete walls would be approximately 3,000 feet in length and would protect the enclosed area against 100-year level floods. The walls would be about average 14 feet in height along the river bank and 6 feet high around the shopping area and bank. The risk of flooding in the main commercial section of Richwood would be virtually eliminated, and the potential for future economic development in this area would be enhanced. However, access to and through this enclosed area, both vehicular and pedestrian, would be restricted to four street openings and six sidewalk openings. During flood conditions, the enclosed area would be inaccessible to the public. The potential area would be enclosed by concrete walls varying in height from 6 feet to 14 feet, consequently, the appearance of the shopping area and the school district would be visually altered.

- **Cherry River School Ring Levee.** A small, earthen levee would surround the school, providing protection up to the 100-year flood level. Since the levee would average only 2 feet high, it would blend in with the grassed landscaping and would not significantly alter the general appearance of the school grounds.

- **Senior Center Ringwall.** A concrete floodwall averaging 4 feet high would completely surround the center, providing flood protection up to the 100-year frequency level. Three openings would provide access to the center, with closures installed during flood conditions. Terrestrial impacts would be limited to the grounds surrounding the center, and the concrete wall would result in some visual impacts.

- **National Guard Armory Ringwall.** The concrete ringwall would surround most of the armory, with some high ground at the entrance. The wall around three sides of the building would provide protection against the 100-year flood. No openings through the wall are required for access, and since the wall is mostly around the backside of the building, visual impacts are minor.

9.0 ECONOMIC ANALYSIS

This section summarizes the benefit and cost analysis performed during the reconnaissance phase for the various alternatives that have been investigated. Discussion also is provided on the without project condition at Richwood, including the number of structures in the study area, the number of structures in the 100-year floodplain and the average annual damages. The cost and benefits for the alternatives have been estimated without the benefits of detailed mapping or a complete field inventory of the structures in the floodplain.

9.1 Benefit Estimates

Benefits for single purpose flood control projects such as dry dams and levees represent flood damages prevented up to the flood of record level or the 100-year flood whichever is greater. Benefit categories include residential, commercial, personal property, utilities, transportation and emergency cost. These projects also would benefit the local economy by making available flood free sites which could be commercially developed. The quality of life would be enhanced because the risk of flooding would be greatly diminished.

Multi-purpose reservoirs in addition to reducing flood damages would benefit the Cherry River watershed by providing water supply storage and a recreation lake which would accommodate boating, swimming and fishing.

For this reconnaissance study, only flood damages prevented have been estimated. For local protection projects, benefits estimated are derived from the number of structures protected and the average annual damages prevented by the floodwalls and levees up to the 100-year flood level. For dry dams and reservoirs, flood risk reduction benefits reflect the reductions in levels along the rivers and streams based on stage-damage relationships, that is the “with” and “without” conditions. Estimated flood damages prevented by the various alternatives are summarized in Table 3.

Benefits not considered during the reconnaissance study include population at risk and loss of life, automobile damages, utility and infrastructure damages, any decrease in flood insurance costs due to putting a project in place, flood recovery costs that would no longer be necessary with a project in place, or the cost associated with false alarm floods. These additional benefits would be addressed during the feasibility phase evaluation.

9.2 Computation of Flood Damages Prevented

The Corps of Engineers uses the Hydrologic Engineering Center’s Flood Damage Analysis (HEC-FDA) computer program to compute project benefits for various alternatives. The HEC-FDA application is required by Corps Guidance in EM 1110-2-1419. The program requires several inputs in order to calculate. These inputs include:

- **Water surface profiles –** describes the relative water surface elevation in relation to specific points on the study stream

- **Commercial and Residential depth damage curves –** describes a percentage of total structure damage per type of structure given the amount of water in the structure.

- **Structure inventory –** complete list of all structures in the study area

Water surface profiles are developed using HEC-RAS, a computer program which can be used to calculate water surface elevations at specific points along a stream given various flow conditions. The residential depth-damage curves used were published in Economics Guidance Memorandum 01-03, "Generic Depth-Damage Relationships (for residential structures without basements)" dated 4 December 2000. The Generic Depth-Damage curves are standard residential depth damage curves which are utilized Corps-wide. They were developed by the Flood Damage Data Collection Program in 2000 to provide Corps district offices with standardized relationships for estimating flood damage and other costs of flooding based on actual losses from flood events. Those curves utilized for estimating damages to commercial structures were the "New Orleans" commercial depth damage functions. The structure inventory consists of data such as structure identification number, stream name, river station, structure value and first floor elevation.

In order to determine the economic viability of a FWS in the Cherry River Watershed, and economic analysis was performed in accordance with the procedures outlined in Chapter IX of the National Economic Development Procedures Manual - Urban Flood Damage (IWR Report 88-R-2) dated March 1988. According to this guidance, a common tool for evaluating the benefits related to warning and preparedness measures is the lead time-damages prevented function. This function was developed by Harold Day and is used to estimate potential damages reduced based on the amount of warning time. Day's curve assumes a 100 percent response meaning all the affected population will receive the message, know what to do, and have the inclination and the capability to respond.

Structure Inventory Data Development. There are a variety of ways that the data for the structure inventory can be gathered. For this project data was gathered by Electronic Field Survey software developed by Pictometry, which specializes in digital, oblique aerial imaging. Aerial photography is joined with a digital elevation model, allowing the user to click on a specific structure visible on the aerial photography and gather the needed data such as elevation, distance, and height. Using this methodology each structure in the study area was cataloged and assigned a structure value derived from usage of Marshall and Swift real estate estimator software, which is the Corps-wide accepted software for the derivation of structure value for use in flood risk management studies.

There are 859 structures located in the study area (including the North Fork, South Fork, and Cherry River to its confluence with the Gauley), of which 123 are commercial buildings and 736 are residential dwellings. The average structure value of a commercial building in Richwood, WV is $189,000. Likewise, the average structure value of a residential dwelling in the same area is $79,000. These averages were derived by performing real estate estimations on a 10 percent sample of the structures in the study area.

Flood Damage Analysis Results. The without project condition at Richwood yields an average annual damage to the study area of $1,692,000. The average annual damages prevented for the various alternatives being studied range from $271,000 to $1,689,000.

Without consideration to project cost, the most beneficial alternative studied is the placement of dry dams on both the North and South Forks of the Cherry River which leave only $3,000 per year in residual damages. The complete results of the FDA analysis are presented in Table 3 including the FWS. More information on the FWS is found in Appendix A.

Table 3 – Cherry River Average Annual Damages by Alternative (x1000)

Plan	Without Project	With Project	Damages Reduced (Benefits)
Without Project	$1,692	$1,692	-
Dry Dam North Fork	$1,692	$437	$1,255
Dry Dam South Fork	$1,692	$299	$1,393
Dry Dams North and South Fork	$1,692	$3	$1,689
Wet Dam South Fork	$1,692	$766	$926
Floodwalls	$1,692	$57	$1,635
Nonstructural*	$1,692	$1,421	$271
Flood Warning System	$1,692	$1,632	$60

**Floodproofing of identified nonresidential structures only*

9.3 Costs, Interest During Construction and Amortization

Cost Estimates. The first cost includes project construction, environmental mitigation and engineering and design. During this reconnaissance phase, real estate and relocation costs have not been included. The cost estimates have a price level of October 2007. The estimates were developed using MCACES 2nd Generations MII Version software, and are based in part on recent cost estimates prepared for the Marlinton LPP Detailed Design Report.

Direct costs were based on equipment, labor and materials necessary to construct a project. Historical data were used to develop some portion of the cost estimate where detailed quantities are not available. The preliminary cost estimates for evaluated alternatives, excluding real estate and relocation, are provided in Table 3. The costs are defined as order of magnitude estimate, suitable for comparison of the alternatives, and assessing which options are most effective in meeting planning objectives. More details on alternative cost estimates are provided in Appendix A.

The total costs, including appropriate mitigation, range from approximately $180,000 for the FWS to a nonstructural alternative of $20,000,000 to $670,000,000 for placement of dry dams on both the North and South Forks of the Cherry River. Total costs per alternative are provided in Table 4.

Table 4 – Costs by Alternative[1]

Alternative	Project Cost
North Fork Cherry River Dry Dam	$328,000,000
South Fork Cherry River Dry Dam	$343,000,000
Dry Dam North and South Forks	$671,000,000
South Fork Cherry River Reservoir	$347,000,000
Floodwalls/Levees (upstream and downstream)	$59,000,000
Nonstructural (identified nonresidential structures only)	$19,770,000
Flood Warning System	$180,000

[1] Order of magnitude estimate; does not include real estate or relocation cost.

Interest During Construction and Amortization. Interest during construction was calculated for a 5-year period with respect to the dams and floodwalls and a 3-year period for the nonstructural alternatives. These costs were annualized at 4.875% (the FY 2008 Federal discount rate) over a 50-year period of analysis. Net benefits and the corresponding benefit-to-cost ratios are provided below in Table 5. The FWS has positive net benefits with a BCR well above unity.

Table 5 – Net Benefits and Benefit-To-Cost Ratios by Alternative

Plan	Net Benefits	B/C ratio
Dry Dam North Fork	-$18,629	0.06
Dry Dam South Fork	-$19,401	0.07
Dry Dams North and South Fork	-$38,999	0.04
Wet Dam South Fork	-$20,110	0.04
Floodwalls	-$2,034	0.45
Nonstructural	-$848	0.24
Flood Warning System	$33,870	2.32

** This venture level estimate does not include real estate or relocation costs.*

10.0 FEDERAL INTEREST DETERMINATION

Federal and non-Federal interests, stakeholders, local government agencies and the interested public have been involved in the development of the concept plans evaluated in this reconnaissance report. All entities involved have demonstrated keen interest in formulating and developing plans that could be investigated further in the feasibility phase. The determination of Federal interest generally is made using the National Economic Development (NED) / National Environmental Restoration (NER) approach as specified in Corps planning regulations. In addition, significant risk for public safety, such as the danger posed by flash flooding to the school and the risk to the student population, could drive Federal interest.

The purpose of Corps' ecosystem restoration is to restore significant ecosystem function, structure and dynamic processes that have been degraded. For an ecosystem restoration project to be considered in the Federal interest there must be a significant increase in habitat benefits compared to the incremental cost of the project. There is authority for the Corps to address ecosystem restoration in the Cherry River Watershed. Potential ecosystem restoration measures identified in the Cherry River Watershed that would be within the Federal Interest for the Corps to address include acid mine drainage treatment and channel alterations on the Cherry River. While opportunities for improvement exist and warrant further study, it should be noted that some measures may provide only limited net benefits given the general high quality of the Cherry River. Potential Ecosystem Restoration projects not in the Federal Interest for the Corps to address include treatment for stream acidity associated with acid deposition, and reduction of sediment delivery to streams. Measures to address acid deposition would limit the sources of acid precipitation, and would not be within the scope of the Corps' authority. This issue is within the scope of the US Environmental Protection Agency and the WV Department of Environmental Protection. Additionally, reductions in sulfur dioxide resulting from the Clean Air Act should reduce acid deposition over time. While excess sediment deposition may be evident and impacts some areas of the watershed, a review of WVDEP habitat quality data does not indicate a level of impact that impairs the aquatic ecosystem in the basin, and no streams in the watershed are listed as impaired due to sediment. Measures to reduce sediment deliver to stream also fall within the authority if the USDA Natural Resource Conservation Service, West Virginia Department of Environmental Protection, and Soil Conservation Service.

The Cherry River watershed and particularly the City of Richwood have major flooding problems which pose serious flood risks to the local residents. The chronic flooding problems together with the lack of a dependable water supply have had a negative impact on the local economy as well as degraded the quality of life of the residents. This reconnaissance report has identified several structural alternatives, such as reservoirs and floodwall/levees, as well as some nonstructural options including a FWS which address these major problems. The FWS produces positive net benefits and should be implemented. Implementation of any of these alternatives would involve the cooperation effort of the Corps and other Federal Agencies, such as FEMA, NCRS, USGS, and EPA, as well as State and local agencies. Reducing the flooding risk to increase public safety and improving the well being of citizens in the Richwood area warrant Federal participation in feasibility level investigations.

11.0 CONCLUSIONS

This reconnaissance study has determined that serious flood risk management concerns exist in the Cherry River Basin, specifically for the City of Richwood. With potential average annual flood damages of $1.7 million, this area is in need of practical, affordable solutions to the most pressing flood-related issues. Many public and institutional structures as well as businesses within the downtown area are subject to frequent flooding that continually debilitate the municipal areas including the county population that depends upon those urban areas. Future without-project conditions are likely to worsen in the absence of some organized planned intervention.

The study area population and business sectors have decreased since the 1989 NRCS study of water supply needs; however, water shortages will persist for this area during drought periods. Alternative water supply opportunities that are more reliable than the shallow impoundment on the North Fork need to be further investigated. The lack of a reliable water supply is considered an obstacle to further business development and job opportunities in the study area.

A number of aquatic and terrestrial ecosystem issues have been described in this study, some of which are localized and small-scale making a comprehensive watershed approach more difficult. Problems with acid deposition and un-reclaimed acid mine pollution that degrade stream quality for certain fish species as well as human use need to be addressed by application of current programs. Infrastructure problems previously discussed, such as combined sewer and stormwater overflows, deteriorating septic tanks and resulting bacteriological loading of the water resources in the study area threatened human health and safety and should be addressed further in the feasibility phase. Although there may be a need for additional in-stream fishing opportunities, failure to address the larger aquatic ecosystem pollutants and bacteriological loading problems may make access to the stream a moot point. Practical, watershed-scale solutions that can be implemented through collaboration of Federal, State and local entities appear to offer the most potential.

Given the above conclusions and the fact that a Federal interest has been established, it is therefore recommended that the many water resource problems described above be investigated in the feasibility phase under the Corps comprehensive watershed management approach. This feasibility study would involve the community in seeking solutions to the water resource issues in the watershed as well the many varied stakeholders in the basin.

Other Federal programs that could be part of a comprehensive watershed plan would be FEMA’s Hazard Grant Mitigation Program which includes floodproofing or acquisition of floodprone structures. This program is administered in the state by WV Homeland Security and Emergency Management Services. The USDA NRCS has programs which focus on water quality impairments and habitat degradation from land use practices, especially those associated with agriculture. The Office of Surface Mining has a Federal interest and authority to address water quality and habitat degradation resulting from abandoned mine lands. These programs are administered at the State level by the WVDEP. The USEPA has a Federal interest in water quality and habitat degradation, although most EPA involvement would be indirect, and available through state and local agencies.

Under the Corps Comprehensive Watershed approach, all of these Federal and State agencies would be cooperative partners in the feasibility level studies, and some may be able to participate in actual project development. The feasibility level studies as well as project construction would require cost sharing by non-Federal interests.

Some smaller, localized problems could potentially be investigated under the Corps' Continuing Authorities Program (CAP). For instance, the CAP Section 205 Program – Small Flood Control Projects – could potentially be used to address flooding for the high and middle schools. Potential also exists to combine flood risk management measures at the schools with the nearby commercial plaza as well as the potential buy-out of structures in the floodway that could provide ecosystem restoration benefits. A flood warning system would be an integral part of any alternatives developed or could be developed as a stand alone project under the Section 205 Program and appears to be justified. This area is also currently part of the overall Section 205 Statewide stream gaging and flood warning plan but would not have as many gauges as a stand alone system would entail.

12.0 PRELIMINARY FINANCIAL ANALYSIS

The local sponsors will be required to provide 50 percent of the cost of the feasibility phase. The City of Richwood, the Nicholas County Commission and the WV Conservation Agency have each expressed interest in potential projects that could be derived from this Cherry River Watershed study. The West Virginia Conservation Agency (WVCA) indicated a willingness to pursue comprehensive basin management plans and to share in the cost of the feasibility study and have sent an LOI (see letter in Appendix B – Federal, State and Local Correspondence). The non-Federal sponsor will cooperate by coordinating with states, counties, local agencies and other interested partners and stakeholders to complete pertinent studies and implement projects that would contribute to the realization of local goals and objectives. The sponsor can contribute in-kind services for the feasibility study up to their full 50% cost share which will be determined prior to signing the Feasibility Cost Share Agreement (FCSA).

13.0 SUMMARY OF FEASIBILITY STUDY ASSUMPTIONS

The assumptions that will be used to guide development of the study plan and schedule for a watershed feasibility study are described below. The feasibility study is currently estimated to cost $2 million and will be cost shared as described in Section 12.0. A detailed scope including schedule and cost will be developed in conjunction with the local sponsor and presented in the Project Management Plan (PMP) prior to signing the FCSA.

1. It appears likely that the Cherry River Watershed Feasibility Study can be accomplished with a single comprehensive PMP and FCSA, and no interim feasibility reports would be required.

2. Some of the potential projects identified herein may more appropriately be implemented under the Continuing Authorities Program (CAP) or under other Federal, State or local programs. These will be identified during the Feasibility phase and become a part of the recommended plan.

3. A flood warning system (FWS) for Richwood appears to be justified as a stand alone project but would likely be combined with other alternatives in a comprehensive watershed plan.

3. Cost estimates prepared in M2 will be prepared for the project features of the recommended plan. Design and cost of preliminary alternatives will be prepared at a lesser level of detail and will be used in the economics evaluation and incremental cost analysis to assist in screening alternatives.

4. An approved Engineering Appendix and Real Estate Plan (containing gross appraisals) will be provided with the final, rather than the draft, feasibility report.

5. An Environmental Impact Statement (EIS) will be prepared for the feasibility report in light of the types of projects likely to be considered. However, if the final array does not contain projects considered to have significant environmental effects, an Environmental Assessment (EA) may be sufficient for the project.

6. A recreation needs analysis will be conducted to help focus the local efforts and to determine the viability of some recreation features of potential alternatives.

14.0 FEASIBILITY PHASE MILESTONES

MILESTONE	APPROXIMATE DURATION*
Notice of Intent/Initiation of Study	1 month
Initial Scoping Meeting	1 month
Field Investigations Complete	6 month
Alternative Formulation & Evaluation (AFB)	1 month
Prepare Draft Feasibility Report & EIS (DFR)	12 month
Transmit DFR/EIS to Division and HQ	1 month
Release Draft for Public Review and Comment	1 month
Prepare Final Feasibility Report and EIS	1 month
Transmit Final Report & EIS to LRD/HQ	-
HQ Issues Project Guidance Memorandum	1 month
CWRB	1 month
Chief's Report	1 month

** to be determined in conjunction with local sponsor when Project Management Plan is developed*

15.0 STUDY AREA MAP

A map of the study area is shown on Figure 2.

16.0 RECOMMENDATIONS

I recommend that the Cherry River watershed study proceed into the feasibility phase to develop a comprehensive watershed management plan for the basin and the Town of Richwood. The U.S Army Corps of Engineers shall finalize negotiations of the Project Management Plan (PMP) and enter into a Feasibility Cost Sharing Agreement (FCSA) with the West Virginia Conservation Agency (WVCA).

/s/

Date: 18 July 2008

DANA R. HURST
Colonel, Corps of Engineers
District Engineer

APPENDIX A

TECHNICAL AND COST

DETAILED DESCRIPTIONS OF DAM ALTERNATIVES

North Fork Dry Dam

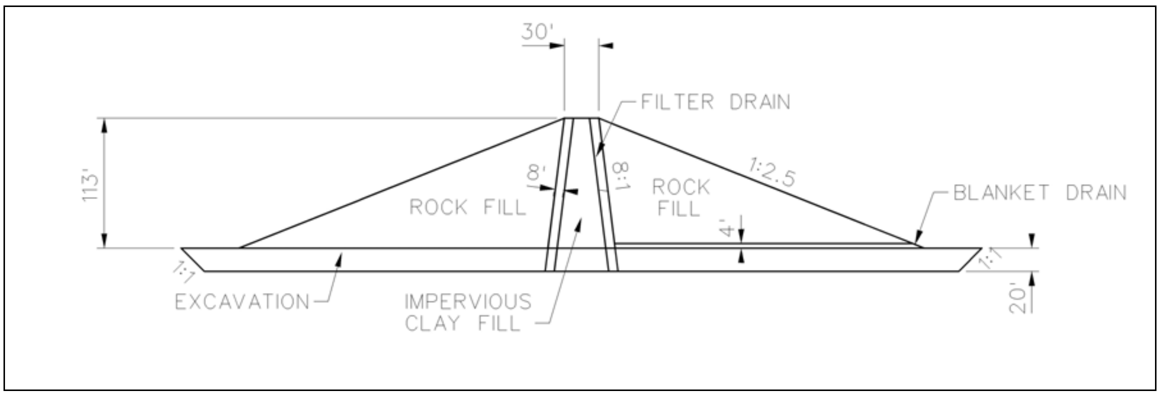
This alternative entails construction of a dam on the North Fork of the Cherry River approximately three miles upstream of Richwood. This project would have no permanent pool. The height of the dam would be 113 feet and the length would be approximately 650 feet. Approximately 325,000 cubic yards of weathered shale would be excavated at the dam foundation.. The core of the dam would be of approximately 76,000 cubic yards of impervious clay fill, 30' wide at the top with 8 vertical to 1horizontal (8V:1H) slopes. An 8-foot-thick filter drain would be constructed upstream and downstream utilizing approximately 52,000 cubic yards of granular material. A 4-foot-thick blanket drain utilizing approximately 25,400 cubic yards of material would be placed downstream. The remainder of the dam embankment would be constructed of approximately 705,000 cubic yards of rock fill with side slopes of 1V:2.5H. Construction of the dam would require the relocation of 4 miles of State Route 39. Other project features include the outlet works, spillway, and operations office. The spillway would require approximately 350,000 cubic yards of excavation which could be utilized for dam construction. Additional borrow material would be obtained from sites within a 5-mile radius. Figure 11 (main report) shows the approximate location of this structure. The venture level construction cost estimate for this alternative is **$328 million** (October 2007 price level)**. *This estimate includes mitigation cost considerations but does not include real estate or utility relocations.***

South Fork Dry Dam

This alternative entails construction of a dam on the South Fork of the Cherry River approximately 5 miles upstream of Richwood. This project would have no permanent pool. The height of the dam would be 120 feet and its length would be approximately 1,010 feet. Approximately 531,000 cubic yards of weathered shale would be excavated at the dam foundation. The core of the dam would have approximately 130,000 cubic yards of impervious clay fill, 30' wide at the top with 8V:1H slopes. The dam would include an 8-foot-thick filter drain upstream and downstream constructed with approximately 84,500 cubic yards of material. A 4-foot-thick blanket drain utilizing approximately 42,000 cubic yards of material would be placed downstream. The remainder of the dam embankment would be constructed of approximately 1,237,000 cubic yards of rock fill with side slopes of 1V:2.5H. Construction of the dam would require the relocation of 2 miles of Johnstown Road. Other project features include the outlet works, spillway, and operations office. Excavation of the spillway would supply approximately 441,000 cubic yards of material. Additional borrow would be obtained from sites within a 5 mile radius. Figure 11 (main report) shows the approximate location of this structure. The venture level construction estimate including mitigation costs for this alternative is **$343 million** (October 2007 price level)**. *This estimate does not include real estate or utility relocations.***

South Fork Reservoir

This alternative entails constructing a wet dam on the South Fork of the Cherry River approximately 5 miles upstream of Richwood (same location as the dry dam above). The height of the dam would be 120 feet and its length would be approximately 1,010 feet. Approximately 531,200 cubic yards of weathered shale would be excavated. The core of the dam would have approximately 129,700 cubic yards of impervious clay fill, 30-feet-wide at the top with 8V:1H slopes. An 8-foot-thick filter drain upstream and downstream would need approximately 84,500 cubic yards of material. A 4-foot-thick blanket drain utilizing approximately 42,000 cubic yards of material would be placed downstream. The remainder of the dam construction would be approximately 1,237,400 cubic yards of rock fill with side slopes of 1V:2.5H. Clearing and grubbing of approximately 105 acres would be required for the pool. Construction of the dam would require the relocation of 2 miles of Johnstown Road. Construction of other features would include the outlet works, spillway, and operations office. The spillway cut would supply approximately 441,000 cubic yards of material. Additional borrow would be obtained from sites within a 5-mile radius. Figure 11 (main report) shows the approximate location of this structure. The venture level construction estimate including mitigation costs for this alternative is **$347 million** (October 2007 price level)**.** ***This estimate does not include real estate or utility relocations.***



TYPICAL DAM SECTON

Upstream Floodwall

This alternative entails placing 2,300 feet of T-base wall and 2,250 feet of I-Wall on the right descending bank of the Cherry River in downtown Richwood. The wall begins at high ground east of the Richwood High School football field and follows the Cherry River before turning north to tie into high ground just west of Commercial Avenue. Two vehicular gate closures would be required, one at the Oakford Avenue bridge, and one at the Dyer Avenue bridge. The height of the T-base wall averages 14 feet while the I-wall averages 9 feet. Internal drainage features required include a storm drainage system with catch basins, collection pipes, headwalls, and a 80,000 gallons per minute pump station.

Additional operation and maintenance would be required for the floodwall, pump station and the gate closures. Figure 12 (main report) shows the general alignment and features of this wall. The venture level construction estimate including mitigation costs for this alternative is **$31 million** (October 2007 price level)**. *This estimate does not include real estate or any relocations costs.***

Downstream Floodwall

This alternative entails placing 1,620 feet of T-base wall and 1,626 feet of I-Wall in an area of Richwood immediately downstream of the downtown area on the left-descending bank of the Cherry River. There are no gate closures required with this alignment. The wall begins at high ground near Greenbrier Road and follows the Cherry River to Bridge Avenue where it turns south and ties into high ground. The height of the T-base wall averages 21 feet while the I-wall averages 7.5 feet. Internal drainage features required include a storm drainage system with catch basins, pipe, headwalls and a 60,000 gallons per minute pump station. Additional operation and maintenance would be required for the floodwall and pump station. Figure 13 (main report) shows the general alignment and features of this wall. The venture level construction estimate including mitigation costs for this alternative is **$28 million** (October 2007 price level)**. *This estimate does not include real estate or any relocations costs.***

Richwood Elementary School Levee

This alternative entails placing a small earthen levee approximately 75 feet long and approximately 2 feet high around the Richwood Elementary School. The levee would be comprised of impervious fill with 3H on 1V slopes. A storm drainage system including catch basins, pipe, and headwalls would be required. Figure 14 (main report) shows the approximate alignment of that levee section. The venture level construction estimate including mitigation costs for this alternative is **$105 thousand** (October 2007 price level)**. *This estimate does not include real estate or any relocations costs.***

Senior Center Ringwall

This alternative entails placing 760 feet of I-Wall with an average height of 4 feet around the Senior Center grounds with 3 pedestrian openings. A storm drainage system including catch basins, collection pipes, portable pumps, and headwalls would be required. Additional operation and maintenance would include pump mobilization and demobilization, pump upkeep, and the pedestrian openings. Figure 15 (main report) shows the approximate alignment of the I-wall structure. The venture level construction estimate including mitigation costs for this alternative is **$2 million** (October 2007 price level)**. *This estimate does not include real estate or relocations costs.***

Hospital Veneer Wall

This alternative entails placing 900 feet of Veneer Wall attached to the Richwood Hospital at an average height of 3.5 feet around the structure with stop log (or gasket sealed) closures located at the entrances. Figure 16 (main report) shows the alignment of this structure at the hospital. The venture level construction estimate including mitigation costs for this alternative is **$1.1 million** (October 2007 price level)**.** ***This estimate does not include real estate or relocations costs.***

West Virginia National Guard Ringwall

This alternative entails placing 950 feet of I-Wall with an average height of 6 feet around the National Guard Armory grounds. No pedestrian or vehicular openings would be required for this alternative because the veneer wall does not cut off access. A storm drainage system including catch basins, pipe, portable pumps, and headwalls would be required. Additional operation and maintenance would include pump mobilization and demobilization, and pump upkeep. Figure 17 (main report) shows the alignment of this ringwall. The venture level construction estimate including mitigation costs for this alternative is **$3.1 million** (October 2007 price level)**.** ***This estimate does not include real estate or relocations costs.***

Junior / Senior High School and Commercial Plaza Ringwall

This alternative entails placing 400 feet of T-base wall and 2600 feet of I-Wall that would completely encircle Richwood High School, Richwood Jr. High School, and nearby fire station, bank and strip mall. The height of the T-base wall averages 14 feet while the I-wall averages 6 feet. Four vehicular gate closures would be required along with six pedestrian openings. A storm drainage system including catch basins, pipe, portable pumps, and headwalls would be required. Additional operation and maintenance would include pump mobilization and demobilization, pump upkeep, and the gate and pedestrian openings. Figure 18 (main report) shows the approximate alignment of this ringwall and its primary gate-closures. The venture level construction estimate including mitigation costs for this alternative is **$10 million** (October 2007 price level)**.** ***This estimate does not include real estate or relocations costs.***

Library Veneer Wall

This alternative entails placing 350 feet of Veneer Wall at an average height of 1.5 feet around the Richwood Library with two stop log (or gasket-sealed) closures located at the entrances. Figure 19 (main report) shows the approximate alignment of this veneer wall. The venture level construction estimate including mitigation costs for this alternative is **$609 thousand** (October 2007 price level)**.** ***This estimate does not include real estate or relocations costs.***

Municipal Building Veneer Wall

This alternative entails placing 350 feet of Veneer Wall at an average height of 2 feet around the Richwood Municipal Building with two stop log (or gasket sealed) closures located at the entrances. The venture level construction estimate including mitigation costs for this alternative is **$742 thousand** (October 2007 price level)**.** ***This estimate does not include real estate or relocations costs.***

HYDROLOGIC AND HYDRAULIC

Flood Frequency

The existing Craigsville gage station on the Gauley River and the Cherry River gage station near Fenwick, WV, (no longer maintained) were used to obtain frequency data for the Cherry River Watershed project. The natural discharge-frequency curves used were previously developed on a regional basis in accordance with COE procedures, Statistical Methods in Hydrology, 1962, and Water Resources Council Bulletin No. 17, Guidelines for Determining Flood Flow Frequency, 1976. The Craigsville gage is located on the right bank, at the downstream side of a bridge on WV Route 20, 200 feet downstream from the confluence of Cherry River, 1.8 miles downstream from Cranberry River, and 2.7 miles south of Craigsville, Nicholas County. The period of record for the Craigsville gage is 1965-Present. The Fenwick gage was located at a highway bridge at Richwood, Nicholas County, approximately a half a mile below the confluence of the North and South Forks of the Cherry River. The period of record for the Fenwick gage was 1930-1961.

	Gauley River Basin					
	Craigsville, WV D.A. (mi^2) = 528 Zero Gage, Ft. M.S.L. = 1870 Natural			Cherry River @ Fenwick, WV D.A. (mi^2) = 150 Zero Gage, Ft. M.S.L. = 2088.94 Natural		
Percent Chance of Exceedence	Flow cfs	Stage ft	Elevation ft	Flow cfs	Stage ft	Elevation ft
0.1	102,000	29.6	1899.6	66,100	27.1	2116.0
0.2	93,000	28.9	1898.9	55,200	24.7	2113.6
0.5	77,800	27.4	1897.4	41,800	21.2	2110.1
1	67,600	26.3	1896.3	33,700	18.5	2107.4
2	58,400	25.1	1895.1	27,200	16.6	2105.5
5	48,100	23.6	1893.6	20,400	14.4	2103.3
10	40,100	22.4	1892.4	16,000	12.6	2101.5
20	33,500	21.0	1891.0	12,500	11.2	2100.1
50	25,500	19.2	1889.2	9,000	9.8	2098.7
99	21,000	18.0	1888.0	7,000	8.8	2097.7

Cherry River Water Surface Profiles

General

Existing condition water surface profiles were developed for a study reach of 10.6 miles. The Cherry River model begins near Craigsville at the confluence of the Cherry and Gauley Rivers downstream of Richwood and extends upstream to RM 10.6, near the confluence of the North Fork Cherry River and South Fork Cherry River. Profiles were computed for the 99, 50, 20, 10, 5, 2, 1, 0.5, 0.2 and 0.1 percent chance exceedence events.

HEC-RAS Numerical Model

Geometric Data

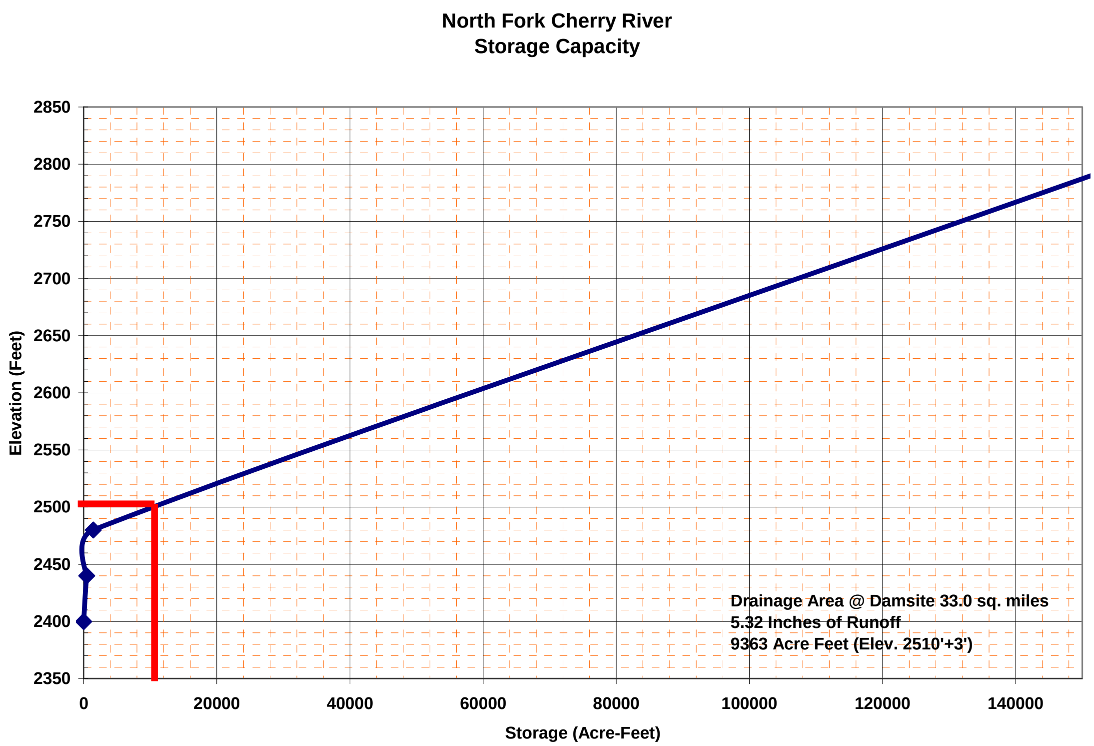
The majority of the geometric input data was obtained from USGS quadrangle maps (2003) with 40 feet contours and orthophotogrammetry (2007). Input data for the HEC-RAS, Version 4.0, numerical model (geometry file) was obtained from an existing HEC-2 model. A combination of the HEC-RAS numerical model, the original topographic data, updated orthophotogrammetry and engineering judgment were utilized to establish coefficients for hydraulic computations associated with the channel analysis. Manning's n-values in Chow (1959) were used as a guide for the initial approximations of overbank n-values, 0.045 – 0.11 with an average value of 0.071, and channel n-values, 0.03 – 0.1, with an average value of 0.038.

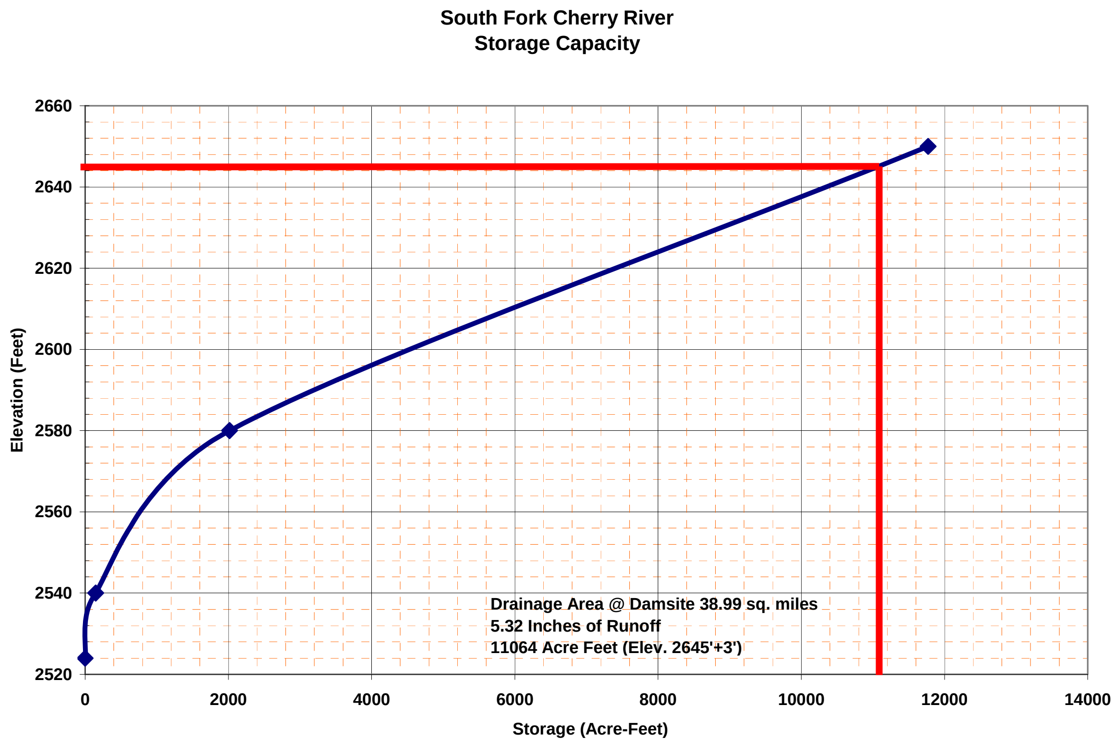
Starting Water Surface Elevations

The normal depth boundary condition was used for the starting water surface elevations for the Cherry River.

Flood Control Reservoir Analysis

Dam site locations, both on the North Fork Cherry River and South Fork Cherry River, were selected based on considerations of topography and point of maximum storage retention within the watershed. Data was obtained to create storage (area) capacity curves to facilitate costing of the dam alternatives. The National Weather Service's Point Precipitation Frequency Data for a 100-yr flood was applied to the contributing drainage area upstream of each of the respective dam sites to determine storage for the dam alternatives.


North Fork Cherry River
Storage Capacity
Elevation (Feet)
2850
2800
2750
2700
2650
2600
2550
2500
2450
2400
2350
0
20000
40000
60000
80000
100000
120000
140000
Storage (Acre-Feet)
Drainage Area @ Damsite 33.0 sq. miles
5.32 Inches of Runoff
9363 Acre Feet (Elev. 2510'+3')


South Fork Cherry River
Storage Capacity
Elevation (Feet)
2660
2640
2620
2600
2580
2560
2540
2520
0
2000
4000
6000
8000
10000
12000
14000
Storage (Acre-Feet)
Drainage Area @ Damsite 38.99 sq. miles
5.32 Inches of Runoff
11064 Acre Feet (Elev. 2645'+3')

FLOOD WARNING ANALYSIS

Flood Warning and Response (Richwood West Virginia)

Flood warning and preparedness systems improve a community's capability for accurate and timely forecasts of severe floods. The purpose of the flood warning system is to reduce the threat to life, reduce social disruption, reduce health hazards, reduce disruption of services, and provide reduced cleanup costs. The warning system would be situated in the county to provide enough time for the local community to get personal belongings to higher ground and out of flood danger. A number of stream gauges would need to be located upstream of the primary damage center to provide valuable information about the potential danger of flooding. Along with the stream gauges, a computer system with software would be installed to provide necessary information about the impending flood.

The Cherry River Watershed is located in the northern part of Greenbrier County, the eastern corner of Nicholas County, the southwestern edge of Pocahontas County, and the southeastern edge of Webster County. The Cherry River flows in a northwestward direction to its confluence with the Gauley River. The drainage pattern is dendritic and is composed of three main tributaries which produce a fan-shaped boundary. The North Fork and South Fork of the Cherry River join at Richwood to form the main stem of the Cherry River. Laurel Creek enters the Cherry River at Fenwick which is approximately three miles downstream from Richwood or about six miles upstream from the mouth of the Cherry River. The watershed is approximately 17 miles long, 13 miles wide and drains about 165 square miles. The topography is steep, and elevations range from 4,524 feet in the headwaters of the North Fork and 4,518 feet near the headwaters of South Fork, to approximately 1,870 feet at the junction with the Gauley River. At the present time, there are no stream gauges upstream of Richwood.

In the Gauley River watershed of which the Cherry River is a subbasin, there is a gauge located on the Cranberry River near Richwood, and one on the North Fork of the Cranberry River near Hillsboro. The Cranberry flows into the Gauley below Richwood, and is located in the Monongahela National Forest. There is a gauge on the Cranberry's left bank, 30 ft. downstream from the U.S. Forest Service Highway Bridge, 0.6 miles upstream from Barrenshe Run, and five miles north of Richwood. It is at mile 5.6 and has a drainage basin of 80.4 sq. mile.

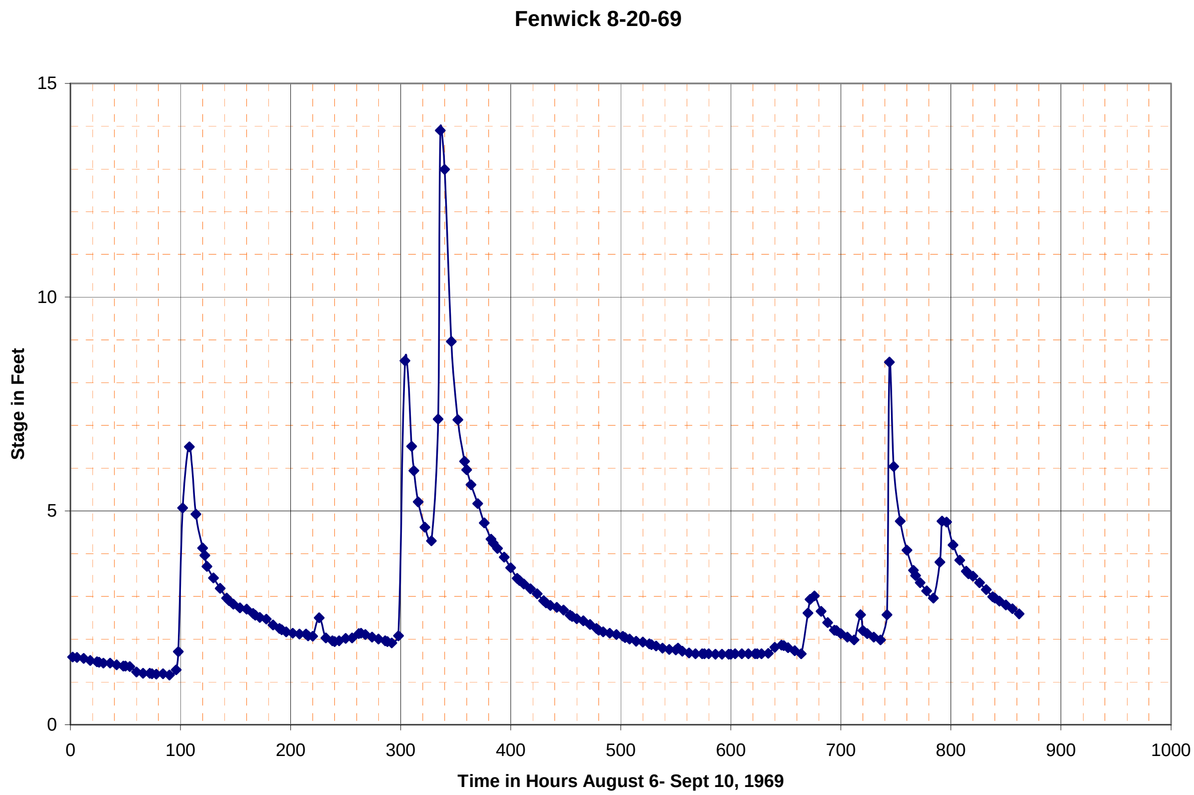
The Huntington District has obtained 2-Hour data from the United States Geological Surveys (U.S.G.S.), located in Charleston, West Virginia on a flood that occurred on August 20, 1969. This data shows that the flood had a maximum rate of rise of approximately 3.4 feet per hour. The channel velocities during the 1954 flood varied from 10.9 feet per second to 19.3 feet per second. With reaches of 13 to 17 miles in length, the flood wave would reach the downtown business district of Richwood in one and one half to three hours. The current HEC-RAS model produced average velocities in the channel of 13.26 feet/second and a little over 2.1 feet/second in the overbanks.

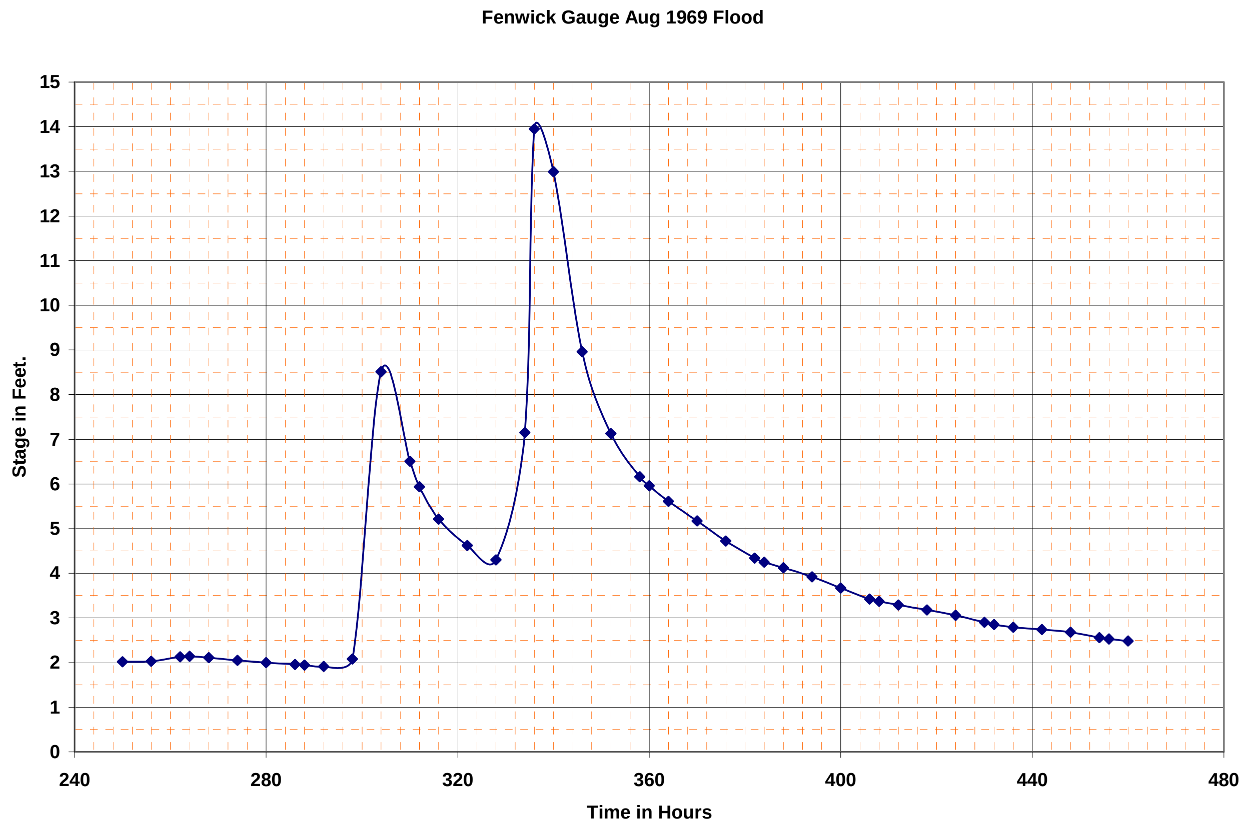
$$\frac{60 \text{ mile/hour}}{88 \text{ feet/second}} = \frac{X \text{ mile/hour}}{13.26 \text{ feet/second}}$$

X= 9.04 mile per hour

A flood wave normally travels slower than what is represented by the channel velocities, therefore the travel time would vary from 5 and 9 miles per hour which would place storms of this magnitude in the streets of Richwood in one and a half to three hours. The historic data on the Cherry River at Fenwick reveals that the time of crest for a large event is less than 8 hours. With a rate of rise of 3.4 feet/hour, it would take one to three hours for the water to be out of banks.

Based on the available data, it would be reasonable to assume that a flood warning system could be installed that would provide two to three hours of advanced flood warning time. The hydrographs below represents the flood that occurred in August of 1969 at the Fenwick Gauge. The peak of the storm occurred between 2 am and 6 am on the 22nd of August 1969. The second chart represents a window of the peak during the same storm.





There have been several significant storms in recent years that have occurred over the area. To control the flooding, it is necessary to control a large portion of the drainage basin. A gauge on the North Fork below the Summit Lake confluence with the North Fork would be a logical place to investigate placing a gauge. A gauge on the South Fork could be located below Rocky Run which is approximately half way up the stream, and one located on Little Laurel Creek in Greenbrier County just below the larger tributary that comes in on the left bank. Normally stream gauges are located on a bridge structure although they can be placed on sturdy metal poles. There was previously a gauge at Fenwick below Richwood and upstream of Holcomb. The gauge at Fenwick was discontinued in September 1982. The gauge structure at Fenwick has been totally removed along with the bridge it was located on. The West Virginia Department of Highways removed the bridge and built a new structure. This gauge would have to be totally rebuilt. It may also be necessary to install a repeater if the path studies reveal the signal can not be heard. The available annual Data for the Cherry River at Fenwick and the Cranberry River in Richwood is tabulated below in Table I and Table II. The gauge data found in Table I and Table II is collected and published by the United States Geological Survey (U.S.G.S.) in Charleston, West Virginia.

Table I

USGS
science for a changing world

USGS Home
Contact USGS
Search USGS

National Water Information System: Web Interface

USGS Water Resources

Data Category: Surface Water
Geographic Area: United States
GO

News: Recent changes

Peak Streamflow for the Nation

USGS 03189000 CHERRY RIVER AT FENWICK, WV

Available data for this site: Surface-water: Peak streamflow GO

Nicholas County, West Virginia
Hydrologic Unit Code 05050005
Latitude 38°13'45", Longitude 80°35'00" NAD27
Drainage area 150.00 square miles
Gage datum 2,088.94 feet above sea level COE1912

Output formats
- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1930	Oct. 02, 1929	12.00	12,100
1931	Apr. 04, 1931	9.44	5,100
1932	Jul. 04, 1932	14.58	21,200
1933	Jan. 21, 1933	9.84	5,900
1934	Mar. 05, 1934	10.04	6,300
1935	Mar. 12, 1935	8.95	4,740
1936	Mar. 17, 1936	11.50	10,400
1937	Dec. 07, 1936	9.94	6,100
1938	Oct. 28, 1937	10.99	8,900
1939	Feb. 03, 1939	11.90	13,100

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1951	Dec. 07, 1950	10.70	9,750
1952	Mar. 11, 1952	10.86	10,200
1953	Feb. 21, 1953	10.19	8,530
1954	Jul. 19, 1954	19.80	37,000
1955	Oct. 15, 1954	10.63	10,900
1956	May 28, 1956	8.73	6,860
1957	Jan. 10, 1957	9.87	9,200
1958	Apr. 06, 1958	8.60	6,680
1959	Jan. 22, 1959	7.77	5,280
1960	Apr. 03, 1960	11.15	12,500

1940	Jun. 27, 1940	15.20	23,100	1961	Feb. 25, 1961	10.70	11,200
1941	Apr. 05, 1941	8.86	5,970	1962	Mar. 21, 1962	9.35	8,200
1942	Mar. 09, 1942	8.87	5,970	1963	Mar. 06, 1963	10.21	9,920
1943	Dec. 30, 1942	8.52	5,270	1964	Mar. 05, 1964	10.38	10,600
1944	Apr. 12, 1944	9.25	6,520	1965	Feb. 07, 1965	7.36	4,780
1945	Jan. 01, 1945	9.26	6,710	1966	Feb. 13, 1966	9.37	8,410
1946	Jan. 07, 1946	11.13	10,800	1967	Mar. 07, 1967	11.86	14,200
1947	Mar. 25, 1947	8.92	5,970	1968	Mar. 12, 1968	8.00	5,800
1948	Feb. 14, 1948	10.43	9,000	1969	Aug. 20, 1969	17.09	29,800
1949	Dec. 15, 1948	8.48	5,270	1980	Nov. 26, 1979	8.37	6,210
1950	Jan. 31, 1950	9.16	6,520	1981	May 28, 1981	13.18	17,400
				1982	May 30, 1982	10.58	11,000

Table II

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National Water Information System: Web Interface

USGS Water Resources | **Data Category:** Surface Water | **Geographic Area:** United States | GO

News: Recent changes

Peak Streamflow for the Nation

USGS 03187500 CRANBERRY RIVER NEAR RICHWOOD, WV

Available data for this site | Surface-water: Peak streamflow | GO

Nicholas County, West Virginia
Hydrologic Unit Code 05050005
Latitude 38°17'43", Longitude 80°31'36" NAD27
Drainage area 80.4 square miles
Contributing drainage area 80.4 square miles
Gage datum 2,129.88 feet above sea level NAVD88

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Streamflow (cfs)
1945	Jan. 01, 1945	7.37	4,120
1946	Jan. 07, 1946	8.65	5,810
1947	Mar. 25, 1947	6.84	3,320
1948	Feb. 14, 1948	7.75	4,550
1949	Dec. 15, 1948	6.65	3,020
1950	Jan. 31, 1950	7.26	3,960
1951	Dec. 04, 1950	7.17	3,790
1954	Jul. 19, 1954	12.22	12,200[7]
1965	Sep. 16, 1965	7.37	4,160
1966	Feb. 13, 1966	7.43	4,260
1967	Mar. 07, 1967	9.18	6,590
1968	Mar. 13, 1968	6.35	2,600
1969	Aug. 20, 1969	7.43	4,260
1970	Dec. 31, 1969	8.72	4,650
1971	Dec. 22, 1970	7.32	4,070
1972	Feb. 26, 1972	8.34	5,470[E]
1973	Nov. 01, 1972	8.91	6,170[E]
1974	Dec. 26, 1973	8.43	5,500[E]
1975	Sep. 23, 1975	7.01	3,570[E]
1976	Jan. 01, 1976	6.91	3,410[E]
1977	Oct. 09, 1976	9.02	6,330[E]
1978	Jan. 26, 1978		8,900[2,E]
1979	Mar. 05, 1979	8.37	5,420[E]
1980	Nov. 26, 1979	6.11	2,610
1981	Jun. 10, 1981	9.18	6,590
1982	May 30, 1982	6.78	3,280
1984	Mar. 21, 1984	11.98	11,270[E]
1985	May 24, 1985	7.25	3,920
1986	Nov. 04, 1985	11.41	10,500
1987	Dec. 24, 1986	6.75	3,220
1988	Sep. 25, 1988	5.80	2,030
1989	Aug. 21, 1989	11.93	11,200
1990	Jan. 01, 1990		3,600[2]
1991	Mar. 23, 1991	8.68	5,850
1992	Dec. 02, 1991	9.80	7,640
1993	Apr. 01, 1993	6.94	3,470
1994	May 08, 1994	9.46	7,040
1995	Jan. 15, 1995	6.80	3,270
1996	Jan. 19, 1996	10.81	9,610
1997	Dec. 02, 1996	6.66	3,070
1998	Jan. 08, 1998	8.75	6,030
1999	Jan. 24, 1999	6.72	2,830
2000	Feb. 19, 2000	8.55	5,680
2001	Jul. 29, 2001	11.09	10,500
2002	May 07, 2002	8.83	6,140
2003	Sep. 04, 2003	7.64	4,120
2004	Nov. 19, 2003	11.90	12,200
2005	Mar. 28, 2005	8.37	5,360
2006	Nov. 29, 2005	9.98	8,230
2007	Mar. 02, 2007	7.63	4,100

Peak Streamflow Qualification Codes.

- 2 -- Discharge is an Estimate
- 7 -- Discharge is an Historic Peak
- E -- Only Annual Maximum Peak available for this year

Title: Surface Water for USA: Peak Streamflow
URL: http://waterdata.usgs.gov/nwis/peak?

A very rough estimate of what a flood warning system for Richwood might look like would be a minimum of two but a likely need for three stream gauges along with an upgrade at the Fenwick Gauge. For an estimated three (3) stream gauges at $25,000 per gauge, path studies at $10,000, stream ratings at $10,000, O&M manual at $50,000, and a computer with Storm Watch software at $10,000, this would be in the neighborhood of

$160,000 to $170,000. The gauge at Fenwick was discontinued in September 1982, so instead of just upgrading the gauge would have to be totally replaced. This would increase the estimate by roughly $25,000 which would raise the overall cost to 170,000 - $180,000. This would be a coordinated effort between the U.S.G.S., NWS, Homelands Security, and the Corps of Engineers to investigate the need to incorporate the Fenwick gauge location into the NWS forecast model.

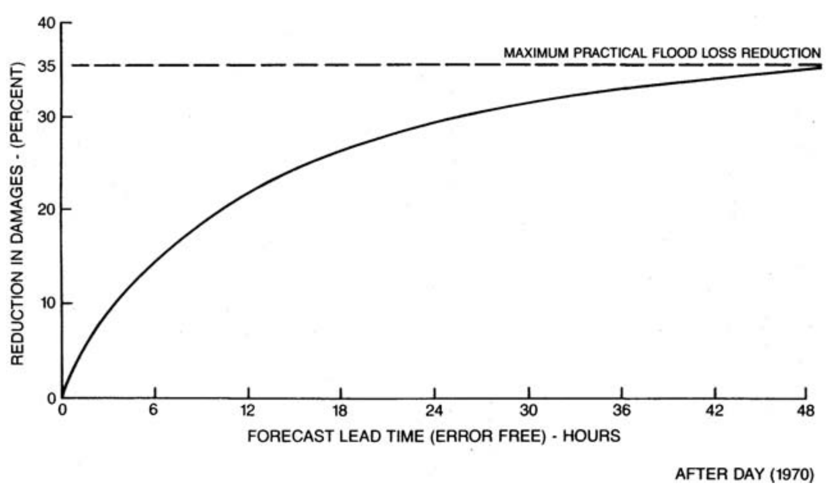
Economic Analysis

Flood Warning Systems (FWS) are designed to improve a community's capability to accurately forecast flood events in a timely manner. These systems provide communications channels and the information necessary for individuals to safely evacuate the area and effectively take actions to reduce flood damages.

The recommended system to aid the residents and business owners of the Cherry River Watershed includes the installation of four new gages. Based on historical data, the baseline cost, which includes procurement and installation of gages, path studies and stream ratings, development of an O&M manual, and equipment and software necessary for system operation, is roughly $180,000. In addition to this first cost, the system would require an additional $16,000 annually for proper operations and maintenance.

In order to determine the economic viability of a FWS in the Cherry River Watershed, and economic analysis was performed in accordance with the procedures outlined in Chapter IX of the National Economic Development Procedures Manual - Urban Flood Damage (IWR Report 88-R-2) dated March 1988. According to this guidance, a common tool for evaluating the benefits related to warning and preparedness measures is the lead time-damages prevented function. This function was developed by Harold Day and is used to estimate potential damages reduced based on the amount of warning time. The Day lead time-damages prevented curve is presented in Figure 1. Day's curve assumes a 100 percent response meaning all the affected population will receive the message, know what to do, and have the inclination and the capability to respond.

FIGURE 1 – Flood Warning Response Maximum Practical Flood Loss Reduction



Based on the Day Curve, benefits associated with flood warning systems can be estimated using two parameters – forecasted advance warning time and existing flood damages. Incorporating the recommended FWS, the warning time within the Cherry River Watershed was calculated as approximately two to three hours. Data to support this estimate is located in Tab I of this write-up.

For this analysis, a conservative two hours of warning time was assumed. Based on the Day Curve, two hours of lead time corresponds to a six percent reduction in residual damages. The expected annual content damages associated with the without project condition was computed as $992,410 using Hec-FDA (Flood Damage Analysis), which is the officially recognized Corps economic model for flood damage reduction evaluations. Based on this estimation and the Day Curve, the recommended FWS could potentially reduce flood damages annually by $59,540.

The average annual costs of the FWS were computed based on a 50-year period and a 4 7/8 percent interest rate. Given a baseline cost of $180,000, the average annual project cost would be $9,670 plus $16,000 for annual O&M for a total of $25,670. When comparing the project benefits to the annualized cost, it is clear a FWS in the Cherry River Watershed is economically feasible. Overall, the recommended FWS produces approximately $33,870 in net benefits equating to a benefit cost ratio of 2.32. Details of this analysis are shown in Table 1.

Table 1: FWS Benefit-Cost Analysis ($1,000s)	
Expected Annual Content Damages – Without Project Condition	$992.41
Warning Time	2 hours
Percent Reduction Based on Day Curve	6%
Expected Annual FWS Benefits	$59.54
Expected Annual Cost	$25.67
Net Benefits	$33.87
Benefit-Cost Ratio	2.32 to 1.00

COST METHODOLOGY

1. GENERAL

Preliminary Estimates have been prepared to an equivalent price level of 1 October 2007. The preparation of the cost estimates is in accordance with guidelines and policies included in "ER 1110-1-1300 - Const Engineering Policy and General Requirements, dated 26 March 1993" and "ER 1110-2-1302 - Civil Works Cost Engineering, dated 31 March 1994". The estimates were prepared using the MCACES 2nd Generation MII Version 2.3 cost estimating software developed by Project Time and Cost, Atlanta, Georgia. The estimates were based on a recent estimate prepared for the Marlinton local protection project design document report. Parameter changes were not made within the estimates. Accounts 01 Lands & Damages, 30 Engineering & Design, and 31 Construction Management have not been included in the MII estimates.

2. DIRECT COSTS

Direct costs were based on anticipated equipment, labor, and materials necessary to construct the project as scoped. Local material quotes were obtained for most of the larger quantity items. Historical cost references were used to develop some portions of the cost estimate where quantities were not as detailed and where recently estimated bid item unit prices would adequately cover costs. Direct costs were calculated independent of the contractor assigned to perform the tasks. Following formulation of the direct cost, a determination was made as to whether the work would be performed by the prime contractor or a subcontractor.

2.1 Labor-Wage Determination

Pocahontas County, West Virginia, Davis-Bacon wage rates (General Decision Number: WV030010 10/06/2006), as provided by the Department of Labor, were used for all craft labor. The total labor rate was developed using the base wage, fringe benefits, Federal Insurance Contributions Act (FICA), Federal Unemployment Tax Act (FUTA), and Workman’s Compensation rates for each craft, 2.5% is added to cover show up time. The base wage rate and fringe were entered into MII and applied accordingly. Additional labor burdens are computed by MII based on the state, which in this case is West Virginia.

2.1.1. Overtime

Overtime was not anticipated and therefore not included.

2.2 Equipment Rates

The latest Equipment database, based on EP 1110-1-8, Construction Equipment Ownership and Operation Expense Schedule, Region II, 2005 was used and adjusted for current fuel costs.

2.3. Crews

Project specific crews have been developed for use in estimating the direct costs of construction for those items not estimated using quotes or historical cost information. Crew members consist of selected complements of labor classifications and equipment pieces assembled to perform specific tasks. Productivity has been assigned to each crew reflective of the expected output per unit of measure for the specific activities listed in the cost estimates.

2.4. Material Quotes

Material prices were obtained through telephone solicitations with vendors, Internet suppliers, the MII Cost Book, and R.S. Means Cost data references.

2.4.1. Sales Tax

West Virginia sales tax is included at 6.0%.

2.5. Quantities

The quantity takeoffs were developed and provided by the Project Development Team (PDT) members. Quantities were spot-checked and sub-quantities for the project were developed by the estimator.

3. INDIRECT COSTS

3.1. PRIME CONTRACTOR

3.1.1. Field Office Overhead (FOOH)

The indirect costs for Field Office Overhead (FOOH) were included as a percentage of the direct costs. For this project, 14% was used for FOOH. This value represents the anticipated prime contractor field overhead costs for such items as project supervision, contractor quality control, contractor field office supplies, personal protective equipment, field engineering, and other incidental field overhead costs.

3.1.2. Home Office Overhead (HOOH)

For Home Office Overhead (HOOH) expense, the cost estimate included an allowance applied as a percentage of direct cost plus field overhead. HOOH included items such as office rental/ownership costs, utilities, office equipment ownership/maintenance, office staff (managers, accountants, clerical, etc.), insurance, and miscellaneous. In this case, a value of 6% was assumed for the prime contractor.

3.1.3. Profit

Profit has been included as a percentage. In this case, a value of 8.3% was assumed for the prime contractor.

3.1. 4. Bond

Bond was included as a running percentage of 2%.

3.1.5. B&O Tax

Business & Operation (B&O) tax was included as a running percentage of 2%.

3.2 SUBCONTRACTORS

3.2.1. Field Office Overhead (FOOH)
All subcontractor overhead costs were set to 12.5% of direct cost to account for such items as project supervision, contractor quality control, contractor field office supplies, personal protective equipment, field engineering, and other incidental field overhead costs. The exception is where the subcontractor has provided a quoted price including overhead. In that case, no additional markups have been included for subcontractor's overhead.

3.2.2. Home Office Overhead (HOOH)
The cost estimate included an allowance applied as percentage of direct cost plus field overhead for HOOH. HOOH included such items as office rental/ownership costs, utilities, office equipment ownership/maintenance, office staff (managers, accountants, clerical, etc.), insurance, and miscellaneous. In this case, a value of 6% was assumed for the subcontractor.

3.2.3. Profit
Profit has been included for Sub-Contractor as a running percentage of 2%.

3.2.4. B&O Tax
B&O Tax was included for the Sub-Contractor at the rate of 2%.

4. ESCALATION
Escalation was not included in the MII Preliminary Estimates.

5. CONTINGENCY
An overall contingency allowance of 25% has been included and is considered reasonable for this stage of design.

VENTURE LEVEL COST ESTIMATE
October 2007 Price Level

	Project Cost Incl Mitigation	Rounded Project Cost**
NORTH FORK CHERRY RIVER DRY DAM	**$ 328,000,697**	**$ 328,000,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
04 Dams	247,343,923	
06 Mitigation	270,000	
30 Engineering & Design	61,835,981	
31 Supervision & Administration	18,550,794	
SOUTH FORK CHERRY RIVER DRY DAM	**$ 342,519,400**	**$ 343,000,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
04 Dams	258,301,434	
06 Mitigation	270,000	
30 Engineering & Design	64,575,358	
31 Supervision & Administration	19,372,608	
SOUTH FORK CHERRY RIVER WET DAM	**$ 347,131,924**	**$ 347,000,000**
01 Lands and Damages (not estimated)	***significant***	
02 Relocations (not estimated)		
04 Dams	258,997,679	
06 Mitigation	3,960,000	
30 Engineering & Design	64,749,420	
31 Supervision & Administration	19,424,826	
RICHWOOD UP STREAM FLOODWALL	**$ 31,380,515**	**$ 31,000,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ 970,000.00	
11 Levee & Floodwall	23,683,408	
30 Engineering & Design	5,920,852	
31 Supervision & Administration	1,776,256	

	Project Cost Incl Mitigation	Rounded Project Cost**
RICHWOOD DOWN STREAM FLOODWALL	**$ 28,017,953**	**$ 28,000,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ 690,000	
11 Levee & Floodwall	21,145,625	
30 Engineering & Design	5,286,406	
31 Supervision & Administration	1,585,922	
RICHWOOD ELEM. SCHOOL LEVEE	**$ 104,922**	**$ 105,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ -	
11 Levee & Floodwall	79,186	
30 Engineering & Design	19,797	
31 Supervision & Administration	5,939	
RICHWOOD HIGH SCHOOL RINGWALL	**$ 10,150,880**	**$ 10,150,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ -	
11 Levee & Floodwall	7,661,041	
30 Engineering & Design	1,915,260	
31 Supervision & Administration	574,578	
SENIOR CENTER RINGWALL	**$ 1,951,445**	**$ 2,000,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ -	
11 Levee & Floodwall	1,472,789	
30 Engineering & Design	368,197	
31 Supervision & Administration	110,459	
W.V. NATIONAL GUARD RINGWALL	**$ 3,110,252**	**$ 3,110,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ -	
11 Levee & Floodwall	2,347,360	
30 Engineering & Design	586,840	
31 Supervision & Administration	176,052	

	Project Cost Incl Mitigation	Rounded Project Cost**
LIBRARY VENEER WALL	**$ 608,935**	**$ 609,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ -	
11 Levee & Floodwall	459,574	
30 Engineering & Design	114,893	
31 Supervision & Administration	34,468	
MUNICIPAL BLDG VENEER WALL	**$ 741,886**	**$ 742,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ -	
11 Levee & Floodwall	559,914	
30 Engineering & Design	139,978	
31 Supervision & Administration	41,994	
HOSPITAL VENEER WALL	**$ 1,063,758**	**$ 1,064,000**
01 Lands and Damages (not estimated)		
02 Relocations (not estimated)		
06 Mitigation	$ -	
11 Levee & Floodwall	802,836	
30 Engineering & Design	200,709	
31 Supervision & Administration	60,213	
FLOOD WARNING SYSTEM	**$ 180,000**	**$ 180,000**
3 gauges/upgrade to Fenwick		
** Assumed 25% of construction costs for E&D.*		
*** Assumed 7.5% of construction costs for S&A.*		

MITIGATION COST CONSIDERATIONS

To approximate mitigation costs for loss of aquatic habitat, the Eastern Kentucky Stream Assessment Protocol (EKSAP) was used. EKSAP has been used on previous USACE projects to determine in lieu fee mitigation costs. By forecasting future with project conditions and comparing them to current conditions, this method provided an effective and efficient way to estimate reconnaissance level mitigation costs. By incorporating habitat quality as a factor in the estimate, the EKSAP forms an approximate representation of expected mitigation costs for direct habitat loss given the high quality of the Cherry River. Data used in the estimation was obtained from the West Virginia Department of Environmental Protection Watershed Assessment Program, and represents habitat and water quality data collected for the entire Cherry River watershed. For each habitat scoring criteria, an average of all sites was used. The $1,050 per acre unit cost used for mitigation of terrestrial habitat loss was derived from a review of terrestrial mitigation for several projects with similar existing conditions as the Cherry River Watershed.

North Fork Cherry River Dry Dam

For the North Fork Dry Dam, mitigation costs were estimated for the direct loss of terrestrial and aquatic habitat from the dam itself, and totaled $270,000. The footprint of the dam was estimated to cover approximately 12 acres of terrestrial habitat and 750 linear feet of aquatic habitat. For aquatic habitat, this equates to 0.91 Ecological Integrity Units over 750 feet, totaling $260,000 in mitigation costs. For terrestrial impacts, the loss of bottomland hardwood forest was estimated to be $10,000 at a unit cost of $1,050 per acre.

This estimate of mitigation only includes direct habitat loss from the dam, and does not consider potential impacts to upstream or downstream aquatic resource, endangered species, fish passage, or cumulative effects.

South Fork Cherry River Dry Dam

For the South Fork Dry Dam, mitigation costs were estimated for the direct loss of terrestrial and aquatic habitat from the dam itself, and totaled $270,000. The footprint of the dam was estimated to cover approximately 12 acres of terrestrial habitat and 750 linear feet of aquatic habitat. For aquatic habitat, this equates to 0.91 Ecological Integrity Units over 750 feet, totaling $260,000 in mitigation costs. For terrestrial impacts, the loss of bottomland hardwood forest was estimated to be $10,000 at a unit cost of $1,050 per acre.

This estimate of mitigation only includes direct habitat loss from the dam, and does not consider potential impacts to upstream or downstream aquatic resource, endangered species, fish passage, or cumulative effects.

South Fork Cherry River Wet Dam

For the South Fork Wet Dam, mitigation was calculated for the loss of aquatic and terrestrial habitat from the formation of the reservoir and the dam itself, which totaled

$3,960,000. A stream length of 9800 linear feet and an area of 300 acres representing the winter pool were used for the estimates. A total loss of the stream habitat was assumed, with 0.91 Ecological Integrity Units lost over a distance of 3246 linear feet, which totaled $3,300,000. For terrestrial impacts, $315,000 was used to represent the replacement of 300 acres of hardwood forest at $1,050 per acre unit cost. Total mitigation costs were estimated to be approximately $3,600,000 for this alternative.

Mitigation costs were also estimated for the direct loss of terrestrial and aquatic habitat from the dam itself. The footprint of the dam was estimated to cover approximately 12 acres of terrestrial habitat and 750 linear feet of aquatic habitat. For aquatic habitat, this equates to 0.91 Ecological Integrity Units over 750 feet, totaling $260,000 in mitigation costs. For terrestrial impacts, the loss of bottomland hardwood forest was estimated to be $10,000 at a unit cost of $1,050 per acre.

This estimate only considers mitigation for direct loss of aquatic and terrestrial habitat from the dam construction and reservoir, and does not incorporate potential aquatic resource impacts downstream of the dam, endangered species, wetlands, fish passage, or cumulative effects.

Richwood Upstream Floodwall

Mitigation for the Upstream Floodwall was calculated for the impacts to the aquatic habitat of the Cherry River, which totaled $970,000. The installation of the floodwall would likely impact the riparian corridor and result in a decrease in the aquatic habitat quality. The Eastern Kentucky Stream Assessment Protocol was used to estimate the reduction in stream quality and associated mitigation costs. A loss of 0.25 Ecological Integrity Units was assessed over a length of 4,500 feet, resulted in approximately $970,000.

Mitigation for the loss of terrestrial habitat due to the Upstream Floodwall was not considered at the reconnaissance level. As the current floodwall design encompasses the primarily urban environment of downtown Richwood, terrestrial resource impacts would not be expected to be significant.

Richwood Downstream Floodwall

Mitigation for the Downstream Floodwall was calculated for the impacts to the aquatic habitat of the Cherry River, which totaled $690,000. The installation of the floodwall would likely impact the riparian corridor and result in a decrease in the aquatic habitat quality. The EKSAP was used to estimate the reduction in stream quality and associated mitigation costs. An estimated loss of 0.25 Ecological Integrity Units was assessed over a length of 3,200 feet, totaling $690,000.

Mitigation for the loss of terrestrial habitat due to the Downstream Floodwall was not considered at the reconnaissance level. As the current floodwall design encompasses the primarily urban environment of downtown Richwood, terrestrial resource impacts would not be expected to be significant.

Non-structural Measures

Given the limited size and scope of the non-structural alternatives and the urban nature of the area, mitigation costs were considered unlikely and were not calculated at the reconnaissance level. Non-structural alternatives include the Richwood Elementary School Levee, the Richwood High School Ringwall, the Senior Center Ringwall, WV National Guard Ringwall, Library Veneer Wall, Municipal Building Veneer wall and Hospital Veneer Wall.

Ecosystem Restoration

Ecosystem restoration measures would result in a positive impact on environmental resources, and would not require mitigation.

APPENDIX B

CORRESPONDENCE

Public Workshop Information and Comments

Federal, State, and Local Correspondence