THE EFFECTS OF FLOOD CONTROL STRUCTURES IN THE UPPER ARROYO SECO WATERSHED

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**EXECUTIVE SUMMARY**

About 70% of the earth’s surface is covered with water. In fact, a large percentage of the earth’s population lives near a body of water. Water was the attraction that brought the first settlers and succeeding generation to the Arroyo Seco. The flowing water and rich soil conditions endowed the Arroyo Seco communities with rich natural heritage. While the Spaniards dubbed the watershed Arroyo Seco or “dry stream,” the Tongva or Gabrielino Native Americans referred to the land region between Los Angeles and San Gabriel Rivers as Hahamongna, “the land of flowing waters, fruitful valley” [1].

A variety of factors have led to a steady deterioration of environmental conditions in the Arroyo Seco watershed. Flood control structures within the watershed are part culpable for the alteration of the stream ecology and hydrology. The following report will give an overview of the U.S. flood control legislations that have shaped the nation’s rivers and streams and describe Brown Mountain Dam’s impact to the Arroyo Seco Watershed ecology.
PROJECT OBJECTIVES

Of the nearly 23 mile stretch, half of the Arroyo Seco’s length and area lies in the upper mountain watershed. This stretch has been subject to fierce rainstorms and raging forest fires that cause substantial damage to erosion-prone slopes in this relative small upper watershed. As flood control measures, flood control structures rose within the upper watershed and eventually generate environmental issues to its surroundings. Of these structures, Brown Canyon Debris Barrier (also known as Brown Mountain Dam) has presented many conflicts with the stream’s geomorphology.

Today, Brown Mountain Dam (BMD) raises many questions regarding its integrity and purpose. BMD has stood tall for over 70 years through violent rainstorms and forest fires. Although vague inspection reports communicate that the structure presents not potential danger to surrounding communities, as of the year 2004, a proper evaluation that includes the impact of the station fire on the structure must be done to reinforce the findings of the 2004 inspection. The purpose of the following is to educate the reader on flood control legislature that lead up to the construction of BMD. Also, the impacts of BMD to the watershed will be described.

PROJECT APPROACH

An analysis of the effect of flood control structures in the upper Arroyo Seco watershed was conducted. In order to get a better understanding of flood control structure, a research study on flood control history was conducted. This study will depict a more enhanced image of how and why BMD rose within the upper watershed and its impact to the streams ecology and hydrology.
1. **Flood Control**

1.1 *Brief History*

Flood on the Mississippi River in 1927 substantially expanded federal flood control funding and raised public awareness to a new level [2]. Though in the late 18th century, the framers of the Constitution did not believe that government should allow spending of tax dollars on improvements that would only benefit a small section of our great nation. In disagreement, John C. Calhoun and Henry Clay, both politicians and supporters of such improvements, contested that “the right to regulate commerce meant the right to facilitate or aid in its movement by funding road and river navigation projects.” Both Presidents, James Madison (1817) and James Monroe (1822), disagreed and vetoed transportation bills. Thanks to the landmark decision of *Gibbons v. Ogden* (1824), Chief Justice John Marshall’s Supreme Court extended the Commerce Clause which in return permitted the federal government to finance and construct river improvements. As a result of this decision, both the federal government and the U.S. Army Corps of Engineers implemented a program for river improvements that began in the 1820s.

With an unanticipated impact on flood control development, the 1850 Act was passed and allocated $50,000 for topographical and hydrographical survey of the Delta of the Mississippi [2]. This survey could have possibly been the foundation to determining a practical strategy that would prevent the river from inundating. One of the two surveys, conducted by Captain A. A. Humphreys and Lieutenant H. L. Abbot of the U.S. Corps of Topographical Engineers, disclosed that levees could possibly be the only effective solution for flood control in the lower Mississippi. In 1879, Congress created the Mississippi River Commission (MRC) to identify and implement the most satisfactory flood control plan possible in order to improve navigation and
The MRC simply stated that “the main purpose” of its levee construction program was “to protect the alluvial lands and their owners” from floods. Unfortunately, the floods of 1912 and 1913 manifested the inefficiencies to protect the river’s surrounding land with the “levees only” policy. Again, as a result of a major catastrophe, Congress began to reconsider a nationwide program of flood control.

Up until the early 20th century, most congressmen still believed that federal flood control projects, except perhaps on the Mississippi, were unconstitutional. It was suggested that the aid to navigation from levees or dams was small compared to the enormous local benefit received by residents and property owners in the protected area. The use of dams for flood control was often suggested but the idea seemed unfeasible to most people. The Pittsburgh Flood Commission Report of 1912 was then published and became the first effort to interest the federal government in funding a reservoir system for flood control. Yet, in 1923, with the completion of the Miami Conservancy District (MCD), it was proven that such systems could work. Designed by Arthur Ernest Morgan, the MCD became a river management agency operating in Southwest Ohio to control flooding of the Great Miami River and its tributaries. Within the design, the MCD built levees, straightened the river channel throughout the Miami Valley, and built five dry dams on various tributaries to control flooding.

The most concrete result of the Progressive Era’s flood control movement was the passage of the Flood Control Act of 1917, an important piece of flood control legislation prior to the 1936 act. The 1917 act was important in four aspects, one of which was that it marked the first time that Congress appropriated funds openly and primarily for the purpose of flood control. Also, the 1917 act established a congressional commitment to fund a long-range and comprehensive program of flood control for at least two flood-prone areas, the lower Mississippi
and the Sacramento rivers. As part of this legislation, Section 3 of the act authorized the Corps of Engineers to undertake examinations and surveys for flood control improvements, which were to be “a comprehensive study of the watershed of watersheds.” A leading authority on water resources law once stated that “the federal government has taken ‘a rather attenuated construction’ of the Commerce Clause promulgated in 1824 and used ‘this somewhat flimsy-looking, but by no means shaky structure for a foundation…[for] a huge program of river regulation and water control.”

1.2 The Flood Control Act of 1936

It was known as the “greatest disaster of peace times in our history” by Secretary of Commerce, Herbert Hoover. In 1927, the Mississippi River swept across an area roughly equal in size to Massachusetts, Connecticut, New Hampshire, and Vermont combined, leaving water as deep as thirty feet on the land stretching from Illinois and Missouri south to the Gulf of Mexico [3]. Flooding 3,000 miles of railroad tracks, the Mississippi flood of 1927 halted transportation through railroad across the Mississippi, south of St. Louis, where the impact was felt from Boston and New York to California. The flood of 1927 compelled people to rebuild their lives only to find themselves faced with the worst economic calamity in our country’s history, the Great Depression. The Corps no longer embraced the “levees only” policy after a series of attacks in Congress and in the public press following the Mississippi Flood of 1927, as it only depleted financial resources.

Engendered by the Mississippi River flood and a devastating November flood in New England, the chairman of the House Flood Control Committee commenced abstracts for possible legislations for a nationwide flood control program. Signed on May 15, 1928, by President
Calvin Coolidge, the Flood Control Act of 1928 became the last salient piece of flood control legislation passed by Congress precedent to the 1936 Flood Control Act. The 1928 Act put flood control up to par with other major projects of its time and it allowed an expenditure of almost $325 million, which became the largest appropriation ever authorized by the federal government [2]. President Coolidge played an important role in the development of the 1928 Act. The Act was later inherited to Herbert Hoover, the President to follow. It became Hoover’s task to implement the act’s plans. During the Great Depression’s distress, Hoover teamed up with political leaders in order to commence the Central Valley Project in California and pushed the flood control work on the Mississippi ahead as an unemployment relief measure.

Eventually, as part of the deep list of important Depression Era legislation enacted by the 74th Congress between the years 1935-1936, the $4.8 billion Emergency Relief Appropriation Act of 1935 gave way to programs designed to create public work. One of these programs was the Flood Control Act (FCA) of 1936 which was signed into law by President Franklin Delano Roosevelt on June 22, 1936. The FCA of 1936 was first introduced in Congress by Riley J. Wilson, an educator, attorney, and legislator from Louisiana that served in the U.S. House of Representatives from 1915 to 1939. The Act became one of the most important pieces of legislation in the history of the American environment. The Act provided the fundamental legislative authority for a vast system of water resource projects including hundreds of miles of canals, levees, channelization and flood walls, and, most importantly, over 375 major dams and reservoirs. The Act would establish an enormous commitment by the federal government to protect people and property on approximately 100 million acres [4].
1.3 The Los Angeles Flood of 1938

According to the Red Cross, the Los Angeles Flood of 1938 was the fifth largest flood in history. Within a span of four days, the Los Angeles Basin received over 10 inches of rain from two storm systems that roamed in from the Pacific. As a result of these storms, 20 structures were destroyed in the Arroyo Seco canyon. This flood event was documented as a 50 year flood, a flood having a 1 in 50, or 2%, chance of happening in any given year. According to the National Oceanic and Atmospheric Administration, floods kill more people annually than lightning, tornadoes, and hurricanes. The flood killed 144 people and left the county with major reconstruction planning for years [5]. It was estimated that damage done in the Los Angeles River watershed was worth up to $37,693,000. The Los Angeles Flood of 1938 served as a catalyst for flood control measures in Southern California and the merge of the Los Angeles Flood Control District and the Army Corp of Engineers to address these measures. Soon after the flood, the Arroyo Seco stream and part of the Los Angeles River were captured in a concrete channel, as seen in Figure 1. In January 1941, William V. Mendenhall, supervisor of the Angeles National Forest, received the approval by Claude Wickard, Secretary of the United States Department of Agriculture, for the $1,170,000 fire, flood protection program for the Arroyo Seco, making Brown Canyon Debris Barrier the first major construction project in this program [6].

2. Brown Mountain Dam

2.1 The Arroyo Seco Watershed

The Arroyo Seco Watershed is a subwatershed of the Los Angeles River Watershed. It stretches from the San Gabriel Mountains to Downtown Los Angeles. Historically a cultural
center of the Gabrielinos, also known as the Tongva or Kizh, the Arroyo Seco, Spanish for dry stream, is fed by a 46.7 square-mile watershed and runs through a span of nearly 23 miles. Starting at Red Box, near Mt. Wilson in the San Gabriel Mountains, the Arroyo Seco flows through steep canyons until it enters the urban plain of Southern California at Jet Propulsion Laboratory. The Arroyo Seco then proceeds through the largely channelized portion south of Devil’s Gate dam through Pasadena, South Pasadena, and Northeast Los Angeles to the confluence with the Los Angeles River near Elysian Park, Chinatown, and Downtown Los Angeles. Affectionately known to locals as simply “the Arroyo”, the Arroyo Seco was recently included in the National Register of Historic Places, placing it among the nation’s top cultural resources [7]. In 1911, the former U.S. President Theodore Roosevelt saw it as he rode through the Arroyo and proclaimed, “The Arroyo would make one of the greatest parks in the world” [8]. Geographically and historically, the Arroyo Seco has played an important in the development of water resources in Southern California [1].

2.2 *Brown Canyon Debris Barrier (Brown Mountain Dam)*

Built in 1942, Brown Canyon Debris Barrier, also known as Brown Mountain Dam (BMD), is a federal arch-gravity dam owned and operated by the U.S. Forest Service. It sits midway of the Arroyo Seco River, about 3.2 miles north of the mouth of the Arroyo Seco at Hahamongna [9]. BMD was the first facility built of a series of engineering structures in the Arroyo and was part of the first upstream flood control project ever attempted in the United State, with which the U.S. Forest Service expected to flood-proof the Los Angeles River Drainage areas back of Pasadena [10]. BMD’s primary function was to capture debris and sediment as well as to regulate the flow of water during the stormy winter seasons. It did not take long for the structure to convey its presence. Shortly after the final pour had been placed in the
BMD, a major flood occurred in the Arroyo Seco River, which stored 243,000 cubic yards of detritus in BMD reservoir, provided the first opportunity to observe the barrier in operation. The flood peak of 4,700 cubic feet per second passed the United States Geological Survey (USGS) Gaging Station, which is located about two miles downstream from BMD, at 1:30 a.m. on January, 1943 [11]. On December of 1944, a review performed on BMD proved that the structure indeed served its purpose. The barrier held back debris for a quarter mile and up to 40 feet. In 1945, Brown Canyon Debris Barrier was viewed as a successful experiment controlling silt and sediment as it was estimated that the barrier was one third filled with 320,000 cubic yards of debris.

2.3 Station Fire

In 2009, the state of California endured a series of 8,291. Burning through a span of nearly three months and 250 square miles of the Angeles National Forest, the 2009 Station Fire became known as the largest wildfire in the modern history of Los Angeles County, clearly transcending the 164 square mile Clampitt Fire of 1970 [12]. The station fire burned through the vulnerable, erosion-prone slopes of the Angeles National Forest. Fierce rainstorms followed the fire’s complete containment in October of that same year. The station fire of 2009 has been considered for partially depleting the dam’s capacity after allocating portion of the sediment trapped behind BMD and Devil’s Gate Dam, located nearly 3.5 miles downstream from BMD. Today, locals protest the Los Angeles County’s $100 million plan to haul away nearly four million cubic yards of sediment, endangering rich riparian and wetland vegetation.
2.4 Fish Passage

Such structure can be beneficial as well as detrimental to its surrounding ecosystems. According to the Department of Water Resources and the Division of Safety of Dams, a dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water that is 25 feet or more in height and has an impounding capacity for maximum storage elevation of 50 acre-feet or more [13]. Sitting at over 80 feet in height, BMD’s primary purpose was to trap debris and sediment as well as to regulate the flow of water. Although BMD has served its purpose and it currently sits full to capacity with sediment, habitats, both upstream and downstream, are being affected due to the inconsistent flow of water. The chemical, thermal and physical changes which flowing water undergoes when it is stilled can seriously contaminate a reservoir and the river downstream [14].

In a 2000 habitat restoration assessment done in the Arroyo Seco Watershed, it was stated that the Arroyo Seco “supports ideal pool and riffle sequences for resident trout or potential steelhead habitat”, with the exception of the vicinity of Brown Canyon Debris Dam or BMD. Southern steelhead is known to be historically present in the watershed. Flood structures within the watershed have been labeled as a primary factor that impedes their anadromous journey. Of these structures, BMD is considered to be the most significant upstream barrier to fish passage. Sitting at over 80 feet from the water surface below, BMD becomes a nearly impossible challenge for this and many other species to overcome. Currently, the dam is filled to capacity with sediment and has significantly altered the stream geomorphology [15].
**PROJECT OUTCOMES**

BMD is a federal dam owned by the U. S. Forest Service (USFS). Over the span of this seven month research study, the USFS opened their doors to their headquarters and gave me the opportunity to inquire about BMD. The USFS provided me with a file containing a log of inspections that dated back to 1983. The most recent inspection was performed on July 2004. Ten years have passed since the last inspection on BMD was executed. The watershed experienced the station fire in 2009 and a series of rain storms, which includes the 2010 storm that topped the 4,000 cubic feet per second mark at the USGS 11098000 Arroyo Seco NR Pasadena Ca. gage station.

During this process, I learned that the U.S. Army Corp of Engineers keeps an inventory of all existing dams. These dams are reported every year by their lawful owner to the Corp of Engineer and the Corp updates the list of dam on their National Inventory of Dams. To my surprise, out of the list of dams in the inventory, BMD was not included. During a meeting with the USFS, I was informed that the structure was reclassified as a debris barrier, not a dam. It is for that same reason that annual inspections have not been executed. The structure has trapped sediment and debris for the last 70 years that the capacity behind the structures is minimal.

**CONCLUSION**

Brown Mountain Dam has become an impediment to fish, habitat, and wildlife passage. It has degraded stream conditions downstream and upstream. In previous listings, BMD was categorized as a “Significant Hazard”, meaning that its failure would result in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities,
or can impact other concerns. Whether it’s categorized as a dam or barrier, a structural evaluation shall be done on the structure to mitigate possible damage due to failure.

In recent years, dam removal has been practiced on similar structures. As a result, many rivers and streams have been rehabilitated to their natural flow. In the best cases, anadromous fish return to spawning grounds that dams kept them from reaching. Brown Mountain Dam could be a possible candidate for removal. It currently sits topped with sediment which has led to the minimal storage capacity.

This experiential learning experience has provided me with great experiences that have broadened my scope of opportunities waiting for student like me to grab onto. It allowed me to meet directly with professional who express the same notion towards engineering and exercise their expertise. I walk away with countless valuable resources that will one day enrich my career.
APPENDICES

1. MODELING

2009 Station Fire and the Arroyo Seco Watershed

Burning through a span of nearly three months and 250 square miles of the Angeles National Forest, the 2009 Station Fire became known as the largest wildfire in the modern history of Los Angeles County, clearly transcending the 164 square mile Clumpit Fire of 1970.
Starting at Red Box, near Mt. Wilson in the San Gabriel Mountains, the Arroyo Seco flows through steep canyons until it enters the urban plain of Southern California at Jet Propulsion Laboratory. The Arroyo Seco then proceeds through the largely channelized portion south of Devil’s Gate dam through Pasadena, South Pasadena, and Northeast Los Angeles to the confluence with the Los Angeles River near Elysian Park, Chinatown, and Downtown Los Angeles.
2. WORK CITED


