

June 2019 | Dam Inundation Study

HAMILTON HIGH SCHOOL EXPANSION

Hamilton Unified School District

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1. Introduction

1.1 PURPOSE

This report presents the results of a dam inundation study prepared for the expansion project at Hamilton High School. The Hamilton Unified School District (District) is planning to expand existing facilities at the current high school campus (project site), which is within the dam inundation zones of Black Butte Lake and Shasta Lake and Reservoir. This study will focus on the potential for flooding at the school site in the unlikely event of a catastrophic failure on either the Black Butte Dam or Shasta Dam.

1.2 SCHOOL SITE LOCATION

The District intends to modernize the existing Hamilton High School, which is located at 620 Canal Street, Hamilton City, Glenn County, California. As part of the proposed project, the District would acquire an approximately 45-acre property adjacent to the existing school; construct new playing fields, a gymnasium and parking lot on the expanded site; modernize existing buildings; and plan future construction of new classroom buildings. The 45-acre project site is bounded by agricultural land to the north, commercial/agricultural properties (Westermann Farms and Dollar General) to the east, West 6th Street/State Route 32 (SR-32) to the south, and Canal Street/State Route 45 (SR-45) and the Glenn-Colusa Canal to the west (Figure 1). The site location and vicinity are shown on Figure 1, and an aerial photograph of the school site is shown on Figure 2.

1.3 REGULATORY REQUIREMENTS

Under Education Code Section 17212 and Section 17212.5 and the California Code of Regulations (CCR), Title 5, Section 14010(g), a school shall not be sited within an area of flood or dam flood inundation unless the cost of mitigating the flood or inundation impact is reasonable.

1.4 ASSESSMENT METHODOLOGY

The California Department of Education (CDE) has developed risk analysis procedures for evaluating flooding associated with releases from large diameter water pipelines and aqueducts, as described in CDE's *Guidance Protocol for School Site Pipeline Risk Analysis* (CDE, 2007). However, the CDE has not yet developed a protocol for evaluating safety hazards associated with water storage tanks or reservoirs/dams. A potential safety issue associated with siting a new school downstream from a dam, reservoir, or storage tank is the potential for flood inundation of the school site due to failure of these structures. The most probable cause of failure is a large magnitude earthquake and associated strong ground shaking, which can cause structural damage and a release of impounded water.

1. Introduction

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Source: Google Earth Pro, 2019

--- Project Boundary

0 3,500
Scale (Feet)



Figure 1
Site Location and Vicinity

1. Introduction

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Source: Google Earth Pro, 2019



--- Project Boundary

Figure 2
Aerial Photograph

1. Introduction

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2. Hazard Assessment

2.1 BACKGROUND AND REGULATORY INFORMATION

Dam failure is the uncontrolled release of impounded water from behind a dam, which can cause downstream flooding and affect property and life. There are many potential causes of a dam failure, including deficiencies in the original design, the quality of construction, and poor maintenance and operation of the dam, as well as acts of nature, including precipitation in excess of the design flood and damage from earthquakes.

The Black Butte Dam is classified as an earth dam. Earthfill dams typically fail gradually due to water overtopping the dam crest or piping, which is a form of internal erosion caused by seepage. With catastrophic failure, a flood wave will gradually build to a peak and then decline until the reservoir is empty. In the unlikely event that Black Butte Dam failed, there should be adequate time to initiate advance warnings and start evacuation procedures. Shasta Dam is a 602-foot high concrete gravity dam. Concrete gravity dams must be sized and shaped to resist overturning, sliding, and crushing at the toe. Concrete gravity dams tend to have a partial breach, as one or more monolith sections fail. This is typically due to earthquakes (ground rupture or severe ground shaking) and/or structural/design flaws.

Dam failure is a very rare occurrence. This is no historic record of dam failure in Glenn County or Hamilton City (Glenn County, 2016). Similarly, there is no historic record of dam failure in Tehama County, where Black Butte Dam is located (Tehama County, 2018), and there is no record of failure for the Shasta Dam in Shasta County (Shasta County, 2011). Since 1929, the State of California has supervised all non-federal dams in California through the Dam Safety Program under the jurisdiction of the Department of Water Resources, Division of Safety of Dams (DSOD). Engineers and engineering geologists review and approve plans and specifications for the design of dams and oversee their construction. In addition, over 1,200 dams are inspected on a yearly schedule to ensure that they are performing and being maintained in a safe manner. Ongoing programs of review, modification, seismic retrofitting, and total reconstruction of existing dams are intended to ensure that dams can withstand the maximum credible earthquake for the area.

The California Office of Emergency Services (Cal-OES) is required by State laws to work with State and federal agencies, dam owners and operators, municipalities, floodplain managers, planners, and the public to make available dam inundation maps. Dam inundation maps are used in the preparation of Local Hazard Mitigation Plans (LHMPs) and General Plan Safety Element updates. In addition, the Federal Emergency Management Agency (FEMA) requires all dam owners to develop Emergency Action Plans (EAPs) for warning, evacuation, and post-flood actions in the event of a dam failure (FEMA, 2013).

On June 27, 2017, Governor Brown signed SB 92 into law, which set forth new requirements focused on dam safety. As part of this legislation, dam owners must now submit inundation maps to the Department of Water Resources, DSOD. After the maps are approved, the dam owner must submit an EAP to Cal-OES.

2. Hazard Assessment

The owner must submit updated plans and inundation maps every 10 years, or sooner under certain conditions. Cal-OES will review and approve the EAPs. This legislation set forth additional provisions for EAPs including compliance requirements, emergency preparedness and evacuation exercises, and coordination with local public safety agencies. On October 19, 2017, emergency regulations were adopted to provide standards for preparing and submitting maps to the Department of Water Resources, DSOD for their review and approval.

The United States Department of the Interior Bureau of Reclamation (USBR) and the United States Army Corps of Engineers (USACE) each have a Dam Safety Program that recognizes the catastrophic nature of potential dam failure and operates a comprehensive dam safety program, which includes:

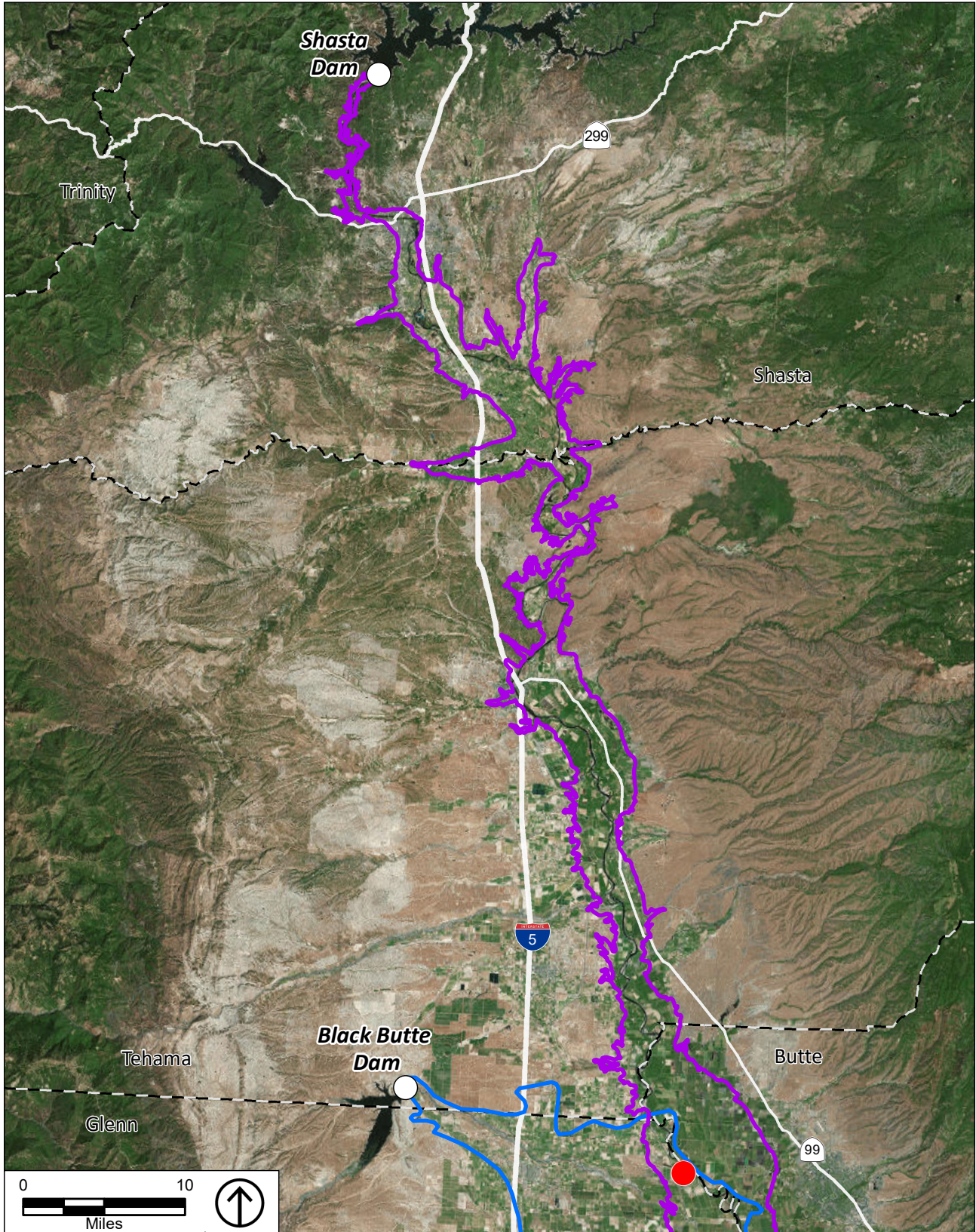
- Periodic special engineering studies;
- Surveillance and monitoring programs;
- Routine inspections and maintenance activities; and
- Maintaining emergency response and preparedness plan.

The County of Glenn has an Emergency Preparedness section within the Sheriff/Office of Emergency Services, which is responsible for the Emergency Operations Plan (EOP). The EOP establishes the framework for implementation of the California Standardized Emergency Management System (SEMS), which will notify residents and workers within the City in the event of a disaster. Details regarding the SEMS are provided in the County's Emergency Operations Plan (Glenn County, 2015). The Glenn County Sheriff's Office administers the CodeRED Emergency Notification System for Glenn County residents and businesses (Glenn County, 2017). CodeRED is a multiplatform messaging service which delivers messages via phone, text, email, mobile app, social media, and FEMA's Integrated Public Alert and Warning System (IPAWS). The Hamilton City Fire Protection District is responsible for reviewing the EOP on an annual basis and coordinating revision of the plan as required. AlertSCC is the way for anyone who lives and works in Glenn County to get emergency warnings sent directly to their cell phone, mobile device, email, or landline. Glenn County, USBR, and USACE coordinate preparedness efforts to mitigate against, plan for, respond to, and recover from natural hazards, including the possibility of dam failure.

2.2 PHYSICAL SETTING

Topography around the site is relatively flat with a very gentle gradient to the east. The site lies at an approximate elevation of 153 feet above mean sea level (msl) and is approximately 0.55 mile southwest of the Sacramento River. The Glenn-Colusa Canal is located approximately 130 feet west of the site.

Surrounding land uses are agricultural fields or vacant land to the north and east, commercial properties adjacent to the south fronting 6th Street/State Route 32, residences farther south across 6th Street, and a parking lot and the Glenn-Colusa Canal to the west. The site is approximately 17.4 miles east from Black Butte Dam and 69.6 miles south from Shasta Dam. There are intervening residential structures, agricultural land, and undeveloped land between the dams and the school site that would attenuate to some extent the impact of a release from the dam. Nevertheless, a catastrophic failure of the dam could result in water flowing onto the site. The dam inundation zones and the school site are shown on Figure 3.



Source: FEMA, 2015; ESRI, 2017; PlaceWorks, 2017.




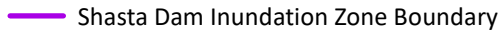
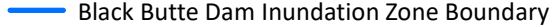
-  County Boundary
-  Dam
-  Project Location
-  Shasta Dam Inundation Zone Boundary
-  Black Butte Dam Inundation Zone Boundary

Figure 3
Dam Inundation Zones

2. Hazard Assessment

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2. Hazard Assessment

2.3 BLACK BUTTE DAM

Black Butte Dam is owned and operated by USACE and was built in 1963. Black Butte Lake is located on Stoney Creek west of the City of Orland in Tehama County and offers water-related recreation. Black Butte Dam is an earthfill dam with a reservoir capacity of 143,700 acre-feet and a surface area of approximately 4,560 acres. The USACE inspects the 17 California dams under their jurisdiction on an annual basis (USACE, 2017). Inspection items at Black Butte Dam include the dam, control tower's outlet works, bulkhead gate and gate hoist, and visual inspections of the embankment, dikes, and spillway.

The school site and Hamilton City are subject to potential dam inundation from the Black Butte Dam. A map of the dam inundation zone based on a 1975 study is provided in Appendix A. According to this map, flood water resulting from dam failure would reach the school site in approximately 7 hours. No water depth is specified on this inundation map. The closest edge of the dam inundation zone to the school site is located along the Sacramento River approximately 0.6 mile to the northeast.

As noted above, there have been no dam failures in Glenn County or Tehama County in the past. Earthfill dams typically fail gradually and there would be additional warning signs before the dam would catastrophically release floodwaters. As flood depths are not predicted to reach the school for at least 7 hours, there would be adequate time for the safe evacuation of students and staff at Hamilton High School in the unlikely event of a dam failure.

2.4 SHASTA DAM

Shasta Dam is owned and operated by USBR and was built between 1938 and 1945. The dam is a 602 feet high concrete gravity dam, which provides flood control, power and water supply.

Lake Shasta, located in Shasta County, is a key facility of the Central Valley Project which provides irrigation and municipal water to the State's Central Valley. Stored water is also used for salinity control for the Sacramento-San Joaquin River Delta. The lake offers water-related recreation within the Whiskeytown-Shasta-Trinity National Recreation Area. Shasta Dam has a reservoir capacity of 4,522,000 acre-feet and a surface area of approximately 30,000 acres, making it the State's largest reservoir and third largest body of water. Additionally, feasibility studies evaluated the raising of the Shasta Dam by 18.5 feet and enlarging Shasta Reservoir by over 600,000 acre-feet. The current project completion date is 2024 (USBR, 2019).

California has had approximately 45 failures of non-federal dams. The most common failure mechanism for non-federal dams in California is overtopping of earthen dams (Shasta County, 2011). Of the concrete dams that failed, all were of the thin-arch design. Shasta Dam is a federally controlled and inspected dam and is considered a thick arch design (Shasta County, 2011). Seismic activity is monitored and tunnels throughout the dam allow inspectors to monitor for cracks and seepage. As the dam is built on bedrock, the probability of a dam failure is considered extremely low (Shasta County, 2011).

The school site and Hamilton City is subject to potential dam inundation from Shasta Dam. A map of the dam inundation zone based on a 1975 study, which was revised in 1976, is provided in Appendix A. According to this map, flood water resulting from dam failure would reach the school site in approximately 22

2. Hazard Assessment

hours with a water surface elevation of 165 feet msl. As the site lies at an approximate elevation of 153 feet, the flood depth could be approximately 12 feet at the school site. However, it should be noted that the dam inundation map was prepared 43 years ago and changes in dam operation and sediment accumulation within the reservoir could result in lower water storage volumes and reduced flood depths. The closest edge of the dam inundation zone to the school site is approximately 0.75 mile to the west.

As noted above, there have been no dam failures in Glenn County or Shasta County in the past. Concrete dams typically do not fail catastrophically, and there would be additional warning signs before the dam would release its floodwaters. As flood depths are not predicted to reach the school for nearly one full day, there would be adequate time for the safe evacuation of students and staff at Hamilton High School in the unlikely event of a dam failure.

3. Summary and Recommendations

The school site is within the inundation zones of Black Butte Dam and Shasta Dam. Black Butte Dam is located 17.4 miles to the west of the site in Tehama County. According to the inundation map prepared by the USACE for Black Butte Dam, flood water resulting from dam failure would reach the school site in approximately 7 hours. Shasta Dam is located 69.6 miles to the north of the site in Shasta County. According to the inundation map prepared by the USBR for Shasta Dam in 1976, flood water resulting from dam failure would reach the school site in approximately 22 hours with a maximum depth of 12 feet.

The probability of dam failure is very low, and Glenn County, Tehama County, and Shasta County have never been impacted by a dam failure. Dams are continually monitored by various government agencies, including the DSOD. Dam owners are required to maintain EAPs that include procedures for damage assessment and emergency warnings. In addition, municipalities and counties address the possibility of dam failure in the Safety Elements of General Plans and the Local Hazard Mitigation Plans. The Hamilton City Fire Protection District coordinates the County of Glenn Emergency Preparedness section within the Sheriff/Office of Emergency Services. The County of Glenn maintains the EOP in accordance with the State of California's SEMS.

It is highly unlikely that either the Black Butte Dam or Shasta Dam would experience a catastrophic failure, even in the case of a maximum credible earthquake. As flood depths would not reach the school site for 7 hours at the earliest, there would be adequate time for the safe evacuation of students and staff at Hamilton High School in the unlikely event of a dam failure.

However, because the school site is located within the inundation zones for two dams, it is recommended that the District coordinate with the Glenn County Sheriff/Office of Emergency Services to ensure that they are notified via the SEMS and CodeRED in the case of an imminent dam failure or other natural disaster.

3. Summary and Recommendations

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4. References

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4. References

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Appendix A. Dam Inundation Maps

Appendix

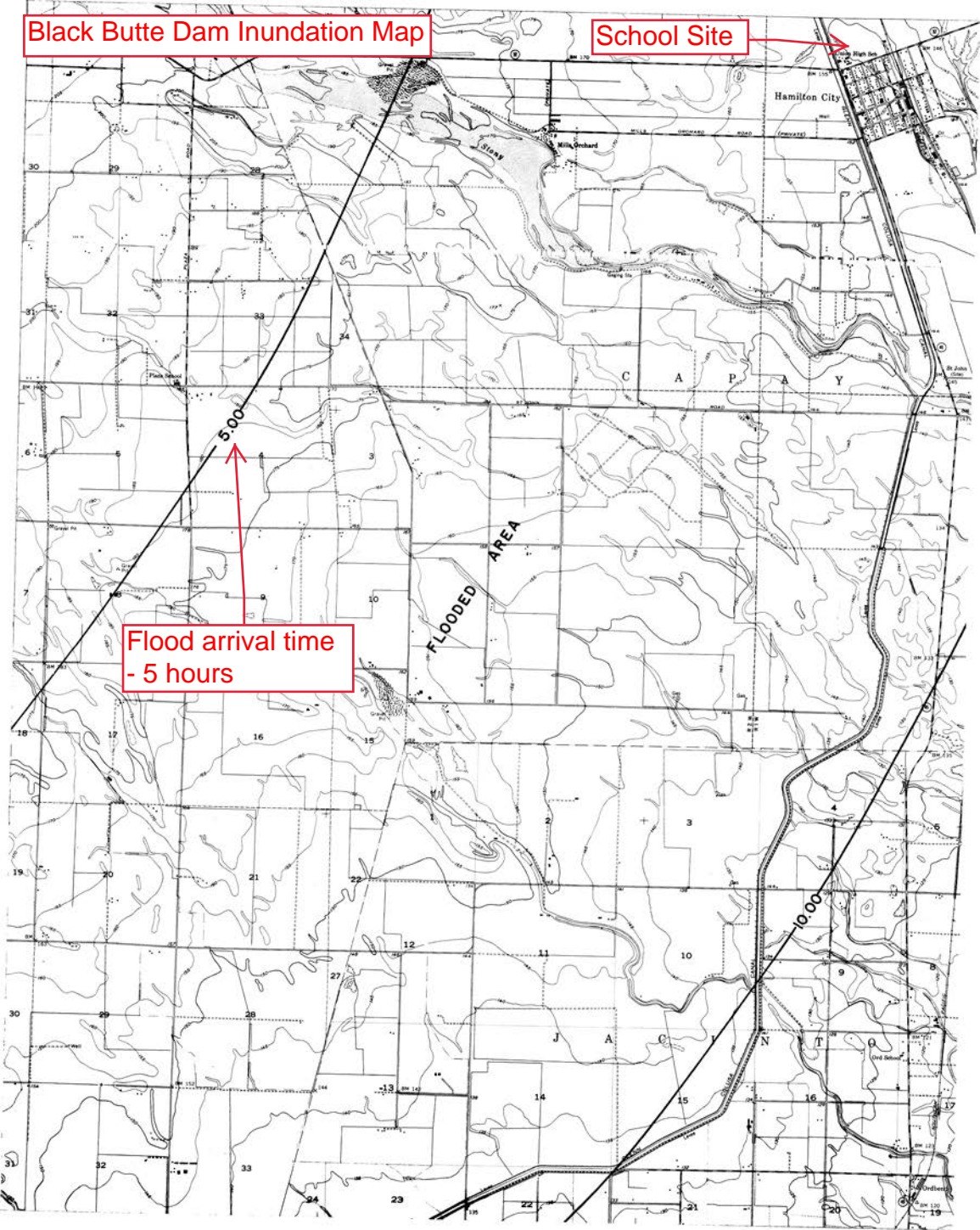
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Black Butte Dam Inundation Map

School Site

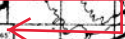
Flood arrival time
- 5 hours

FLOODED AREA



Shasta Dam Inundation Map

Station 8
WS EI 165'
Flood arrival time -
1300 hours



School Site

