U.S. Department of the Interior
National Park Service

Amistad National Recreation Area
Val Verde County, Texas

Breakwater System at Diablo East Harbor

Environmental Assessment

February 2011

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SUMMARY

The National Park Service is preparing an Environmental Assessment for the construction of a breakwater system near the mouth of the Diablo East Harbor at Amistad National Recreation Area, Val Verde County, Texas. The purpose of the project is to install a permanent breakwater to protect boats and structures in Diablo East Harbor from sustaining extensive damage from the waves generated by strong north and northwest winds during storms. This action is needed to provide a safer environment in which park visitors can launch and retrieve their recreational boats at the Diablo East boat ramp during storm conditions, prevent wave damage to NPS and Border Patrol boats and slips, and protect boat docks at the marina.

The Diablo East boat ramp is the largest and most popular location for the launching of boats on the U.S. side of the reservoir. The largest concession-operated marina on Amistad Reservoir is located adjacent to this Diablo East boat ramp. The Diablo East Harbor provides excellent protection against the strong prevailing winds that blow from the southeast. However, during winter storms the broad mouth of the harbor does little to block large waves 3-6 feet in height generated by strong north winds blowing across the main body of the lake. The Diablo East boat ramp faces to the north, and is subject to these direct winds and wind-generated waves. Historically, these wind-generated waves have caused extensive damage to the public boat docks provided and maintained by the NPS and to the floating dock system of the adjacent concession-operated marina. Additionally, NPS has several patrol and maintenance vessels housed in slips, and the Border Patrol also keeps several boats in the harbor. The large waves also pose a serious safety hazard to visitors trying to launch or recover their boats at the boat ramp, and have swamped boats that were tied to the public boat dock.

Resource topics that were addressed in the EA were: water resources, geology and soils, archeology, fish and aquatic habitat, special status species, visitor use and experience, park operations, and socioeconomics. All other resource topics were dismissed from further evaluation in the document because the associated impacts would be negligible or less. Impacts of the preferred alternative are summarized here; no major effects were identified as a result of the proposed project.

Impacts to water resources would be short-term and long -term, negligible to minor, and adverse. There would be no long-term impacts to present water circulation and water exchange between harbor and reservoir.

Impacts on geology and soils would be short-term, minor, and adverse from compaction and erosion of soils on 0.8 acres during construction activities. There would be no cave or karst feature concerns.

Impacts on archeology would be negligible.

Impacts on fish and aquatic habitat would be short-term and long-term, negligible, and adverse during both the construction and operational phases. There would be no change in water exchange between the harbor and reservoir.

Impacts to special status species would be short-term, negligible to minor, and adverse from disturbance and displacement during construction and temporary habitat disturbance.

Impacts on visitor use and experience would be short-term, minor, and adverse due to noise, traffic, and access during construction of the breakwater. Long-term, moderate, and beneficial impacts would occur with improved conditions in the harbor and new recreational opportunities with the presence of a new breakwater. There would be the bonus of providing a perfectly-located fishing platform accessible to the non-boating public for the lifetime of the reservoir.

Impacts to park operations would be long-term, minor, and beneficial due to the diminished need for dock repairs and visitor assistance at Diablo East during storms. Short-term, minor, and adverse impacts would occur due to the need for increased staff time required to manage contractors during project implementation. The structure would need to be replaced after 25 years.

Impacts on socioeconomics would be short-term, negligible to minor, and adverse during the construction period. Long-term, moderate, beneficial impacts would occur due to reductions in storm damage.

Note Regarding Public Comment

The Environmental Assessment is made available on the Planning, Environment, and Public Comment (PEPC) web site at the following address: http://parkplanning.nps.gov/. If you wish to comment on the Environmental Assessment, you may submit comments through the PEPC web site. For those without access to the internet send comments to the name and address below. This Environmental Assessment will be on public review for 30 days. Please note that names and addresses of people who comment become part of the public record. If you would like your name and/or address withheld, please state this prominently at the beginning of your comment. All submissions from individuals, organizations, and businesses will be made available in their entirety for public inspection.

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ACRONYMS AND ABBREVIATIONS

ADA	Americans with Disabilities Act
APE	Area of Potential Effect
BMP	Best Management Practice
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act
CY	Calendar Year
DO	Director's Order
EA	Environmental Assessment
EFDC	Environmental Fluid Dynamics Code
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
FPPA	Farmland Protection Policy Act
ft	feet
GMP	General Management Plan
IBWC	International Boundary and Water Commission
km	kilometers
m	meter
msl	mean sea level
N/A	Non Applicable
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
SHPO	State Historic Preservation Office
spp	species
SWPPP	Storm Water Pollution Prevention Plan
TCEQ	Texas Commission on Environmental Quality
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1.0 PURPOSE AND NEED

1.1 INTRODUCTION

Amistad National Recreation Area (Amistad or park) is a unit of the National Park Service (NPS) located in a remote area of southwest Texas near the town of Del Rio, Texas (Figure 1-1). It is approximately 150 miles west of San Antonio, Texas on US Highway 90. Del Rio, which is near the southeast end of the recreation area, shares a border with Ciudad Acuña in Mexico.

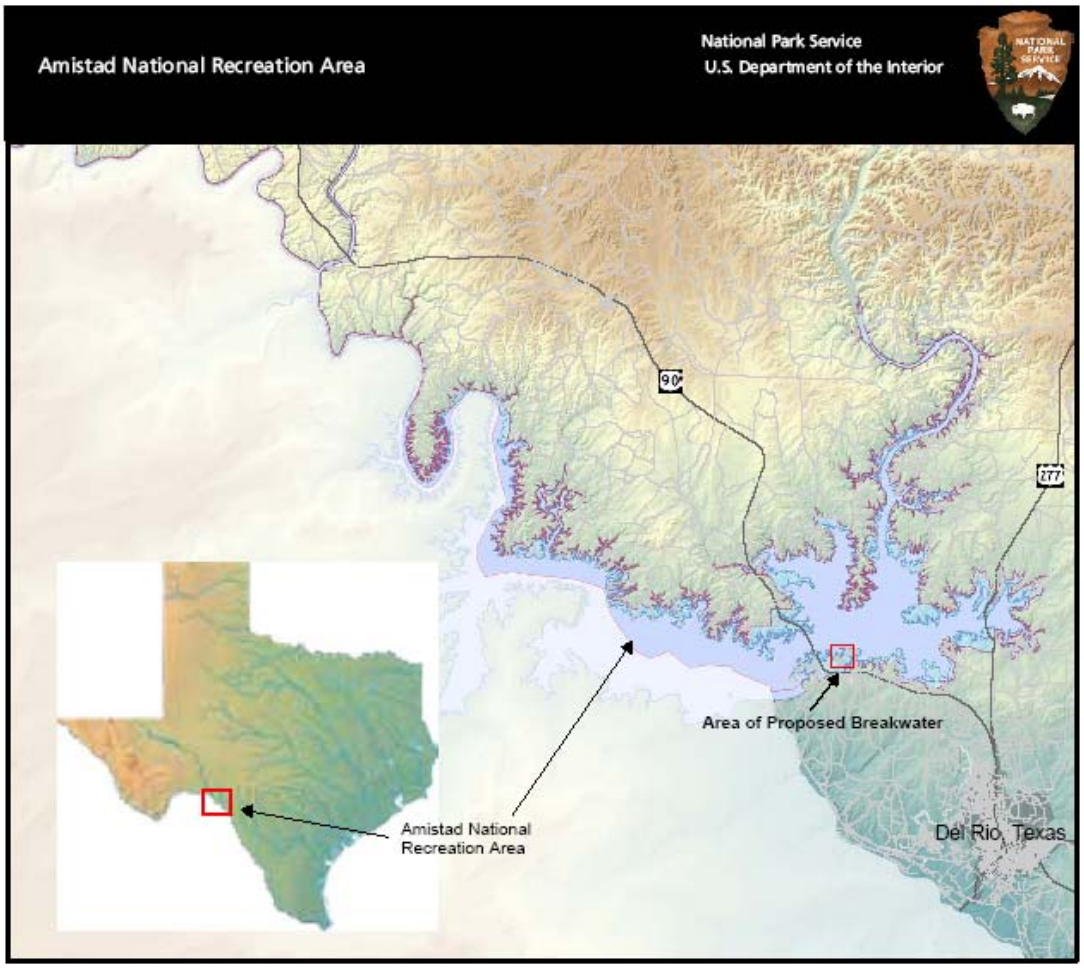

Figure 1-1. Amistad National Recreation Area vicinity with project area location.

Amistad Dam, which is managed by the International Boundary and Water Commission (IBWC) was created for flood control in 1968 and resulted in the creation of an international reservoir with a maximum storage capacity of 65,000 surface acres that extends 79 miles up the Rio Grande from Amistad Dam. The recreation area, which is administered by the NPS, was created primarily for water based recreation. It consists of a reservoir that is bordered by the United States and Mexico.

The Diablo East boat ramp is the largest and most popular location for the launching of boats on the U.S. side of the reservoir. The largest concession-operated marina on Amistad Reservoir is located adjacent to this Diablo East boat ramp. The Diablo East Harbor provides excellent protection against the strong prevailing winds that blow from the southeast. However, during winter storms the broad mouth of the harbor does little to block large waves 3-6 feet in height generated by strong north winds blowing across the main body of the lake. The Diablo East boat ramp faces to the north, and is subject to these direct winds and wind-generated waves. Historically, these wind-generated waves have caused extensive damage to the public boat docks provided and maintained by the NPS and to the floating dock system of the adjacent concession-operated marina. Additionally, NPS has several patrol and maintenance vessels housed in slips, and the Border Patrol also keeps several boats in the harbor. The large waves also pose a serious safety hazard to visitors trying to launch or recover their boats at the boat ramp, and have swamped boats tied to the public boat dock.

The reservoir level over the past 15 years has fluctuated a total of 72 feet, from 59 feet below conservation level to 13 feet above conservation level. In the 1980's, the reservoir dropped about five inches per day for a two week period when water was released from Amistad Dam for irrigation purposes to farmers downstream from the dam. In 1998 there was a significant rain event where the reservoir rose ten feet in a 24-hour period. In 2008 the reservoir rose about three inches per day for three weeks as a result of a significant rain event in northern Mexico. In July 2010, the lake level rose over 15 feet over a five day period from 1,114.38 feet to 1,129.87 feet due to a flooding event. As a result of the near-record lake levels following the significant rain event of 2010, the marina docks and houseboats were all exposed to direct north winds as the peninsula protecting them was now essentially even with the lake level. Inflows on the Rio Grande exceeded 117,000 cubic feet per second, and 35,000 cubic feet per second were being released from the dam immediately after the 2010 rain event, flooding the residences in the Vega below the dam. The lake level stabilized several days after the flood event, and actually dropped 6-8 inches per day. A breakwater system would need to be designed to allow for this type of fluctuation in water levels.

When the lake level is up, the marina's slips are in a cove protected by a peninsula from strong winds and waves. When the lake level drops ten feet or more below conservation level, the marina starts running out of room in its' protected cove and needs to move the boat slips outside of the protective peninsula to an area which is exposed to potentially damaging north and northwest winds.

1.1.1 Park Purpose and Significance

The land on the United States side of the Amistad Reservoir was designated as Amistad National Recreation Area in 1990, and is managed by the NPS. Amistad encompasses 57,292 acres, most of which is the U.S. portion of the reservoir's water surface. Amistad's boundary is the reservoir surface and shore area up to the 1,144-foot elevation contour. Amistad provides a variety of recreational activities including boating, fishing, hunting, and camping. The park preserves important cultural resources, including some of the oldest pictographs in North America.

The purposes and significance of Amistad, as outlined in the draft General Management Plan/Environmental Assessment (GMP/EA) (NPS, 2006a), determines how the national recreation area is managed. The purposes tell why the national recreation area was set aside as a unit in the national park system. The significance of the national recreation area addresses why the area is unique, why it is important enough to our natural and/or cultural heritage to warrant national park designation, and how it differs from other parts of the country.

The purposes of Amistad National Recreation Area are to:

- Provide for public outdoor recreation use and enjoyment of the lands and waters associated with the United States portion of the reservoir known as Lake Amistad; and
- Protect scenic, scientific, cultural, and other values contributing to the public enjoyment of such lands and waters.

Amistad National Recreation Area is significant for the following reasons:

- As one of only two reservoirs managed jointly by the United States and the Republic of Mexico, Lake Amistad commemorates a water conservation partnership between the two nations.
- The waters of Lake Amistad provide diverse water-based recreational opportunities, including some of the finest recreational black bass fishing in the southwestern United States.
- Amistad National Recreation Area protects and interprets exceptional examples of Lower Pecos River rock art, one of the densest concentrations of Archaic rock art in the New World and comparable in significance to rock art found in Europe, Australia, and Baja California.
- The archeological sites of the Lower Pecos river region, including Amistad National Recreation Area, are among the oldest and best preserved archeological sites in North America and provide important information about the unique cultures and environment of southwest Texas.
- Amistad manages a large museum collection which consists of approximately 980,000 prehistoric archeological materials that span over 10,000 years of Native American history.
- Amistad National Recreation Area includes one of the largest tracts of public land available for hunting in southwest Texas.

1.2 PURPOSE AND NEED

The National Park Service is considering the construction of a breakwater system near the mouth of the Diablo East Harbor at Amistad National Recreation Area. The purpose of the project is to install a permanent breakwater to protect boats and structures in Diablo East Harbor from sustaining extensive damage from the waves generated by strong north and northwest winds during storms. This action is needed to provide a safer environment in which park visitors can launch and retrieve their recreational boats at the Diablo East boat ramp during storm conditions, prevent wave damage to NPS and Border Patrol boats and slips, and protect boat docks at the marina.

The following chapters provide a description of the proposed alternatives, the affected environment, and the potential environmental consequences of the implementation of the

alternatives. A summary of the applicable regulations and policies that shape the management decisions regarding the proposed project is also provided.

An EA analyzes the proposed action and alternatives and their impacts on the environment. This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code (USC) 4321 et seq.), the Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations (CFR) 1500 through 1508) for implementing NEPA, and the NPS NEPA compliance guidance handbook (DO-12, *Conservation Planning, Environmental Impact Analysis, and Decision-making*). The intent of this document is to also meet the requirements for protection of cultural resources, including Section 106 of the National Historic Preservation Act (NHPA) in accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 (36 CFR Part 800.8, *Coordination with the National Environmental Policy Act*). The EA will determine whether significant impacts would occur as a result of the proposed project and if an environmental impact statement (EIS) or finding of no significant impact (FONSI) would be required.

1.2.1 Related Planning Documents

Several plans, projects, and standards that the National Park Service and Amistad National Recreation Area either have in place or are planning for the future may affect decisions regarding installation or construction of a breakwater system.

The *Draft General Management Plan/Environmental Assessment* (NPS, 2006a) establishes the guiding management philosophy for the Park and provides strategies for addressing issues and achieving management objectives. The Amistad Draft GMP/EA proposes management actions such as designating different management zones within Amistad and constructing improvements such as a new park headquarters, maintenance facility, and visitor contact facility. Under the Preferred Alternative, the new breakwater would be constructed at Diablo East Harbor, which is within the Rural Developed Zone.

NPS Management Policies, 2006 addresses facilities for water recreation in Section 9.3.4.2, "Boating facilities (such as access points, courtesy docks, boat ramps, floating sewage pump-out stations, navigational aids, and marinas), breakwaters, and fish cleaning stations may be provided as appropriate for the safe enjoyment by visitors of water recreation resources, when (1) they are consistent with the purposes for which the park was established, and (2) there is no possibility that adequate private facilities will be developed. Facilities must be carefully sited and designed to avoid unacceptable adverse effects on aquatic and riparian habitats and minimize conflicts between boaters and other visitors who enjoy use of the park."

1.3 APPROPRIATE USE

Section 1.5 of *Management Policies* (2006b), "Appropriate Use of the Parks," directs that the National Park Service must ensure that park uses that are allowed would not cause impairment of, or unacceptable impacts on, park resources and values. A new form of park use may be allowed within a park only after a determination has been made in the professional judgment of the park manager that it will not result in unacceptable impacts.

Section 8.1.2 of *Management Policies* (2006b), Process for Determining Appropriate Uses, provides evaluation factors for determining appropriate uses. All proposals for park uses are evaluated for:

- consistency with applicable laws, executive orders, regulations, and policies;
- consistency with existing plans for public use and resource management;
- actual and potential effects on park resources and values;
- total costs to the Service; and
- whether the public interest will be served.

Park managers must continually monitor all park uses to prevent unanticipated and unacceptable impacts. If unanticipated and unacceptable impacts emerge, the park manager must engage in a thoughtful, deliberate process to further manage or constrain the use, or discontinue it.

The proposed breakwater at Diablo East Harbor is consistent with the evaluation factors listed above, particularly that the public interest would be served by protecting recreational facilities and making them safer for use. It is also consistent with the Amistad Draft GMP/EA which places the area within the Rural Developed Zone where most development proposed in the GMP occurs (NPS, 2006a). Many recreational facilities are located at Diablo East, including a main boat launch ramp and marina, all of which need to be protected from storm damage. The NPS finds that constructing a breakwater system is an acceptable use at Amistad.

1.4 SCOPING

Scoping is an open process that determines the breadth of environmental issues and alternatives to be addressed in an EA. Scoping involves obtaining internal and external input on project-related issues from resource specialists and the public, respectively. The purpose of the scoping process, as outlined in CEQ's regulations for implementing NEPA (40 CFR 1501.7), is to determine the scope of issues to be addressed in the EA and to identify significant issues relating to the Proposed Action.

Amistad initiated public scoping on April 26, 2010 to provide the public and interested parties an opportunity to comment on the proposed project. The park sent letters (Appendix A) to interested individuals; organizations; state, county, and local governments; and federal agencies describing the proposed action and asking for comment. American Indian tribes (Comanche Nation, Kickapoo Traditional Tribe of Texas, Kiowa Tribe of Oklahoma, and Mescalero Apache Tribe) also were sent scoping letters. Comments on the proposed action, as well as consultation on threatened and endangered species, were also requested from the U.S. Fish and Wildlife Service (USFWS) and the Texas Parks and Wildlife Department (TPWD).

The NHPA (16 United States Code [U.S.C.] 470 et seq.); NEPA; NPS Organic Act; NPS *Management Policies 2006*; Director's Order – 12: *Conservation Planning, Environmental Impact Analysis, and Decision-making* (2001); and Director's Order – 28: *Cultural Resources Management Guideline* require the consideration of impacts on cultural resources, either listed in or eligible to be listed in, the National Register of Historic Places (NRHP). The Texas Historical

Commission – State Historic Preservation Office and Val Verde County Historical Commission were notified of the project by letter, and input into the project was solicited. The park will cooperate with the Texas Historical Commission to address mitigation of impacts to any cultural resources from the proposed action.

Comments on the proposed action were solicited through May 26, 2010. There were five comment letters received from individual members of the public. No comments were received from organizations, and three comment letters were received from agencies (U.S. Customs and Border Protection, the USFWS, and TPWD). Six comment letters specifically expressed support for the project, and no letters were in opposition. Specific issues and concerns brought up included boater safety, protection and safety of government and marina facilities, protection of federal and state listed species, wetlands, migratory birds, soil erosion and compaction, sediment loading, and landscaping. No other public or agency scoping comments were received as of the date of this EA.

The public, agencies, and American Indian groups traditionally associated with the lands of Amistad also will have an opportunity to review and comment on this EA.

1.5 IMPACT TOPICS

Specific impact topics were developed for discussion focus, and to allow comparison of the environmental consequences of each alternative. These impact topics were identified based on federal laws, regulations, and Executive Orders; 2006 NPS *Management Policies*; and NPS knowledge of limited or easily impacted resources identified on the Environmental Screening Form. A brief rationale for the selection of each impact topic is given below, as well as the rationale for dismissing specific topics from further consideration.

1.5.1 Impact Topics Retained

Water Resources
NPS *Management Policies 2006,* Chapter 4, Section 4.6 Water Resource Management, requires protection of water quality consistent with the provisions of the Clean Water Act (CWA) of 1977, a national policy to restore and maintain the chemical, physical, and biological integrity of the nation's waters and to prevent, control, and abate water pollution. There are no wetlands or floodplains in the project area. Sedimentation and turbidity during construction, as well as changes in water circulation and exchange over the long-term could impact water quality. Therefore, water resources are discussed in this EA.

Geology and Soils
Construction activities, such as the use of heavy equipment, would disturb soils and potentially cause soil compaction and erosion in the project area. Therefore, soils are addressed as an impact topic in this EA. This impact topic is addressed in accordance with *NPS Management Policies, 2006*, Chapter 4, Section 4.8 Geological Resource Management, Sub-section 4.8.2.4 Soil Resource Management.

Driving of heavy equipment and trucks over the karst landscape could impact karst features. Therefore, geology is addressed as an impact topic in this EA. This impact topic is addressed in accordance with *NPS Management Policies, 2006*, Chapter 4, Section 4.8 Geological Resource Management, Sub-sections 4.8.1.2 Karst and 4.8.2.2 Caves.

Archeology
Archeological resources could be impacted by the proposed project during construction if trucks and heavy equipment drive on or near archeological sites. The NPS is required to, "preserve collections of prehistoric and historic material remains, and associated records, recovered under the authority of the Antiquities Act (16 USC 431-433), the Reservoir Salvage Act (16 USC 469-469c), section 110 of the National Historic Preservation Act (16 U.S.C. 470h-2), or the Archaeological Resources Protection Act (16 USC 470aa-mm)" (36 CFR Part 79). These regulations, promulgated under the authority of the Secretary of Interior, apply to findings made by historic preservation professionals that meet qualification standards for Federal projects.

Fish and Aquatic Habitat
Impacts on fish and aquatic habitat could occur from runoff, sedimentation, turbidity, and disturbance of bottom habitat during breakwater construction activities, and from potential reduced water circulation and lower dissolved oxygen levels. This impact topic is addressed in accordance with *NPS Management Policies, 2006*, Chapter 4, Section 4.4 Biological Resource Management.

Special Status Species
The Endangered Species Act of 1973 requires disclosure of impacts of federal actions on all federally protected threatened or endangered species. *NPS Management Policies, 2006* requires assessment of impacts to certain rare, candidate, declining and sensitive species. The project area contains suitable habitat for Texas tortoise, indigo snake, and horned toad, which are state species of concern. Federally listed threatened or endangered species known to occasionally occur in the project area are the brown pelican and interior least tern. Since it is possible that the project could affect these species, threatened and endangered species are discussed in this EA.

Visitor Use and Experience
The proposed project could affect visitor use and experience during construction, but also benefit it with additional recreational opportunities and improved harbor conditions during storms. Therefore, visitor use and experience is addressed as an impact topic in this EA. This impact topic is addressed in accordance with *NPS Management Policies, 2006*, Chapter 8, Section 8.2 Visitor Use.

Park Operations
The proposed project could improve the long-term efficiency of park operations, although there would likely be additional time required of park staff during construction. Therefore, the park operations topic is addressed as an impact topic in this EA. This impact topic is addressed in accordance with NPS *Management Policies 2006; OMB Circular A-123; Federal Managers'Financial Integrity Act of 1982 (31 U.S.C.3512(d)); Government Performance and Results Act of 1993 (GPRA).*

Socioeconomics
The proposed project could have impacts on socioeconomics during construction and from reduced storm damage and associated costs. Therefore, socioeconomics is addressed as an impact topic in this EA.

1.5.2 Impact Topics Dismissed

Air Quality
Amistad is a designated Class I airshed, which under the Clean Air Act, prevents significant deterioration of air quality. Air quality could be impacted during the construction phase of the project; however, impacts would be temporary and negligible in intensity. Overall, there could be a slight and temporary degradation of local air quality due to dust generated by activities and emissions from construction equipment. These effects would last only during construction activities. Best Management Practices (BMPs) would be utilized to limit dust generation and dispersal. To keep equipment emissions down, equipment would be properly maintained. Therefore, Air Quality was dismissed as an impact topic in this document.

Soundscape
In accordance with NPS *Management Policies 2006* and *Director's Order – 47: Sound Preservation and Noise Management*, the park strives to preserve the natural soundscape. The soundscape could be impacted during the construction phase of the project; however, impacts would be temporary and negligible to minor in intensity. The proposed action would not affect natural ambient sound in the long-term. Therefore, soundscape was dismissed as an impact topic in this EA.

Lightscape
In accordance with NPS *Management Policies 2006*, the NPS strives to preserve natural ambient landscapes, which are natural resources and values that exist in the absence of human-caused light. Amistad strives to limit the use of artificial outdoor lighting to that necessary for security and human safety. Amistad also strives to ensure that all outdoor lighting is shielded to the maximum extent possible to keep light on the intended subject and out of the night sky. A new breakwater system would not introduce any additional light sources to Diablo East Harbor other than small navigational hazard reflectors. Therefore, lightscape was dismissed as an impact topic in this EA.

Wildlife
NPS Management Policies 2006, Chapter 4, Section 4.4.2 Management of Native Plants and Animals provides guidance on management of wildlife. Construction activities and noise that could affect wildlife in the project area would be temporary and negligible. Therefore, wildlife was dismissed as an impact topic in this EA.

Vegetation
Although there could be some vegetation disturbance from trucks carrying breakwater materials and equipment in the project area, impacts are expected to be negligible and vegetation would recover over the short-term. Therefore, vegetation was dismissed as an impact topic in this EA.

Floodplains

Executive Order (EO) 11988 Floodplain Management, *NPS Management Policies 2006*, and *Director's Order 77-2* require an examination of impacts to floodplains and potential risks involved in placing facilities within floodplains. The floodplains of the Pecos River, the Devils River, and the Rio Grande upstream of Amistad Dam are all submerged by the waters of Lake Amistad. No proposed work activities or structures would be located in a floodplain under any of the project alternatives. Because there would be no impact to floodplains, this topic is dismissed from further consideration in this EA.

Wetlands

EO 11990 Protection of Wetlands, *NPS Management Policies 2006*, and *Director's Order 77-1* direct that wetlands be protected, and that wetlands and wetland functions and values be preserved. These orders and policies further direct that impacts to wetlands be avoided when practicable alternatives exist. No wetlands occur in the project area and no impacts are anticipated to occur to wetlands from the project alternatives. Because there would be no impacts to wetlands from the proposed project, this topic is dismissed from further consideration in this EA.

Wild and Scenic Rivers

The National Wild and Scenic Rivers Act is administered by four federal agencies; NPS, the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the U.S. Forest Service. The Act protects selected rivers, and their immediate environments, which possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values. In Texas, there is only one National Wild and Scenic River, the Rio Grande River, which is designated for its reach between Big Bend National Park and Amistad National Recreation Area. The reach of the designated Rio Grande River will not be affected by the proposed project. Therefore, this topic is dismissed from further consideration in this EA.

Climate Change

A growing body of scientific research, published in peer reviewed journals and synthesized by groups such as the Intergovernmental Panel on Climate Change and the U.S. Climate Change Science Program, depicts a global climate that is changing. Research also shows that human activities, especially emissions of greenhouse gases into the atmosphere, contribute to this changing climate. Emissions of greenhouse gases would be temporary and minor during construction, but the park's long-term carbon footprint would not change, thus this project's contribution to climate change would not be measurable. Therefore, Climate Change was dismissed as an impact topic in this EA.

Environmental Justice

EO 12898 General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires all Federal agencies to incorporate environmental justice into their missions by identifying and addressing the disproportionately high and/or adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The proposed project would not have disproportionate health or environmental effects on minorities or low-income populations or communities as defined in the

US Environmental Protection Agency's (USEPA) Draft Environmental Justice Guidance (July 1996). Therefore, Environmental Justice was dismissed as an impact topic in this EA.

Prime and Unique Farmlands

In August 1980, the CEQ directed that Federal agencies must assess the effects of their actions on farmland soils classified by the U.S. Department of Agriculture's Natural Resources Conservation Service as prime or unique. Prime or unique farmland is defined as soil that particularly produces general crops, such as common foods, forage, fiber, and oil seed; unique farmland produces specialty crops, such as fruits, vegetables, and nuts. Since the project area does not meet the definition of farmland as stated in Title 7, Chapter 73, Section 4201 (c)(1) of the Farmland Protection Policy Act (FPPA), it is not applicable to the FPPA. Therefore, the topic of Prime and Unique Farmlands was dismissed as an impact topic in this EA.

Indian Trust Resources

Secretarial Order 3175 requires that any anticipated impacts to Indian trust resources from a proposed project or action by the U.S. Department of the Interior agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights. The order represents a duty to carry out the mandates of the federal law with respect to American Indian and Alaska Native tribes. There are no Indian trust resources in Amistad (NPS 2006a). The lands comprising the park are not held in trust by the Secretary of the Interior for the benefit of Indians due to their status as Indians. Therefore, the Indian trust resources topic was dismissed as an impact topic in this EA.

2.0 PROPOSED ACTION AND ALTERNATIVES

CEQ regulations for implementing NEPA require that Federal agencies explore and objectively evaluate all reasonable alternatives to the preferred alternative, and briefly discuss the rationale for eliminating any alternatives that were not considered in detail. This chapter describes a range of reasonable alternatives, including the No Action Alternative, the Preferred Alternative, and two other action alternatives. There are also three alternatives that were considered and eliminated from further analysis.

2.1 ALTERNATIVE A – NO ACTION

Under the No Action Alternative, there would not be any construction of a breakwater in Diablo East Harbor. North facing facilities in the harbor would remain exposed to wind and waves during storms.

CEQ regulations (40 CFR 1502.14) require the assessment of the No Action Alternative in NEPA documents. The No Action Alternative describes the action of continuing current management and conditions. It does not imply or direct discontinuing the current action or removing existing uses, developments, or facilities. The No Action Alternative provides a basis for comparing the management direction and environmental consequences of the other action alternatives and must be considered in every EA.

2.2 ALTERNATIVE B – FIXED BREAKWATER AT MOUTH OF HARBOR

Under the Alternative B, two overlapping standard US Army Corps of Engineers (USACE) Coastal Engineering Manual three-layer rock jetties (fixed breakwaters) that create an extension of the existing peninsulas on the east and west sides of the Diablo East Harbor mouth would be constructed (Figure 2-1).

Characteristics of the fixed breakwater system:

- The existing channel width is 1200 feet at its narrowest point between the two peninsulas and perpendicular to a majority of the wind waves.
- The opening width for two direction vessel traffic, with a safety factor for crossing conditions, would be 120 feet at the lowest expected operational water depth.
- The opening would be facing toward the west and south in a manner to prevent waves from entering the harbor.
- The minimum non-wave overtopping crest elevation of the fixed breakwater would be 1133 feet above sea level.
- The desired rubble mound slope to remain stable while stopping the waves would be 1:1.5 (vertical distance to horizontal distance).
- The top crest width of the fixed breakwater would be 15 feet.
- The outer armor layer minimum thickness = 6.5 feet.
- The minimum mean armor rock weight = 669 pounds.

- The minimum mean middle layer rock weight = 67 pounds.
- The minimum mean internal foundation layer rock weight = 0.2 to 3.3 pounds.

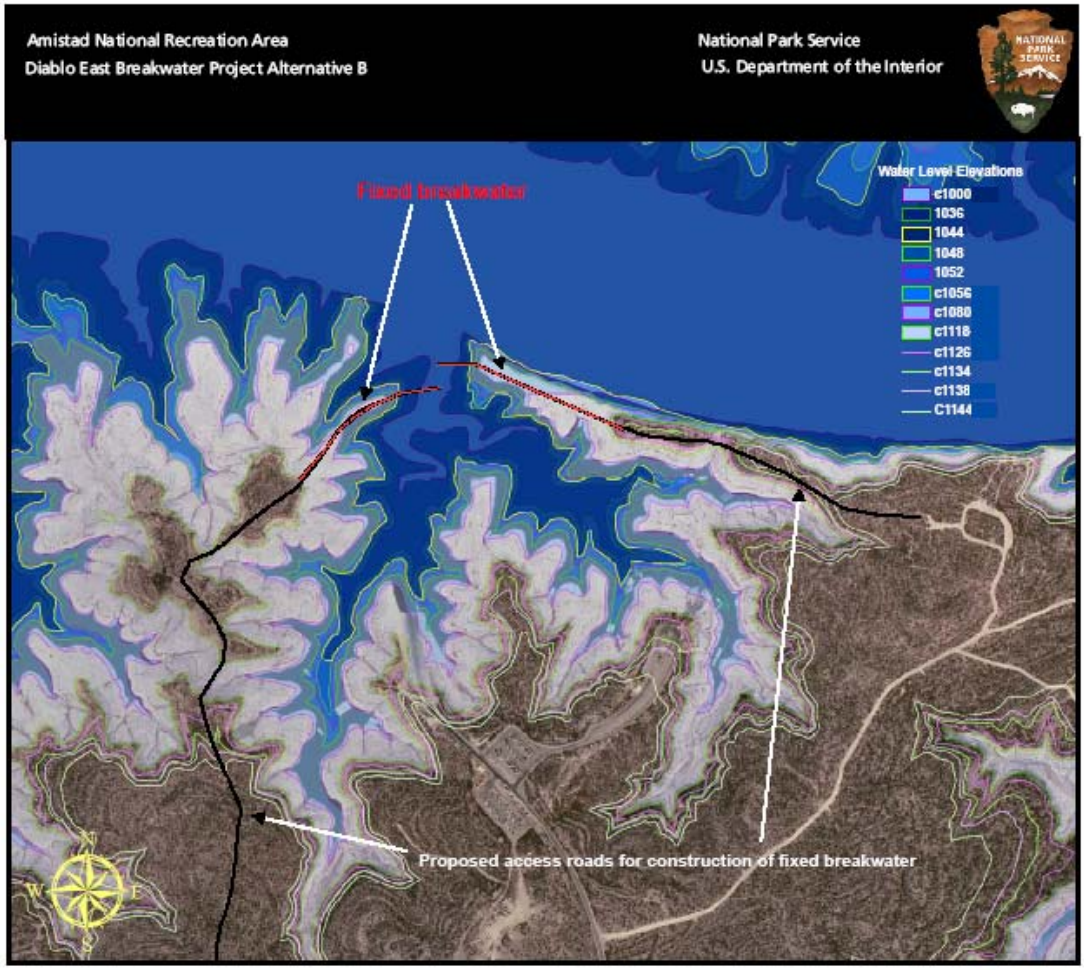

Figure 2-1. Alternative B showing the proposed location of a fixed breakwater.

Rock for the breakwater in this alternative would be obtained from a local quarry. Location where materials and equipment would be staged is the Diablo East storage area location known as the Bone yard.

Land-based construction by dump truck would be the method used for constructing the breakwater. A truck route for hauling of rock would be established on the eastern peninsula. A two track road going out to the end of the western peninsula is overgrown with forty years worth of vegetation growth and would be used as a truck route. Where the existing road crosses over Ladder Cave, based on engineering assessments, either a temporary bridge would be installed so as not to put direct pressure on the surface to avoid collapse, or the road may be re-routed to the west by removing a limestone outcrop. The construction period would be 18-24 months.

The fixed breakwater would be vegetated with native plants on the top and sides for it to look like a natural feature. The fixed breakwaters would be designed to look like a natural continuation of the east and west peninsulas.

Calculations for this fixed breakwater system are shown in Appendix B (Loesch, 2010). Additional calculations, geotechnical information, soil samples, and modeling would be needed to complete construction designs and specifications for this alternative.

2.3 ALTERNATIVE C – FLOATING BREAKWATER INSIDE HARBOR (PREFERRED ALTERNATIVE)

Under the Alternative C, a floating breakwater would be installed inside the harbor (Figure 2-2) and would provide land access from the center spit to a "Y" shaped floating breakwater dock system.

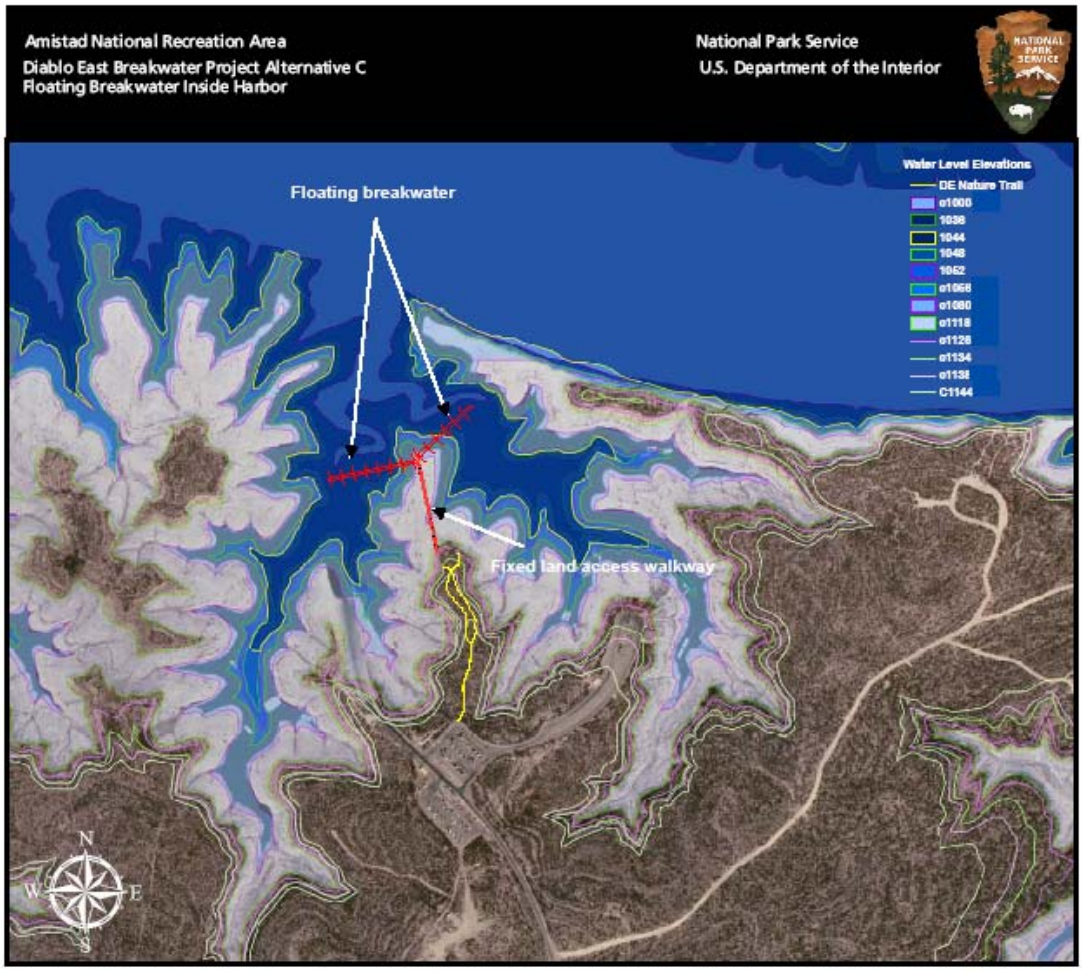

Figure 2-2. Alternative C showing the proposed location of a floating breakwater.

The floating breakwater/dock system would be held in place with concrete, rock, or driven plate anchors and chain matched to the bottom geo-technical properties and wave loading conditions. The floating docks would be made of concrete to provide the weight and strength necessary to attenuate waves. The anchor system would allow self adjustment with the lake level without the need for mechanical systems. The floating platforms would be six feet tall with sufficient density to have a 2-foot freeboard and 4-foot draft to adequately break down incoming waves up to four feet in height. The floating platforms would be twelve feet wide so that they can double as platforms for use by the general public, and they would have the ability to adjust as the lake level rises and falls.

A very long and straight rolling fixed and floating walkway would connect the floating docks to the central peninsula at Diablo East, which would be needed to account for the very large fluctuations in lake level. Reinforced concrete and/or steel piles can easily be found in sufficient size, length, and quantities for use in supporting the fixed bridge in the shallow water to the floating "Y" shaped concrete breakwater dock.

The breakwater would be anchored using chain and a combination of steel plate and concrete anchors. This would allow for natural adjustment of the breakwater dock with fluctuating lake levels without use of winches and other mechanical devices that require maintenance.

The floating breakwater docks should be made out of precast reinforced concrete. A significant amount of weight, size, and strength is needed to dampen the most significant waves and be strong and flexible enough to be long lasting.

The docks should be oriented so that their length is in alignment with the storm wave direction (winds from the north and northwest). In this alignment, the docks would be better able to dampen the highest most probable significant wave.

Floating concrete docks are prefabricated and designed to be transported by truck over US Highways. Their widths are limited by highway standards and are usually 6 feet wide. Additional discussions with manufacturers such as Bellingham Marine (a large USA concrete floating dock and breakwater supplier) are needed to confirm the optimum sizes and configuration. The breakwater docks come with interlocking joints and reinforced wood side panels that allow the docks to work as one continuous system.

Calculations for this floating breakwater system are shown in Appendix C (Loesch, 2010). Additional calculations, geotechnical information, soil samples, and modeling would be needed to complete construction designs and specifications for this alternative. For the purposes of the environmental assessment, calculations and results have been simplified by aligning the docks along their length directly into the wind and waves to form a series of interconnecting "++++++++" shapes. There are probably other shapes or combination of shapes (such as circular and diamond) in which the floating docks can interconnect to enhance year round vessel flow, fishing event activities, sponsorships, ADA (Americans with Disabilities Act) access, dock amenities, and esthetics.

Staging of materials and equipment would be located at the Diablo East storage area known as the Bone Yard. The construction period would be 12-18 months.

Alternative C is the preferred alternative at this time; however, NPS may choose a different alternative in the future after the completion of an engineering assessment if it is determined that water quality concerns within the harbor can be adequately mitigated by construction of a fixed breakwater with openings at various levels that would provide for continued exchange of water between the harbor and the main reservoir, and still adequately break down the incoming waves.

2.4 ALTERNATIVE D – FIXED AND FLOATING BREAKWATER COMBINATION

Under Alternative D, a combination of fixed and floating breakwaters would be constructed (Figure 2-3). The fixed breakwater would be placed on top of the existing east and west naturally formed peninsulas at the mouth of the harbor with an opening of 400 feet. A concrete floating breakwater dock would be anchored approximately 120 feet inside the harbor entrance formed by the new fixed breakwaters. The floating dock breakwater would be positioned to block any waves missed by the rubble mound jetties. There would be no walkway access from shore to the floating breakwater dock.

Characteristics and calculations for Alternatives B and C would apply to this alternative as well. The opening between the fixed breakwaters would be wider, estimated 400 feet at the average lake level. Additional analysis on the shape of the breakwater matched to existing concrete floating dock methods and wave condition would be needed to confirm the exact shape. The rubble mound three layer fixed breakwater would be the same as discussed in Alternative B.

The floating docks would be constructed as discussed in Alternative C and positioned to block any waves attempting to refract and directly push through the opening into the harbor. There would be no mechanical devices (winches or machinery) required; the system would rise up and down with the lake water level.

Staging of materials and equipment would be located at the Diablo East storage area known as the Bone Yard. The construction period would be 18-24 months.

Calculations for this combination fixed and floating breakwater system are shown in Appendix D (Loesch, 2010). Additional calculations, geotechnical information, soil samples, and modeling would be needed to complete construction designs and specifications for this alternative.

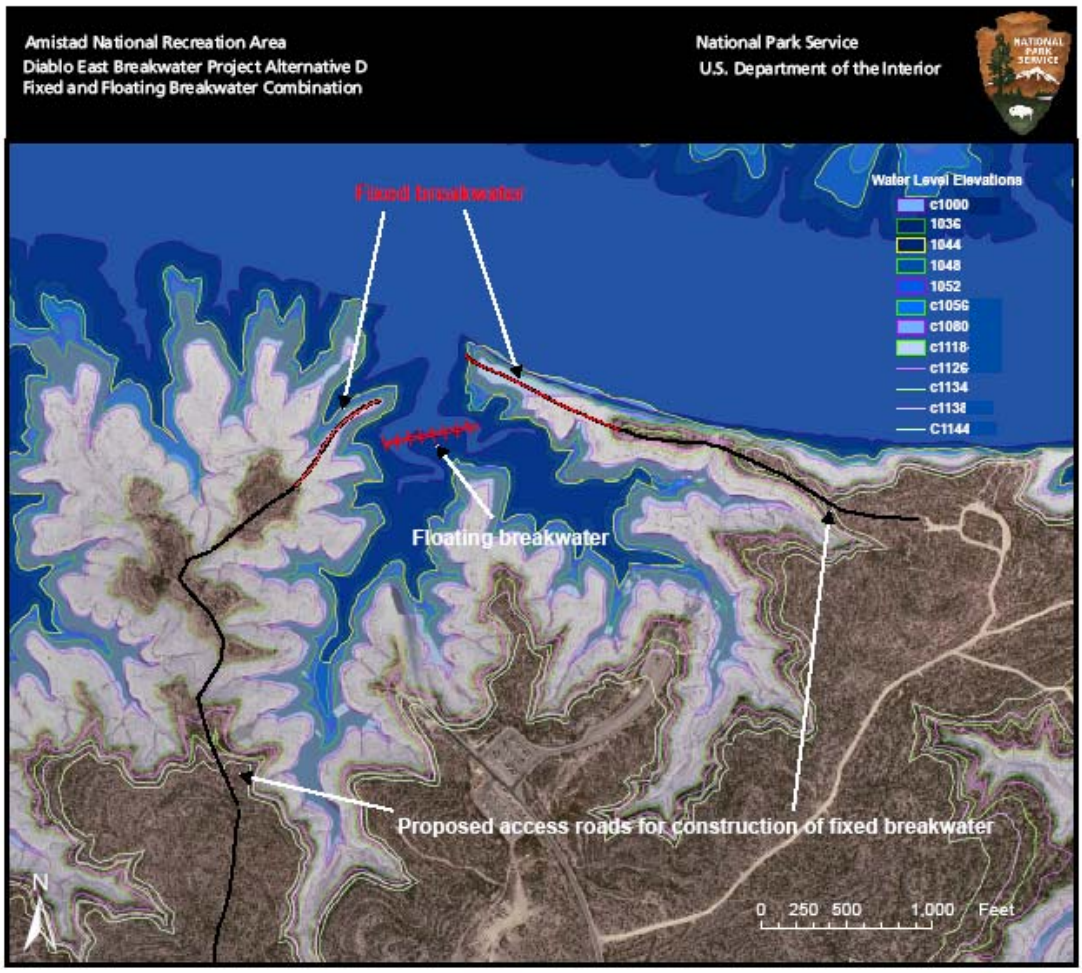

Figure 2-3. Alternative D showing the proposed location of a fixed and floating breakwater.

2.5 ALTERNATIVES CONSIDERED BUT DISMISSED

CEQ regulations for implementing NEPA require that Federal agencies explore and objectively evaluate all reasonable alternatives, and briefly discuss the rationale for eliminating any alternatives that were not considered in detail. This section describes three alternatives that were considered and eliminated from further study. The rationale for elimination is given below.

Floating breakwater platforms that slide up and down on pillars
Pillars anchored to the lake bottom (80 foot depth) would be installed and a series of breakwater platforms extending between the pillars would be constructed. The breakwater platforms would need to be at least six feet deep and of a sufficient density so that they would naturally float on the water with at least four feet of the structure extending down into the water to adequately break down the incoming waves. The breakwater platforms would be at least twelve feet wide

so they can double as fishing platforms for use by the general public. The breakwater platforms would need to be constructed so that they would naturally slide up and down the pillars as the lake level rose and fell.

This alternative was dismissed because the pillars would not work in deep water. In water deeper than 40 feet, minimum18 inch diameter steel pipe piles with black coal tar epoxy coating for corrosion protection would be needed. Pile lengths in the deepest portion may be in excess of 200 feet long to account for soil conditions and varying lake levels. This is very long for a marina pile and would likely require a very large diameter pile.

Two smaller breakwaters inside the harbor
Two smaller fixed or floating breakwaters would be constructed; one in front of the marina and the other in front of the government boat slips. This option was dismissed because the closer-in breakwaters would not allow the marina enough room to move their slips further out into the harbor out of the protected cove when lake levels drop.

Other configurations of fixed and floating breakwaters
There are many configurations and combinations of breakwaters that could be installed. For example, two non-overlapping fixed breakwaters creating an extension of the existing peninsulas on the east and west sides of the Diablo East Harbor mouth, three breakwaters configured as in Alternative D but all floating, and other shapes (such as circular and diamond) for floating breakwaters inside the harbor. Many of these are viable, but the ones deemed to fit best with the situation at Diablo East Harbor were selected for analysis.

2.6 ENVIRONMENTALLY PREFERRED ALTERNATIVE

In accordance with DO-12, the NPS is required to identify the "environmentally preferred alternative" in all environmental documents, including EAs. The environmentally preferred alternative is determined by applying the criteria suggested in NEPA, which is guided by the CEQ. As stated in Section 2.7 (D) of the NPS DO-12 Handbook, "The environmentally preferred alternative is the alternative that will best promote the national environmental policy expressed in NEPA (Section 101(b))." This environmental policy is stated in six goal statements, which include:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
3. Attain the widest range of beneficial uses of the environment without degradation, risk to health and safety, or other undesirable and unintended consequences;
4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain wherever possible, an environment which supports diversity and variety of individual choice;
5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (NEPA, 42 USC 4321-4347).

In sum, the environmentally-preferred alternative is the alternative that not only results in the least damage to the biological and physical environment, but also that best protects, preserves, and enhances historic, cultural, and natural resources. Alternative A (No Action) is the environmentally preferred alternative because no new adverse impacts to the environment would occur from installation of a new breakwater. Implementing any of the action alternatives (B, C, or D) would be beneficial for preventing damage to government and concession facilities and improve visitor safety when attempting to launch and retrieve boats during storms. However, without the construction of a new breakwater under Alternative A, biological, physical, and cultural resources would be preserved without any additional adverse impacts.

2.7 MITIGATION MEASURES

For all action alternatives, Best Management Practices (BMPs) and mitigation measures would be used to prevent or minimize potential adverse effects associated with improvement of canoe launches and expansion of visitor parking. These practices and measures would be incorporated to reduce the magnitude of impacts and ensure that major adverse impacts would not occur. Mitigation measures undertaken during project implementation would include, but would not be limited to, those listed below. The impact analysis in the *Environmental Consequences* chapter was performed assuming that these BMPs and mitigation measures would be implemented as part of all action alternatives.

General Considerations

- Construction zones would be identified with construction fence, silt fence, or similar material prior to construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction. All protection measures would be clearly stated in the construction specifications and workers would be instructed to avoid conducting activities beyond the construction zone. Disturbances would be limited to roadsides, culvert areas, and other areas inside the designated construction limits. No machinery or equipment would access areas outside the construction limits.

- Construction equipment and materials would be stored in designated staging areas.

- Contractors would be required to properly maintain construction equipment (i.e., mufflers and brakes) to minimize noise. Construction vehicle engines would not be allowed to idle for extended periods of time.

- Material and equipment hauling would comply with all legal load restrictions. Load restrictions on park roads are identical to state load restrictions with such additional regulations as may be imposed by the park Superintendent.

- Water sprinkling would be used as needed to reduce fugitive dust in work zones.

- All tools, equipment, barricades, signs, surplus materials, and rubbish would be removed from the project work limits upon project completion.

Water Quality and Soils

- Erosion-control BMPs for drainage and sediment control, as identified and used by the NPS, would be implemented to prevent or reduce nonpoint source pollution and minimize soil loss and sedimentation in drainage areas. These practices may include, but are not limited to, silt fencing, filter fabric, temporary sediment ponds, check dams of pea gravel-filled burlap bags or other material, and/or immediate mulching of exposed areas to minimize sedimentation and turbidity impacts from construction activities. Silt fencing fabric would be inspected daily during project work and weekly after project completion, until removed. Accumulated sediments would be removed when the fabric is estimated to be approximately 75 percent full. Silt removal would be accomplished in such a way as to avoid introduction into any flowing water bodies.

- All work would cease during heavy rains and would not resume until conditions are suitable for the movement of equipment and material.

- Regular site inspections would be conducted to ensure that erosion-control measures are properly installed and functioning effectively.

- The operation of ground-disturbing equipment would be temporarily suspended during large precipitation events to reduce the production of sediment.

- All equipment would be maintained in a clean and well-functioning state to avoid or minimize contamination from fluids and fuels. Prior to starting work each day, all machinery would be inspected for leaks (e.g., fuel, oil, and hydraulic fluid) and all necessary repairs would be made before the commencement of work.

- Prior to the start of construction, a hazardous spill plan would be required from the contractor stating what actions would be taken in the case of a spill and preventive measures to be implemented. Hazardous spill clean-up materials would be on-site at all times. This measure is designed to avoid/minimize the introduction of chemical contaminants associated with machinery (e.g., fuel, oil, and hydraulic fluid) used in project implementation.

- BMPs required by appropriate authorities, such as the installation of double-walled silt curtain in the reservoir surrounding construction activities, the installation of silt fencing and other erosion and sediment control measures when working on the adjacent land, and additional structural practices and stormwater management controls as necessary.

- A Storm Water Pollution Prevention Plan (SWPPP) would be required for any construction activities that would disturb a total area of greater than five acres.

- Mitigation measures could be employed that would increase water exchange between the harbor and the reservoir if dissolved oxygen levels were anticipated to decrease. Possible

mitigation measures would include designing a fixed breakwater with openings to allow for the flow of water through it at varying depths, or large volume aerators that could be used to mechanically oxygenate the water inside the harbor.

Vegetation

- Site reclamation and revegetation would use appropriate BMPs that include planting native plants. Until the soil is stable and vegetation is established, erosion-control measures would be implemented to minimize erosion and prevent sediment from reaching the lake.

- To prevent the introduction of, and minimize the spread of, nonnative vegetation and noxious weeds, the following measures would be implemented during construction:
    - Soil disturbance would be minimized;
    - All construction equipment would be pressure washed and/or steam cleaned before entering the park to ensure that all equipment, machinery, rocks, gravel, and other materials are clean and weed free;
    - All haul trucks bringing rock from outside the park would be covered to prevent seed transport;
    - Vehicle and equipment parking would be limited to within construction limits or approved staging areas;
    - Staging areas outside the park would be surveyed for noxious weeds and treated appropriately prior to use;
    - All rock would be obtained from approved local quarries. NPS personnel would certify that the source is weed free; and
    - Monitoring and follow-up treatment of exotic vegetation would occur after project activities are completed.

- Sensitive plant surveys would be conducted prior to disturbance of any suitable habitat. If sensitive species are found, the area would be avoided (if practicable), mitigation measures would be implemented to minimize impacts, or affected plants would be transplanted.

Wildlife and Fish

- The construction contractor would be required to keep all garbage and food waste contained and removed daily from the work site to avoid attracting wildlife into the construction zone. Construction workers would be instructed to remove food scraps and not feed or approach wildlife.

- Surveys for Texas horned lizard, Texas indigo snake, and Texas tortoise, as well as for the presence of other rare species, would be conducted prior to disturbance of suitable habitat. If any of these species are found, the area would be avoided (if practicable), mitigation measures would be implemented to minimize impacts, or affected animals would be relocated. The Texas tortoise would be permitted to leave on their own.

- Any vegetation clearing would be scheduled outside of migratory bird nesting season.

- Deposits of rock to construct the fixed breakwaters should be made, preferably, during times of year when fish are not spawning.

- To reduce fish mortality during tournaments:
    - Reduce the length of tournaments.
    - Reduce daily bag limits.
    - Reduce the number of fish brought to the official end-of-the-day weigh-in.
    - Schedule tournaments during cooler months.
    - Change the location of the weigh-in to preclude water quality concerns in the harbor.

  These five mitigation measures to reduce fish mortality during tournaments are being studied at this time, but NPS does not intend to implement any of these suggested changes until additional scientific data from further studies confirm that these actions would actually reduce fish mortality of the released tournament fish. NPS would then discuss the proposed changes with the tournament directors before implementing any of the changes.

- Mitigation measures could be employed that would increase water exchange between the harbor and the reservoir if dissolved oxygen levels, which affect fish, were anticipated to decrease. Possible mitigation measures would include designing a fixed breakwater with openings to allow for the flow of water through it at varying depths, or large volume aerators that could be used to mechanically oxygenate the water inside the harbor.

Visitor Use and Experience and Human Health and Safety

- Visitors would be informed in advance of construction activities via a number of outlets including the park website, newspaper, and visitor contact facility.

- Provide signs to warn travelers and boaters about closed areas; such notifications would also be posted at the Visitor Center.

- An explanation of the project, including information about closed areas, would be included as part of Lake Use Permits.

Archeology

- If archaeological features are encountered during construction, work would cease immediately and the park Superintendent and Cultural Resource Specialist would be notified. Procedures would be followed, as per Director's Order 28 and found in the guiding regulations in 36 CFR 800.13. No further action would take place until the NPS provides clearance.

- To mitigate effects of using roads to transport materials on the east and west peninsulas:
    - A layer of fill would be brought in to cover and protect the exposed portion of archeological sites.
    - Equipment operators would receive a briefing by park resource management personnel that there are sensitive archeological sites immediately adjacent to the

established roadsides within the APE, that they are not to leave the established roads in these areas, and that the most sensitive areas would be barricaded along the roadside.
- The roadsides adjacent to the most sensitive areas would be barricaded to help equipment operators remember to avoid these areas.
- Park resource personnel would monitor construction activities to ensure compliance.

Socioeconomics

- A combination of scheduling modifications for specific marina events along with public information efforts to make boaters and other users aware of the need for the temporary stoppage of boats through the harbor during the construction period would potentially alleviate any decreases in visitor use and spending during the period of construction.

2.8 COMPARISON OF ALTERNATIVES

Table 2-1 compares and contrasts the alternatives, including the degree to which each alternative accomplishes the purpose or fulfills the project objectives identified in the purpose and need section.

Table 2-2 compares the potential environmental impacts resulting from the alternatives. Potential impacts are provided according to environmental resource topic. The *Environmental Consequences* section of this EA contains a detailed discussion of these potential impacts by resource topic.

Table 2-1. Alternatives Comparison Table

	Alternative A: No Action	Alternative B: Fixed Breakwater	Alternative C: Floating Breakwater (Preferred Alternative)	Alternative D: Fixed and Floating Breakwater Combination
Truck route for construction	N/A	two track road on western peninsula, establish route on eastern peninsula	establish route on central peninsula	two track road on western peninsula, establish route on eastern peninsula
Fixed Breakwater Opening	N/A	120 feet	N/A	400 feet
Top Elevation/ Height	N/A	1133 feet	6 feet total, with 2 feet above the surface and 4 feet below the surface	Fixed: 1133 feet Floating: 6 feet total, with 2 feet above the surface and 4 feet below the surface
Top Width	N/A	15 feet	12 feet	Fixed: 15 feet Floating: 12 feet
Material	N/A	rock	concrete	Fixed: rock Floating: concrete
Connected to shore?	N/A	no	yes	no
Vegetated breakwater?	N/A	yes	no	yes, fixed breakwater only
Construction Period	N/A	18-24 months	12-18 months	18-24 months
Fulfills Purpose and Need?	no	yes	yes	yes

Table 2-2. Summary Comparison of Environmental Consequences

Impact Topic	Alternative A: No Action	Alterative B: Fixed Breakwater	Alterative C: Floating Breakwater (Preferred Alternative)	Alterative D: Combination Breakwater
Water Resources	Negligible to minor adverse impacts from the continuation of storm damaged structures, and associated contaminants and turbidity, released into the lake.	Short- and long-term adverse minor impacts as a result of sedimentation and contamination from construction activities entering the reservoir waters. Water exchange between the harbor and reservoir could decrease by up to 65-75%. Dissolved oxygen in harbor could decrease and nutrient concentration could increase. Long-term, indirect, adverse moderate impacts due to decreased water circulation and water exchange.	Short- and long-term adverse negligible to minor impacts. No long-term impacts to present water circulation and water exchange between harbor and reservoir.	Short- and long-term adverse minor impacts as a result of sedimentation and contamination from construction activities entering the reservoir waters. Water exchange between the harbor and reservoir could decrease by up to 50%. Dissolved oxygen in harbor could decrease and nutrient concentration could increase. Long-term, indirect, adverse minor to moderate impacts due to decreased water circulation and water exchange.
Geology and Soils	The No Action Alternative would have no new effects on geology and soils.	Short-term, minor, adverse impacts from compaction and erosion of soils on 5.8 acres during construction activities and from the possible use of a temporary bridge to span Ladder Cave so trucks can	Short-term, minor adverse impacts from compaction and erosion of soils on 0.8 during construction activities. No cave or karst feature concerns.	Short-term, minor, adverse impacts from compaction and erosion of soils on 5.8 acres during construction activities and from the possible use of a temporary bridge to span Ladder Cave so trucks can

Impact Topic	Alternative A: No Action	Alterative B: Fixed Breakwater	Alterative C: Floating Breakwater (Preferred Alternative)	Alterative D: Combination Breakwater
		drive over top without it collapsing. Adverse, moderate long-term impacts if a limestone outcropping is removed to reroute the road.		drive over top without it collapsing. Adverse, moderate long-term impacts if a limestone outcropping is removed to reroute the road.
Archeology	The No Action Alternative would have no new effects on archeology.	Minor, long-term, adverse impacts from use of access roads that pass adjacent to or within a number of archeological sites on the eastern and western peninsulas. Mitigation actions would be required.	Negligible archeological concerns.	Minor, long-term, adverse impacts from use of access roads that pass adjacent to or within a number of archeological sites on the eastern and western peninsulas. Mitigation actions would be required.
Fish and Aquatic Habitat	The No Action Alternative would have no new effects on fish and aquatic habitat.	Short-term, minor, adverse impacts during the construction phase from runoff from roads used to deliver breakwater materials, and from the construction of the breakwater. Long-term impacts during the operational phase including negligible positive impacts through increased fish habitat, and minor adverse impacts related to the 65-	Negligible short-term and long-term impacts during both the construction and operational phases. No change in water exchange between harbor and reservoir.	Short-term, minor, adverse impacts during the construction phase from runoff from roads used to deliver breakwater materials, and from the construction of the breakwaters. Long-term impacts during the operational phase including negligible positive impacts through increased fish habitat, and minor adverse impacts related to the 50%

Impact Topic	Alternative A: No Action	Alterative B: Fixed Breakwater	Alterative C: Floating Breakwater (Preferred Alternative)	Alterative D: Combination Breakwater
		75% decrease in water exchange between the harbor and reservoir.		decrease in water exchange between the harbor and reservoir.
Special Status Species	The No Action Alternative would have no new effects on special status species.	Short-term, minor, adverse impacts from disturbance and displacement during construction and temporary habitat disturbance.	Short-term, negligible to minor, adverse impacts from disturbance and displacement during construction and temporary habitat disturbance.	Short-term, minor, adverse impacts disturbance and displacement during construction and temporary habitat disturbance.
Visitor Use and Experience	Long-term, moderate, adverse impacts due to the continued unsafe and stressful conditions in Diablo East Harbor during storms.	Short-term, minor, adverse impacts due to noise, traffic, and access during construction of the breakwater. Long-term, moderate, beneficial impacts due to improved conditions in the harbor and new recreational opportunities with the presence of a new breakwater. Long-term, minor, adverse impacts as many boaters attempt to return through the restricted breakwater opening during storms. Ease of access to the fixed	Short-term, minor, adverse impacts due to noise, traffic, and access during construction of the breakwater. Long-term, moderate, beneficial impacts due to improved conditions in the harbor and new recreational opportunities with the presence of a new breakwater. Bonus of providing a perfectly-located fishing platform accessible to the non-boating public for the lifetime of the reservoir.	Short-term, minor, adverse impacts due to noise, traffic, and access during construction of the breakwater. Long-term, moderate, beneficial impacts due to improved conditions in the harbor and new recreational opportunities with the presence of a new breakwater. Ease of access to the fixed breakwater, then to shoreline, by non-boating fishing public is uncertain as it may require a substantial hike from the nearest parking area and the difficulty of scrambling over

Impact Topic	Alternative A: No Action	Alterative B: Fixed Breakwater	Alterative C: Floating Breakwater (Preferred Alternative)	Alterative D: Combination Breakwater
		breakwater, then to shoreline, by non-boating fishing public is uncertain as it may require a substantial hike from the nearest parking area and the difficulty of scrambling over large, irregularly-shaped rocks. The viewscape of the harbor mouth after construction may not appeal to all park visitors.		large, irregularly-shaped rocks. The viewscape of the harbor mouth after construction may not appeal to all park visitors.
Park Operations	Long-term, minor adverse impacts due to the continued need for dock repairs and visitor assistance at Diablo East during storms.	Long-term, minor, beneficial impacts due to the diminished need for dock repairs and visitor assistance at Diablo East during storms. Short-term, minor, adverse impacts due to the need for increased staff time required to manage visitors and contractors during project implementation. Maintenance-free breakwater for lifetime of reservoir.	Long-term, minor, beneficial impacts due to the diminished need for dock repairs and visitor assistance at Diablo East during storms. Short-term, minor, adverse impacts due to the need for increased staff time required to manage contractors during project implementation. Structure would need to be replaced after 25 years.	Long-term, minor, beneficial impacts due to the diminished need for dock repairs and visitor assistance at Diablo East during storms. Short-term, minor, adverse impacts due to the need for increased staff time required to manage contractors during project implementation. The floating breakwater component would need to be replaced after 25 years.

Impact Topic	Alternative A: No Action	Alterative B: Fixed Breakwater	Alterative C: Floating Breakwater (Preferred Alternative)	Alterative D: Combination Breakwater
Socioeconomics	Minor to moderate and adverse over the long-term, depending on the frequency and severity of storm events in any given year.	Minor, short-term adverse impacts during the construction period. Long-term, moderate, beneficial impacts due to reductions in storm damage.	Negligible to minor, short-term adverse impacts during the construction period. Long-term, moderate, beneficial impacts due to reductions in storm damage.	Minor, short-term adverse impacts during the construction period. Long-term, moderate, beneficial impacts due to reductions in storm damage.

3.0 AFFECTED ENVIRONMENT

This chapter describes the existing environment and current conditions of resources at the Park that are analyzed in this EA. Topics discussed are water resources, geology and soils, archeology, fish and aquatic habitat, special status species, visitor use and experience, park operations, and socioeconomics. These resources have the potential to be affected by the construction of a new breakwater system in Diablo East Harbor.

3.1 WATER RESOURCES

The Amistad Reservoir is located on the Rio Grande River, at its confluence with the Devils River. The reservoir was formed in November 1969 by the construction of Amistad Dam to provide flood control, water conservation, irrigation, hydroelectric power, and recreation. At the conservation pool water level (the amount of water designated to meet water supply needs) the reservoir has 65,000 surface acres (26,299 hectares) of water, with 43,250 acres (17,499 hectares) in the United States and 21,750 acres (8,800 hectares) in Mexico (Purchase et al., 2001).

Amistad is generally defined as the U.S. portion of the Amistad Reservoir surface and shore area up to the 1,144-foot elevation contour above mean sea level (msl), with a pool conservation level of 1,117 feet above msl (NPS, 2006a). This includes 81 river miles (130 kilometers (km)) of the Rio Grande, 14 river miles (22.5 km) of the Pecos River, and 28 river miles (45 km) of the Devils River. The NPS manages all lands and surface waters of the reservoir and associated area for recreation. However, all management decisions regarding water flow, including water inflows into the reservoir and water discharges from the Amistad Dam, are managed by the IBWC and the Texas Council on Environmental Quality (TCEQ) Watermaster (Garetz, 2010c). For the purposes of water flow management, the Amistad and Falcon International Reservoirs are often considered one system with water frequently released from the upstream Amistad Dam to replenish Falcon reservoir and meet the demands in the Lower Rio Grande valley (Purchase et al., 2001).

The Diablo East Harbor, where the Lake Amistad Resort and Marina is found, is located on the southern shore of Amistad National Recreation Area.

3.1.1 Hydrology

The Amistad Reservoir is located within the Upper Rio Grande sub-basin of the Rio Grande watershed. The Rio Grande, Pecos River, and Devils River contribute more than 70% of the flow into Amistad Reservoir (NPS, 2006a). The Rio Grande stretches nearly twelve hundred miles along the Texas-Mexico border before reaching the Gulf of Mexico. The Pecos River drains a watershed of 44,000 square miles, and joins the Rio Grande in the upper portion of the recreation area. The Devils River drains a watershed of 4,305 square miles, and enters the north side of the reservoir in the lower portion. The Devils River is spring-fed, its flow is not regulated, and it is largely uninfluenced by land use in the watershed (Purchase et al., 2001).

Average annual flows in the Devils River are slightly higher than in the Pecos River, but both rivers have flows in the range of near 100 cfs (cubic feet per second) to more than 900 cfs. Base flows in the Pecos and Devils rivers are 70-180 cfs and 110-250 cfs, respectively (NPS, 2006a). The flow of the Rio Grande and Rio Conchos combined contribute more than two-thirds (or 700 cfs) of the flow into the reservoir. Most of the remaining inflows are from springs that flow directly into the Rio Grande. These springs either are upstream of the reservoir or inundated in the reservoir.

Springs, the discharge of groundwater at the surface, served as the formative agents of hydrological processes in the reservoir area (NPS, 2006a). Pressure release due to well drilling, and head decrease due to many years of pumping for drinking supply and agricultural use, have reduced the flows substantially at many springs. Some spring flow may also have decreased due to reduced recharge over the watershed due to a shift from grass to shrub cover, and the subsequent loss of infiltration capacity resulting from a century of grazing (NPS, 2006a). The Devils River has one of the largest base flows of rivers in Texas due to flow from such springs as Willow Springs, Indian Springs, Satan Springs and Lowry Springs. The Pecos River also has several named springs within the recreation area, including Dead Man Springs and Pecos Springs. In the Rio Grande watershed, the most significant spring is the artesian Goodenough Spring, which flows into the reservoir below water surface. Additional springs that flow into the Rio Grande include Pump Canyon Springs and Eagle Nest Springs.

The water level of the reservoir varies depending on inflow from rain and outflow from the dam. While the elevation of 1,117 feet is considered conservation pool, in drought years water levels have gone as low as 1,058.38 feet (NPS, 2006a). Conversely, significant flooding events such as those that occurred in 1972, 1974, 1998, and 2010, have inundated park facilities causing extensive damage. Outflows from the reservoir change abruptly in response to storms and irrigation demands downstream. In a typical year, the highest outflows (about 7,000 cfs) occur during the late spring/early summer and the early fall (September and October). Lower outflows (less than 1,500 cfs) typically are seen the remainder of the year, except in response to storms (NPS, 2006a)

Due to the size and depth of Amistad Reservoir, hydrodynamic circulation in the reservoir is mainly driven by wind. Due to the depth of the reservoir (more than 140 feet in many areas), significant vertical variations in current velocity exist in the reservoir, with the highest velocities typically occurring in the surface layer (Anchor QEA, 2010).

3.1.2 Water Quality

The TCEQ has classified all major stream segments in the state according to designated uses. The Amistad Reservoir corresponds to Segment 2305. The designated uses of the segment are high aquatic life, contact recreation, general use, fish consumption, and public water supply. TCEQ has determined that the aquatic life, contact recreation, public water supply, and general uses are fully supported in the reservoir (TCEQ, 2002). The fish consumption use has not been assessed. Although the Rio Grande both above and below the Amistad Reservoir has listed water quality impairments (for elevated concentrations of total dissolved solids, chloride, sulfate and bacteria), the reservoir itself has no listed water quality impairments (TCEQ, 2010). Elevated

concentrations of nitrate, however, which can cause nutrient enrichment, have been documented in several areas of the reservoir, in particular at the Devils River Arm (TCEQ, 2010). Elevated phosphorus concentrations have, in the past, been found in the reservoir near the dam (TCEQ, 2002).

The state has an established antidegradation policy designed to protect water quality at existing levels and to prevent a deterioration of water quality below achievable uses for a given stream segment. For Amistad Reservoir and the primary rivers feeding into the reservoir, antidegradation means that existing uses should be maintained and protected (NPS, 2006a). Through the Texas Clean Rivers Program, the IBWC coordinates monitoring activities in the Amistad Reservoir and its tributaries by supporting efforts of monitoring partners including: the IBWC; TCEQ; U.S. Geological Survey (USGS); NPS; the Upper Pecos Soil and Water Conservation District; the cities of Del Rio, Laredo, and Brownsville; and the Rio Grande International Study Center at Laredo. This monitoring program supports special projects, acts as a clearinghouse for data, provides a point of contact for issues in the Rio Grande basin, and provides annual summary reports. In the 2001 Amistad National Recreation Area Water Resources Scoping Report, water quality data were compiled from 84 monitoring stations for up to 30 years, from 1964 through 1993 (Purchase et al., 2001).

In the Water Resources Scoping Report, the major water resource issues identified for the Amistad Reservoir centered on the declining water quantity and quality of the Rio Grande and the Pecos Rivers (Purchase et al., 2001). Declining water quality and flows in the Rio Grande have been determined to be degrading reservoir water quality and impacting park operations (Purchase et al., 2001). Salinity levels in the reservoir are generally increasing. Concentrations of nutrients and some trace elements, such as mercury, are also on the rise (Purchase et al., 2001).

Salinity has been a concern for many years in the Upper Rio Grande Basin, primarily due to extensive water use for agriculture. Water from the Rio Grande picks up salt from the soil after it has been used for irrigation from one community to the other, increasing the dissolved salt content (TCRP, 2008). Salinity levels in the Rio Grande above and below Amistad Reservoir have been increasing since at least 1975. During the growing season, salinity levels can triple due to irrigation return flow. With increasing salinity in the tributaries, Amistad Reservoir has had rising salinity since 1983 (Purchase et al., 2001). The Pecos River and the flow from the Rio Grande above the Rio Conchos contribute significantly more to the salt-loading of the reservoir due to the high salinity of both these rivers as compared to the Rio Conchos. Salinity levels in the Rio Grande above the Rio Conchos vary with the amount of rainfall. During wet years, rainfall dilutes the concentration of salts in the tributary rivers from irrigation return flows. Salinity levels in Amistad Reservoir are reduced somewhat by the inflow of fresh water from the Devils River and freshwater springs under and adjacent to the reservoir. However salinity levels in the reservoir have been estimated to be rising at a rate of 15 milligrams/liter per year (Purchase et al., 2001). The primary concerns associated with increased salinity in the reservoir are potential downstream impacts on irrigated crops and drinking water.

Elevated levels of nutrients, including nitrogen, phosphorus and ammonia concentrations, usually lead back to a discharge from municipal/industrial or agricultural source in general. High nitrogen and phosphorus levels can lead to algal blooms, which may lead to eutrophication

(depressed dissolved oxygen levels). During periods of low flow and warm temperatures, oxygen levels can drop to critically low levels in nutrient rich systems. Fish kills can result as well as impacts on other aquatic life. High nutrient levels can also alter the species composition and diversity of aquatic life. Fish are sensitive to dissolved oxygen deficits in rivers and lakes when an overabundance of algae critically depresses oxygen levels in the water. Certain algae also release specific toxins in aquatic systems during seasonal periods, in response to nutrient conditions or upon death of large masses of the algae. Algae such as Golden Alga are toxic to fish species and can result in large fish kills. This has happened several times in the Pecos River and has also occurred in the Rio Grande around Big Bend (TCRP, 2008). Maintaining nutrient concentrations below the standards can limit and prevent algae blooms from occurring. Ammonia can be toxic to certain aquatic species and, as stated, could be an indicator that other pollutants may be present in the water associated with the source (Purchase et al., 2001).

The concentrations of most metals and trace elements appear to be steady in Amistad Reservoir, although mercury concentrations have increased in the Pecos River, the Rio Grande above Amistad, and in the reservoir itself (Purchase et al., 2001). Selenium is also increasing in the reservoir (Purchase et al., 2001). These metals are associated with atmospheric sources such as burning of fossil fuels and incineration of solid waste.

Additional potential contaminants that may be present in the Diablo East Harbor are oil and gas and gray water (Purchase et al., 2001). Boating activity within Amistad includes houseboats, fishing and speedboats, and personal watercraft. All these watercraft contribute pollutants of concern to the waters within the park. The effects of oil and gas contamination on water quality are present, but to what degree is not currently know (Purchase et al., 2001). The principal sources of oil and gas contamination at Amistad are (1) the use of two-cycle outboard motors, and (2) on the water refueling at marinas. Emissions from two-cycle engines, in which oil is mixed with the fuel, often produce a sheen on the water. This is readily observed when boats are started and idled in calm water conditions (Purchase et al., 2001). Gray water and human waste may enter the Diablo East Harbor from bank fishermen or houseboat activities in the area.

3.2 GEOLOGY AND SOILS

The land throughout most of southern Val Verde County is undulating to nearly level, but with steeper slopes and eroded canyon walls having ten to several hundred foot elevation differentials close to the rivers. The subsurface geology surrounding Amistad is one primarily of limestone in the Edwards Plateau (Purchase et al., 2001). Many geologic studies have been performed in the region for several reasons: easily accessible formation exposures in eroded river channels and road cuts; geotechnical studies for dam and petroleum studies; and the presence and great interest in large subsurface springs in this dry region.

The long stretch of US 90 north-northwest of the reservoir lies on thick gray lower cretaceous limestone. It is seen in numerous eroded and exposed locations in Amistad including bluffs and cliffs west of the US 90 bridge over the reservoir and on the west side of the Pecos River canyon. Steep canyons of limestone (Salmon Peak Limestone) surround the reservoir; Devils River Limestone, Del Rio Clay, Buda Limestone, and Boquillas Formation are also exposed within the park (KellerLynn, 2008).

Excavations for the Amistad Dam construction and nearby drill cores gathered by the IBWC yielded detailed limestone bedrock definition. Nearly 450 feet (137 meters) of the Salmon Peak Formation, consisting of lime mudstone overlays about 300 ft (91 m) of limestone shales, anhydrite grainstones, and lime mudstones of the McKnight Formation (Purchase et al., 2001).

Amistad receives major groundwater flow through springs and partially spring-fed rivers that tap the Edwards-Trinity aquifer. Extensive fractures, joint cavities, and porosity caused by the dissolution of unstable carbonates and evaporates provide the conduit for the aquifer to Amistad Reservoir (Purchase et al., 2001).

In 1995, an inventory of cave and karst resources was conducted at Amistad (KellerLynn, 2008). Twenty-three significant karst features were noted. Since then investigators and visitors have discovered additional caves. As of April 2008, the count was up to thirty-six. At about 1,290 m (4,000 ft) long, the longest known cave at Amistad is Diablo Cave. Cavers mapped this cave in the 1950s and 1960s. The deepest cave, Goodenough Springs, is submerged; its "end" is 76 m (250 ft) below the entrance. Generally, the caves range from small sinkholes to conduits of up to 100 m (330 ft) in length. Typical drops for sinkholes are 11–18 m (35–60 ft). Cave and karst features exist on the western peninsula of Diablo East Harbor. One such karst feature on the western peninsula, Ladder Cave, has three entrances located in close proximity to each other where the breakwater access road needs to go. There is a large void or chamber beneath the area where the three openings are located.

One of the larger known caves in the park, Ladder Cave is located on the western peninsula of Diablo East Harbor. The three vertical pit entrances to this cave are arrayed in a NE-SW line across a constriction in the peninsula. An old ranch road passes between the central and western entrances, and directly over the main underground chamber of the cave. Two other karst features, too small to be entered by humans, are also present in the immediate vicinity and testify to the fractured and solutioned nature of the bedrock in this location.

Soils on the eastern peninsula of the project area have been mapped as Zorra-rock outcrop complex, 1 to 8 percent slopes and on the western peninsula they are Zorra-rock outcrop complex, 8 to 15 percent slopes (NRCS, 2010). Soils on the center peninsula have been mapped as Langtry-rock outcrop association, very steep. These are shallow soils derived from weathered limestone with scattered areas of limestone bedrock exposed at the surface. Zorra soils are droughty, stony, have low available water for plant growth, and have low erosion potential. Zorra soils typically have an 8-inch surface layer of moderately alkaline, dark brown stony loam overlying 4 inches of caliche. Below the caliche layer is a 3-inch layer of fractured limestone with calcium carbonate within the cracks. The surface of Zorra soils are typically covered by gravel and cobbles from limestone parent material. Langtry soils have similar characteristics to Zorra soils, but are highly erodible due to steep slopes of 15 to 70 percent.

3.3 ARCHEOLOGY

Amistad is located in a distinct archeological region of southwest Texas known as the Lower Pecos. The region is defined by (and best known for) the colorful and complex Pecos River Style

pictographs, which were painted on rockshelter walls throughout the area. The region is centered on the confluence of the Pecos into the Rio Grande river, but Pecos River Style pictographs are found as far east as Del Rio and westward past Langtry. The prehistory of this region is divided into four main periods roughly corresponding to major climatic, technological, and /or cultural transitions: Paleoindian, Archaic, Late Prehistoric, and Historic (Johnson, 2010).

To add to the knowledge of previously known archeological sites, an archeological survey was conducted by Johnson (2010) to document the cultural resources that may be affected by the construction of a breakwater system for this project. The project surveyed a minimum 75 foot width Area of Potential Effect (APE) corridor for a total linear distance of 2.5 km (1.6 miles) on three peninsulas. This corridor represents a 15 foot roadway flanked by 30 foot possible impact zones on either side. The central peninsula and outer portions of the other peninsulas were surveyed in their entirety, and much of the corridor was surveyed out well beyond the 75 foot APE. A total of 16 shovel tests were placed non-randomly along the corridor in areas that appeared most likely to have soil depth and/or would help evaluate the potential significance of archeological sites.

The thin soils in the project area provide few locations that buried archeological deposits could exist. However, depressions within the Zorra Rock-outcrop complex can contain relatively small but surprisingly deep pockets of soil which were sometimes used in prehistoric times for the construction of earth oven cooking facilities.

Four previously recorded archeological sites occur within or in close proximity to the APE, consisting of middens (a mound or deposit containing fire cracked rock, shells, animal bones, and other refuse that indicates the site of a human settlement), lithic debris (stone artifacts including ground and chipped stone tools and the debris resulting from their manufacture), and fire-cracked rock scatter on the eastern and western peninsulas.

The recent archeological survey (Johnson, 2010) did not identify any archeological sites on the central peninsula, although it did find stone tools such as a dart point fragment and a scraper. A new site was found on the western peninsula composed of two loci, a light hilltop lithic scatter and a nearby but discontinuous small scatter of fire-cracked rock and lithic debris. Two other locations of interest were found on the western peninsula, one with a concentration of stone tools and another outside the APE for the roadway where limestone had been quarried. Several sites were found on the eastern peninsula, which would have offered a superb view of the Devils River canyon and its tributaries from atop 250-foot high cliffs before the creation of the reservoir. Artifacts found at these sites include scatter of fire-cracked rock and lithic materials, middens, sotol pit, rock cairn, and stone tools.

3.4 FISH AND AQUATIC HABITAT

3.4.1 Fish

Although Lake Amistad is highly regarded as a world class largemouth bass (*Micropterus salmoides*) fishery, it actually receives both commercial and recreational fishing activity. Commercial fishing is limited to the Mexican side of the reservoir and is heavily regulated by the

government to conserve the resource. Commercial fishing primarily focuses on catfish (*Ictalurus* and *Pylodictis* spp.), as over 40 percent of the annual haul is comprised of such fish. Other commercially important species include: common carp (*Cyprinus carpio*), tilapia (*Oreochromis* and *Tilapia* spp.), freshwater drum (*Aplodinotus grunniens*), bigmouth buffalo (*Ictiobus ciprinellus*), gizzard shad (*Dorosoma cepedianum*), and gar (*Lepisosteus* spp.), although a variety of minnows and suckers may also be commercially sought as bait fish. Commercial fishing has resulted in an annual catch of 209 metric tons (230 tons) (TPWD et al., 2006).

It is the recreational fishery, however, for which Lake Amistad is best known. The search for trophy bass attracts over 150 organized bass tournaments each year. Approximately 94 percent of these tournaments occur on the United States side. It has been reported that as many as five concurrent tournaments have been held over the same weekend, resulting in over 600 boats on the water (TPWD et al. 2006). Due to its popularity as a tournament fishing destination, the National Park Service has regulated largemouth bass tournaments via a tournament permitting process since 2004 (Myers and Dennis, 2008). In addition to largemouth bass, other species of fish sought by Lake Amistad's sport and recreational fishermen include: smallmouth bass (*Micropterus dolomieu*), striped bass (*Morone saxatilis*), white bass (*Morone chrysops*), channel catfish (*Ictalurus punctatus*), blue catfish (*Ictalurus furcatus*), and flathead catfish (*Pylodictis olivaris*); as well as a variety of sunfish (*Lepomis* spp.) and white crappie (*Pomoxis annularis*). A list of fish species identified and/or collected from the reservoir is shown in Table 3-1.

Table 3-1. Fish species found within the Amistad National Recreation Area boundaries.

Scientific name	Common name	Occurrence
Ameiurus natalis	yellow bullhead	present
Aplodinotus grunniens	freshwater drum	present
Astyanax mexicanus	Mexican tetra	abundant
Carassius auratus	goldfish	rare
Carpiodes carpio	river carpsucker	abundant
Cichlasoma cyanoguttatum	Rio Grande cichlid	present
Cycleptus elongatus	blue sucker	rare
Cyprinella lutrensis	red shiner	abundant
Cyprinella proserpina	proserpine shiner	present
Cyprinella venusta	blacktail shiner	abundant
Cyprinodon eximius	Conchos pupfish	rare
Cyprinodon hybrids	sheepshead minnow x Pecos pupfish	rare
Cyprinus carpio	common carp	abundant
Dionda argentosa	manantial roundnose minnow	abundant
Dionda episcopa	roundnose minnow	present
Dorosoma cepedianum	gizzard shad	abundant
Dorosoma petenense	threadfin shad	abundant
Etheostoma grahami	Rio Grande darter	present
Fundulus grandis	Gulf killifish	present
Gambusia affinis	western mosquitofish	present
Gambusia geiseri	largespring gambusia	present
Gambusia senilis	blotched gambusia	extirpated
Gambusia speciosa	Mexican mosquitofish	abundant
Ictalurus furcatus	blue catfish	present
Ictalurus lupus	headwater catfish	rare

Scientific name	Common name	Occurrence
Ictalurus punctatus	channel catfish	abundant
Ictiobus bubalus	smallmouth buffalo	abundant
Lepisosteus oculatus	spotted gar	present
Lepisosteus osseus	longnose gar	present
Lepisosteus spatula	alligator gar	present
Lepomis auritus	redbreast sunfish	abundant
Lepomis cyanellus	green sunfish	abundant
Lepomis gulosus	warmouth	abundant
Lepomis macrochirus	bluegill	abundant
Lepomis megalotis	longear sunfish	present
Lepomis microlophus	redear sunfish	present
Macrhybopsis aestivalis	speckled chub	rare
Menidia beryllina	inland silverside	abundant
Micropterus dolomieu	smallmouth bass	present
Micropterus salmoides	largemouth bass	abundant
Morone chrysops	white bass	abundant
Morone saxatilis	striped bass	abundant
Moxostoma austrinum	west Mexican redhorse	rare
Moxostoma congestum	gray redhorse	abundant
Notemigonus crysoleucas	golden shiner	present
Notropis amabilis	Texas shiner	abundant
Notropis braytoni	Tamaulipas shiner	abundant
Notropis chihuahua	Chihuahua shiner	rare
Notropis jemezanus	Rio Grande shiner	rare
Notropis stramineus	sand shiner	abundant
Noturus gyrinus	tadpole madtom	rare
Oreochromis aureus	blue tilapia	present
Percina caprodes	logperch	abundant
Pimephales vigilax	bullhead minnow	abundant
Poecilia latipinna	sailfin molly	present
Pomoxis annularis	white crappie	present
Pylodictis olivaris	flathead catfish	abundant
Rhinichthys cataractae	longnose dace	rare
Stizostedion vitreum	walleye	rare

Source: Dean and Garrett, 2001

Historically, both Mexico and the United States have managed fish populations independent of one another, often with differing goals. Mexico has focused on stocking and improving primarily the channel catfish and flathead catfish populations in conjunction with the management and sustainment of the commercially fished species discussed above. For the United States, however, the TPWD and the NPS are charged with monitoring, protection, and improvement of the sport fishery. Toward that end, the focus of stocking and management programs has been primarily centered on game fish. Largemouth bass are far and away the most sought after species, receiving 83 percent of the reservoir's annual angling hours (Myers and Dennis, 2008). As such, largemouth bass (both Florida and northern largemouth bass genotypes) are routinely stocked to maintain the fishery. Striped bass are also routinely stocked. Smallmouth bass were stocked in the 1970s and early 1980s. Although they are no longer stocked, smallmouth bass have developed into a fishery in the Devils River above the reservoir and incidental catches do occasionally occur in the Devils River arm of Lake Amistad. Blue and channel catfish were last stocked in 1967 and 1973, respectively. Both species have maintained

sustainable populations. Experimental stockings of walleye, northern pike, and muskellunge were conducted in the 1970's, but were unsuccessful and were discontinued (Meyers and Dennis, 2008).

In 2006, steps were taken to begin to cooperatively manage the entire lake's fisheries through the development of a Binational Fisheries Management Plan (TPWD et al., 2006). Although not fully implemented, this binational management plan underscores the importance of the fisheries resource at Lake Amistad to the local fishing and tourism economies on both sides of the border. For example, the 2007 direct expenditures related to the reservoir's fishery in Texas alone were $20.7 million (Meyers and Dennis, 2008).

An ongoing concern at the reservoir is mortality of largemouth bass caught during fishing tournaments. Fishing tournament data have indicated that total mortality of black bass captured during tournaments at Amistad Reservoir can range from relatively minor (0.3 percent) to considerable (64.8 percent) (Wilde et al., 2002). More recent data has shown total mortalities ranging from 5.6 percent to 50.8 percent (Table 3-2). In nearly all cases, increased mortality coincides with increased water temperature. Mortality rates appear to remain below 10 percent at water temperatures at or below 70^{o} F, increasing up to 60 percent as water temperatures approach and surpass 80^{o} F. According to Randy Myers, TPWD Inland Fisheries Division District Biologist, some 20,000 to 30,000 largemouth bass are caught and weighed-in during fishing tournaments held at Amistad Reservoir each year (Myers, 2010). An estimated 80-90 percent of those are weighed at the Diablo East Marina. As such, any change in the harbor's water quality that could impact bass survival rates would be of concern to the NPS, TPWD, and anglers alike.

Table 3-2. Summary of Amistad black bass mortality from five large tournaments held at Amistad Reservoir during 2009 (Myers, 2010).

Tournament	Bass Champs 1	Bass Champs 2	BASS Elite Series	FLW Stren Series	Permian Open
Date	01/17/2009	02/21/2009	03/13/2009	05/22/2009	09/19/2009
Water temperature (F)	53-56	57-59	57-63	79-80	83
Percent Initial Mortality*	4.2	1.7	2.1	4.7	8.7
Percent Delayed Mortality*	4.4	4.6	3.5	18.3	42.1
Total Tournament Mortality	8.6	6.3	5.6	23.0	50.8

* Initial mortality includes both fish that were dead at the time of weighing and those that died in the release tank following weighing. Delayed mortality are those dead fish observed in the weigh-in area of the lake up to three days following a tournament.

3.4.2 Aquatic Habitat

For the purposes of this discussion, aquatic habitats are defined as those areas within an aquatic ecosystem where sufficient amounts of dissolved oxygen, structure, and food occur with the minimum spatial and temporal frequencies necessary to meet the biological needs of a given species. In addition, these discussions are further restricted to lacustrine or lake ecosystems.

Lakes are divided by limnologists into the littoral, sublittoral and profundal zones. These zones are defined as follows:

- littoral, from the lake margin to a depth at which aquatic vegetation, through lack of light, can no longer grow;
- sublittoral, extends from the lower edge of the rooted macrophyte zone to about the level of the upper boundary of the hypolimnion; and
- profundal, roughly, the area of the bottom in contact with the hypolimnion, which consists of exposed fine sediment free of vegetation (Williams and Feltmate, 1992).

Benthic macroinvertebrates form an important link between primary producers and higher trophic levels in aquatic food webs (Stoffels et al., 2005). Food availability, substrate, water quality, and lake contour affect community structure of macroinvertebrates (Callisto et al., 2005; Rasmussen, 1988). The littoral habitat of lakes usually supports larger and more diverse populations of benthic invertebrates than do the sublittoral and profundal habitats (Moore, 1981; Wiederholm, 1980). Therefore, only the effects on the littoral zone are evaluated for this project. Under all four alternatives, aquatic vegetation and benthic macroinvertebrates in the littoral zone follow the rise and fall of the lake level.

The size and extent of the littoral zone can affect the amount of aquatic habitat in lacustrine ecosystems. The size and shape of this zone are affected by several factors, including water clarity and depth gradient (bank slope). Generally speaking, clear water and shallow depth gradients support broader littoral zones. In lacustrine ecosystems, the majority of aquatic plant life and structure in the form of rocks and large woody debris are concentrated in the littoral zone. This concentration of plant life and structure provides foraging, breeding, and escape cover for a variety of aquatic species. Previous studies have determined that macroinvertebrate (Gilinsky, 1984) and fish (Borawa et al., 1979) abundance and diversity are higher in areas with aquatic plants than in unvegetated areas, and many North America fishes are obligatory plant spawners (Pflieger, 1975).

A second component of an aquatic ecosystem affecting the spatial arrangement of aquatic life is dissolved oxygen. In still waters, dissolved oxygen enters a water column through two main mechanisms; by diffusion from atmospheric air and through the mixing action of waves. Because of this, dissolved oxygen concentrations are typically highest in the upper reaches of the water column and decrease with increasing depth.

Prior to inundation, the stretch of the Rio Grande River basin now under water consisted of a diversity of riverine, palustrine, and riparian habitats surrounded by Chihuahuan Desert scrub

(Powell, 1998). In 1973, water levels in Lake Amistad first reached the conservation pool level of 1117 feet above sea level, inundating the native woody vegetation of the surrounding landscape which then provided valuable structure for fish and other aquatic life. Over time, much of this woody vegetation began to deteriorate, effectively decreasing the amount of available aquatic habitat in the reservoir.

In 1993, the water levels in Lake Amistad began falling and reached their lowest level of 1,058.38 feet mean sea level (msl) on August 5, 1998. This drop in water levels revealed approximately 59 vertical feet of previously inundated substrate, which was quickly revegetated by upland woody and herbaceous plant species. In 2003-2004, water levels increased to within a few feet of pool level (1,117 feet msl) inundating the vegetation that had revegetated the exposed substrate over the previous 12 years. This newly inundated vegetative structure substantially improved the aquatic habitat in Lake Amistad (Myers and Dennis, 2008).

In 2007, the TPWD conducted an aquatic vegetation survey on the Texas side of Lake Amistad. The results of the survey indicated that approximately 17,499 acres (50 percent) of the approximately 34,312 acres of aquatic habitat located on the Texas side contained submerged vegetation or brush (Myers and Dennis, 2008). Of that 50 percent, herbaceous vegetation dominated the surveyed area with 13,347 acres of coverage, while submerged brush covered 4,152 acres. Hydrilla was the dominant herbaceous species occurring in an estimated 7,995 acres, with pondweed species occurring in 5,353 acres, and chara in 4,049 acres (Myers and Dennis, 2008). The minimum depth at which aquatic structure was recorded was one foot with a maximum depth of 32 ft.

Diablo East Harbor is a deep cove with water depths near the mouth of the cove reaching more than 100 feet at normal pool level. Because this area was once a deep canyon with steep slopes, much of the depth increase of Diablo East Harbor occurs near the current shoreline. The steep depth gradient in this area is one of the main limiting factors influencing the size and extent of the littoral zone in this area of the reservoir. Fortunately, the relatively clear water of Lake Amistad allows sunlight to reach greater depths, thereby countering the limiting effects of the steep gradient on plant life and increasing the depths to which aquatic plants can grow.

The TPWD 2007 fish monitoring program survey of Lake Amistad indicates that fish populations are stable or have improved since previous surveys (Myers and Dennis, 2008). Lake Amistad is widely considered one of the premier bass fishing lakes in the country. This and other data suggest that the current conditions of aquatic habitats in the reservoir are in excellent condition capable of supporting healthy and balanced populations of aquatic invertebrate and vertebrate species.

3.5 SPECIAL STATUS SPECIES

Special status species include species listed as threatened, endangered, or candidate under the Endangered Species Act (ESA); species considered sensitive by the park; and species listed as threatened or endangered within Texas by the Texas Parks and Wildlife Department (TPWD, 2010). Federally listed and candidate plant and wildlife species that occur in Val Verde County

are listed in Table 3-3. One of these species, the interior least tern, may be found in the project area. The delisted brown pelican may be found as well and is considered here.

Table 3-3. Federally listed and candidate species, Val Verde County, Texas.

Common Name	Scientific Name	Federal Status	Found in Project Area?
Black-capped vireo	*Vireo atricapilla*	Endangered	No
Brown pelican	*Pelecanus occidentalis*	Delisted	Yes
Devil's river minnow	*Dionda diaboli*	Threatened	No
Interior least tern	*Sterna antillarum anatum*	Endangered	Yes
Texas hornshell	*Popenaias popeii*	Candidate	No
Texas snowbell	*Styrax platanifolius* ssp. *texanus*	Endangered	No
Tobusch fishhook cactus	*Sclerocactus brevihamataus* ssp. *tobuschii*	Endangered	No

Source: USFWS, 2010

Interior least terns nest on several islands in Amistad Reservoir and feed in shallow waters nearby within the reservoir. The interior least tern is known to feed and nest in the vicinity of the Diablo East Harbor, and on rare occasions have been seen actively feeding inside the Diablo East Harbor in small numbers (Garetz, 2010a). Their nearest documented nesting site is an island approximately two miles from the Diablo East Harbor. The Diablo East Harbor historically has not been their preferred feeding area. There are no documented cases of brown pelicans nesting at Amistad, but birds may occasionally be seen passing through Diablo East Harbor, which provides suitable feeding habitat (Garetz, 2010a).

Amistad also provides habitat for other sensitive wildlife species listed as State threatened, endangered, or species of concern (Table 3-4). Suitable habitat for three reptiles (Texas horned lizard, Texas indigo snake, and Texas tortoise) and four bats (cave myotis, Brazillian free-tailed bat, pale Townsend's big-eared bat, and Yuma myotis) is found in the project area. Texas horned lizards were documented in a 2003-04 national recreation area-wide herpetology inventory near Diablo East; the Texas indigo snake has been observed along Viewpoint Road; and the Texas tortoise has been observed near the Diablo East ranger station (Prival and Goode, 2005; NPS, 2006a). The four species of bats likely forage in the project area along the eastern and western peninsulas. Peregrine falcons may be found near the project area feeding on cliff swallows that roost on the Hwy 90 and railroad bridges (Garetz, 2010a). The Mexican hooded oriole and trans-pecos black headed snake have been documented within 1.5 miles of the project area. It is also possible that the zone-tailed hawk, reticulate collared lizard, ferruginous hawk, and Audubon's oriole could be affected by project activities if suitable habitat is present.

Amistad also hosts ten plant species considered rare by the State of Texas because of their limited distribution (endemism) or because they are disjunct from more abundant population centers. Most of the species are known to occur in Val Verde County, and are expected to occur within Amistad (NPS 2006a). Table 3-5 lists Amistad rare plants. None of the rare plant species have been documented from, or are likely to occur in, the project area. If suitable habitat is present, Rydberg's scurfpea and Wright's water-willow could be affected by the project.

Table 3-4. State listed and sensitive wildlife species, Val Verde County, Texas.

Common Name	Scientific Name	State Status	Found in Project Area?
Audubon's oriole	*Icterus graduacauda audubonii*	SOC	No
Black bear	*Ursus americanus*	ST	No
Blotched gambusia	*Gambusia senilis*	ST	No
Blue sucker	*Cycleptus elongatus*	ST	No
Cave myotis	*Myotis velifer*	SOC	Yes
Conchos pupfish	*Cyprinodon extimius*	ST	No
Ferruginous hawk	*Buteo regalis*	SOC	No
Greater western mastiff	*Eumops perotis californicans*	SOC	No
Mexican hooded oriole	*Icterus cucullatus cucullatus*	SOC	No
Pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	SOC	Yes
Peregrine falcon	*Falco peregrinus*	ST	No
Proserpine shiner	*Cyprinella proserpina*	ST	No
Reticulate collared lizard	*Crotaphytus reticulatus*	ST	No
Rio Grande darter	*Etheostoma grahami*	ST	No
Rio Grande shiner	*Notropis jemezanus*	SOC	No
Texas horned lizard	*Phrynosoma cornutum*	ST	Yes
Texas indigo snake	*Drymarchon corais*	ST	Yes
Texas tortoise	*Gopherus berlandieri*	ST	Yes
Trans-Pecos black-headed snake	*Tantilla cucullata*	ST	No
Western burrowing owl	*Athene cunicularia hypugaea*	SOC	No
Yuma myotis	*Myotis yumanensis*	SOC	Yes
Zone-tailed hawk	*Buteo albonotatus*	ST	No

SE = State endangered, ST = State threatened, SOC = State species of concern.
Sources: Prival and Goode, 2005; NPS, 2006a; TPWD, 2010

Table 3-5. Texas State rare plant species, Amistad National Recreation Area.

Common Name	Scientific Name	Global Rank/ State Rank*	Found in Project Area?
Cliff bedstraw	*Gallium correllii*	G2/S1	No
Correll's false dragonhead	*Physostegia correllii*	G2/S2	No
Perennial caltrop	*Kallstroemia perennans*	G1/S1	No
Rydberg's scurfpea	*Pediomelum humile*	G1/S1	No
Sabinal prairie-clover	*Dalea sabinalis*	GH/SH	No
Sonora fleabane	*Erigeron vetensis*	G/S	No
Texas greasebush	*Glossopetalon texense*	G1/S1	No
Texas trumpet	*Acleisanthes crassifolia*	G2/S2	No
Warnock's rock-daisy	*Perityle warnockii*	G1/S1	No
Wright's water-willow	*Justica wrightii*	G2/S2	No

Sources: NPS 2006a; TNHS, 2004
*G = Global rank, describes the species status globally, and best describes the risk of extinction. S = State rank, for smaller portions of a species range. 1 = Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences. 2 = Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6-20 occurrences. H = Historical Occurrence, formerly part of the native biota with the implied expectation that it may be rediscovered.

3.6 VISITOR USE AND EXPERIENCE

Amistad hosts on average 1.4 million visitors annually; in 2009 the park experienced a high of over 2.5 million visitors (Klein, 2010). About 85 percent of Amistad visitors participate in water-based recreation; the rest use the park for camping or day use activities. Amistad visitation correlates very closely with lake levels. Amistad Reservoir levels began dropping in 1994, and subsequent visitation shows a sharp decrease, with gains from 1998 through 2004 when rising water levels resulted in a corresponding increase in recreation visits to the reservoir (NPS, 2006a).

Amistad is open year-round, and the highest visitor use occurs between March and September, with March and September often showing higher visitation than some summer months (NPS, 2006a). Visitation is typically lower in July and August because of high temperatures and humidity. Winter visitation decreases as well, although boating and fishing are still popular during the winter months, and RV camping typically increases during the winter. Watercraft use of Amistad Reservoir is highest on weekends in the spring and on holidays.

Visitor use tends to concentrate in the southeastern portion of the lake, in and around the dam, Diablo East, Governor's Landing, and Air Force marina sites. In these areas, the water is deepest and access from Del Rio is easiest, and it is where most of the park facilities are located. Facilities at Diablo East include a boat ramp, which is the largest and most popular location for the launching of boats on the U.S. side of the reservoir, and parking lot. The largest concession-operated marina on Amistad Reservoir is located adjacent to this Diablo East boat ramp. There is also a nature trail with interpretive signs with a trailhead near the parking area.

Recreational activities at Amistad include fishing, hunting, camping, hiking, visiting cultural sites, swimming, scuba diving, bird watching, and watercraft use. Amistad provides one of the outstanding fishing experiences in the American Southwest. The U.S. portion of Amistad Reservoir supports major sport fisheries for catfish, bass, and striped bass (NPS, 2006a). Amistad hosts approximately 150 fishing tournaments annually, most of which focus on bass fishing. The reservoir also attracts thousands of non-tournament fishermen. Roads provide access to certain areas of the Amistad Reservoir shoreline. The heaviest shoreline use is near the boat ramps at Diablo East, Southwinds Marina, Rough Canyon, and Spur 454.

A variety of watercraft are used on Amistad Reservoir. Bass boats associated with fishing tournaments comprise a large portion of the boating activity at Amistad Reservoir. The largest bass tournaments have attracted as many as 550 boats for a single tournament weekend, and many smaller bass tournaments of 60 or fewer boats are held at the lake nearly every weekend. On some weekends there may be as many as 12 small bass tournaments. During bass tournaments, anglers tend to fish the entire lake, with many of them launching from Diablo East.

Recreational boats not associated with bass tournaments comprise another large portion of the boating activity at Amistad. These users come to water-ski, sightsee, relax, swim, camp, hunt, and fish (non-tournament fishing).

3.7 PARK OPERATIONS

Ongoing park operations strive to maintain park physical, natural, and cultural resources while providing recreational opportunities for park visitors. Amistad's main visitor center and maintenance facility are located in a leased visitor facility on Highway 90 W, 5 miles west of Del Rio. Administrative functions are located in the headquarters building on 4121 Veterans Boulevard (Highway 90 W) in Del Rio. The current NPS staff consists of 37 permanent and 3 seasonal employees. The main ranger station is at Diablo East.

Currently, during large storms, the main dock at Diablo East Harbor can break loose and sustain damage. To fix the dock, the maintenance staff spends a day moving anchors while the rangers dive in the water with scuba gear to reset broken cables. This level of effort occurs approximately once every two years.

Smaller wind and storm events regularly occur two to three times a year, during which docks are damaged (i.e., broken boards, buckling, damaged winches). The maintenance staff spends one to two days making repairs after each wind and storm event.

Under the current situation (without a breakwater), visitors often need help during smaller wind and storm events. Ranger assistance is provided six to eight times per year during such storm events. For example, rangers assist visitors who sustain injuries while loading boats during storms. They also direct traffic when there are too many people trying to retrieve their boats at the same time during storms. Additionally, rangers assist with more infrequent occurrences, such as the sinking of private boats right at the dock.

3.8 SOCIOECONOMICS

Socioeconomic resources can be adversely impacted through activities that may alter the manner in which these resources (physical and natural, as well as human) are defined and utilized by the affected communities. The analysis of socioeconomic impacts identifies those aspects of the social and economic environment that are sensitive to change and that may be affected by actions associated with the alternatives proposed here. Specifically, the assessment considers how these actions might affect individuals, communities, and the larger social and economic patterns of life within communities. The data supporting this analysis are collected from standard sources, including the U.S. Census Bureau, Federal, state and local agencies or other local authorities and from local private operators at the Lake Amistad Resort and Marina. This section addresses the socioeconomic conditions that may be affected by implementation of the alternatives presented here and any potential sources of impact.

Diablo East, one of three major boating areas on Lake Amistad, is located approximately ten miles to the northwest of the City of Del Rio, Texas along Highway 90 West in Val Verde County, Texas. Other nearby population concentrations are found in Ciudad Acuna, across the international border, in the State of Coahuila, Mexico. The Lake Amistad Resort and Marina, managed by Forever Resorts, an NPS concessionaire, provides boat rentals, rental slips, fuel, bait, and a convenience store.

3.8.1 Local and Regional Economy

The leading sectors of the Val Verde County economy by employment in 2008 were Educational Services, Health Care and Social Assistance, followed by Public Administration and Retail Trade (Census, 2008). Val Verde County employment by industry sector is presented in Table 3-6.

Table 3-6. Employment by Industry Sector, Val Verde County, Texas.

Industry	Employees
Agriculture, forestry, fishing and hunting, and mining	437
Construction	1,537
Manufacturing	1,303
Wholesale trade	253
Retail trade	2,380
Transportation and warehousing, and utilities	1,125
Information	372
Finance and insurance, and real estate and rental and leasing	671
Professional, scientific, management, administrative and waste management	851
Educational services, and health care and social assistance	4,212
Arts, entertainment, and recreation, and accommodation, and food services	1,562
Other services, except public administration	803
Public administration	2,823
Total civilian Population	18,329

Source: Census, 2008

In 2010, Val Verde County supported a labor force of 21,760 of which 1,949 workers, or 9.0 percent, were unemployed (BLS, 2010). Month to month unemployment in the county has been consistently high since January 2009, ranging from 8.5 to 10.2 percent of the total workforce. Prior to the end of 2008, county unemployment held steady in the five to six percent range. Leading employers in the county are presented in Table 3-7.

Table 3-7. Leading Employers in Val Verde County.

Agency or Firm	Employees
Federal Agencies	1,955
San Felipe Del Rio School District	1,567
Laughlin Air Force Base	
Military Personnel	1,327
Civilian Employees	1,455
Wal-Mart Supercenter	473
Val Verde Regional Medical Center	500
City of Del Rio	485
Plaza Del Sol Mall	445
Home Depot	79
H.E.B. Grocery	256
Texas State Agencies	222
The GEO Group Correctional Facility	198
Val Verde County	206
Union Pacific Railroad	150

Source: DRCoC, 2003

Per capita personal income for Val Verde County residents in 2008 was $27,244, an increase of 4.6 percent from 2007. The county ranked 201st of 254 counties in the state with a per capita income that was 72 percent of the state average of $37,807 (BEA, 2010). Median household income for county residents in 2008 was $37,809 (Census, 2008).

3.8.2 Amistad National Recreation Area and Lake Amistad Resort and Marina

Amistad is a part of the International Amistad Reservoir situated on the Rio Grande along the border between the U.S. and Mexico. The park is open all year. The park offers visitors a variety of water-based recreation, camping, hiking and scenic viewing, as well as the experience of border culture along the Rio Grande (NPS, 2010e). For calendar year (CY) 2008, the park recorded a total of 1,980,718 recreation visits, of which 550,642 were to the Diablo East area. Visitation to the park has been increasing. In 2009, the park hosted 2,573,966 visitors of which 1,274,724 involved the Diablo East area (NPS, 2010a). In 2008, total spending in the region by Amistad NRA visitors was $58.1 million including $50.6 million spent by non-local visitors. Spending by Amistad visitors generated 109 jobs in the local region, contributing $2.2 million in labor income during CY 2008 (Stynes, 2009).

Marina facilities at Diablo East are operated by Forever Resorts, a private business entity acting as concessionaire under agreement with NPS. Lake Amistad Resort and Marina facilities include: houseboat rentals; ski boat, deck cruiser and fishing boat rentals; a full service marina; boat slip rentals; dry storage and a convenience store (Forever Resorts, 2010). The marina employs a staff of approximately 14 during the peak summer season, seven during the winter months. The current fleet of rental boats maintained by the marina includes 12 houseboats, 3 deck cruisers, 3 fishing boats, and one ski boat. On average the marina maintains approximately 40 slips for rental by private boat owners. These slips are fully utilized during the summer peak season, winter usage is substantially lower (Reilly, 2010).

3.8.3 Demographics

With the exception of the city of Del Rio, the remaining portion of Val Verde County is sparsely populated, with an average density of 14.2 persons per square mile. In 2008, Val Verde County had a total estimated population of 47,677. The county's population has increased by 6.3 percent from its 2000 total of 44,856. Of the total population of the county in 2008, 48.4 percent were male, a proportion comparable to the United States population which was 49.3 percent male in that same year. The median age for the population of Val Verde County in 2008 was 33.7 years. In 2008, the county contained an estimated 14,275 households with an average size of 3.31 persons per household. Of the total 17,489 housing units present in the county in 2008, 14,275, or 81.6 percent, were occupied. (Census, 2008).

The City of Del Rio, located approximately ten miles from the project site, is the largest city in Val Verde County and also the county seat. By contrast with Val Verde County, the City of Del Rio is rather densely populated, with an average 2,193.5 persons per square mile. Population estimates for 2008 indicate a total of 38,014 residents; an increase of 12.2 percent from the city's population of 33,867 in 2000. In 2008, the community's population was 48.7 percent male, with

a median age of 34.9 years. The city supports a total of 11,397 households with an average size of 3.34 persons per household. In 2008, the city contained a total of 13,311 housing units of which 11,397, or 85.6 percent, were occupied (Census, 2008).

4.0 ENVIRONMENTAL CONSEQUENCES

The *Environmental Consequences* section provides an analytic evaluation of the potential effects or impacts of each of the alternatives on the resources described in the affected environment section. It is organized by impact topic for analysis. These topics focus on the presentation of environmental consequences and allow a standardized comparison between alternatives. The objective analysis and disclosure of potential environmental impacts of the proposed action and alternatives facilitates informed decision-making.

4.1 METHODOLOGY

NEPA requires consideration of context, intensity, and duration of impacts, direct or indirect impacts, cumulative impacts, and measures to mitigate for impacts. NPS policy also requires that "impairment" of resources be evaluated in all environmental documents.

Overall, the NPS based the following impact analyses and conclusions on the review of existing literature and Amistad National Recreation Area studies, information provided by experts within the NPS and other agencies, professional judgments and park staff insights, and public input.

4.1.1 General Impact Definitions

Potential impacts are described in terms of type (beneficial or adverse), context, duration, intensity, and impairment. The following general definitions were used to evaluate the context, intensity, duration, and cumulative nature of impacts associated with project alternatives. Impairment is discussed below. The specific criteria used to rate the intensity and duration of potential impacts for each resource topic are presented within each resource area impact analysis in this chapter.

Context of Impact
Context is the setting within which an impact is analyzed, such as local, park-wide, or regional. CEQ requires that impact analyses include discussions of context. Localized impacts are those that affect the resource area only on the project site or its immediate surroundings, and would not extend park-wide or into the region.

Intensity of Impact
Impact intensity is the degree to which a resource would be beneficially or adversely affected by an action. Impact intensities are quantified as negligible, minor, moderate, or major. Resource-specific criteria used to rate the intensity of project impacts are presented within each resource area impact analysis.

Duration of Impact
For purposes of analysis, impact duration is measured as short-term or long-term. Because duration of impact (short or long term) will also vary by impact topic, a description of duration should be provided separately for each impact topic. Depending on the resource, impacts may last as long as construction takes place, or a single year or growing season, or longer.

Direct verses Indirect Impacts

Direct effects are impacts caused by the alternative(s) at the same time and in the same location as the action. Indirect effects are impacts caused by the alternative(s) that occur later in time or farther in distance than the action, but still reasonably foreseeable. An indirect impact could occur because of a change to another resource or impact topic.

4.1.2 Cumulative Effects

CEQ regulations (40 CFR 1508.7) require the assessment of cumulative impacts in the decision-making process for Federal projects. A cumulative impact is an impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (Federal or non-Federal), organization, or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

Cumulative impacts are considered for all alternatives and are presented at the end of each impact topic discussion analysis. To determine potential cumulative impacts, projects in the vicinity of the proposed project site were identified. Potential projects identified as cumulative actions included any planning or development activity that was currently being implemented or that would be implemented in the reasonably foreseeable future.

These cumulative actions are evaluated in the cumulative impact analysis in conjunction with the impacts of each alternative to determine if they would have any additive effects on natural resources, cultural resources, or visitor use. Because some of these cumulative actions are in the early planning stages, the evaluation of cumulative effects was based on a general description of the project. Known past, current, and reasonably foreseeable future projects and actions in the vicinity of the project area are described below.

Past and Present Projects and Actions

- Existing facilities – Diablo East is currently one of the most popular visitor locations in the park, and contains several existing developments including roads, parking areas, boat ramps, fish tube, government boat slips, public marina, comfort stations, nature trail, and a ranger station.
- Fishing tournaments – Some of the finest recreational black bass fishing in the southwestern United States occurs on Lake Amistad. Amistad issues Special Use Permits for a number of organized fishing tournaments throughout the year, most of which focus on bass fishing. The tournaments vary from small, local clubs to large national and international competitions.
- Houseboats tie up to a marina-provided houseboat dock adjacent to the NPS-provided public boat dock at the main boat ramp to load and off-load directly from vehicles. This causes congestion at the ramp for park visitors.
- Bank fishermen fish off the point at the end of the nature trail.
- School groups use the nature trail for ranger led tours.
- Houseboat tours – The marina concession allowed use of its houseboats for NPS led environmental education for kids.
- Education programs and other events are hosted periodically in the Diablo East parking lot.

Future Projects and Actions

- Joint operations facility - NPS is proposing to construct a facility at Diablo East to act as a hub for combined law enforcement and border security operations, park headquarters, maintenance, and visitor contact component.
- New trail – After construction of the joint operations facility, the park may construct a new handicap accessible nature trail from the new visitor contact facility to Amistad Reservoir, following the shoreline onto part of the western peninsula for 2.7 miles.
- Road improvement – Widening of East Diablo Road or construction of additional lanes may be needed in the future to accommodate increased traffic to the joint operations facility from the intersection with US Highway 90. The park also may make minor improvements to the existing gravel Viewpoint Road to the reservoir that begins on East Diablo Road at the intersection with the proposed new access road to the joint operations facility.

4.1.3 Impairment of Park Resources

In addition to determining the environmental consequences of the Proposed Action and the No Action alternative, the *NPS Management Policies 2006* and DO-12 require analysis of potential effects to determine if actions would impair a park's resources.

The fundamental purpose of the National Park System, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. National Park Service managers must always seek ways to avoid or minimize to the greatest degree practicable adverse impacts on park and monument resources and values. However, the laws do give NPS management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values. Although Congress has given NPS management discretion to allow certain impacts within parks, that discretion is limited by statutory requirement that the NPS must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise.

The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including opportunities that otherwise would be present for the enjoyment of those resources or values. An impact to any park resource or value may constitute impairment. However, an impact would more likely constitute impairment to the extent it affects a resource or value whose conservation is:

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- Identified as a goal in the park's Master Plan or General Management Plan or other relevant NPS planning documents.

Impairment may result from NPS activities in managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park. In this section, a

determination on impairment is made in the conclusion statement of each resource area for each alternative. The NPS does not analyze the potential for impairment of recreational values/visitor experience (unless impacts are resource based), socioeconomic values, or park operations.

4.1.4 Unacceptable Impacts

The impact threshold at which impairment occurs is not always readily apparent. Therefore, the Service will apply a standard that offers greater assurance that impairment will not occur. The Service will do this by avoiding impacts that it determines to be unacceptable. These are impacts that fall short of impairment, but are still not acceptable within a particular park's environment. Park managers must not allow uses that would cause unacceptable impacts; they must evaluate existing or proposed uses and determine whether the associated impacts on park resources and values are acceptable.

Virtually every form of human activity that takes place within a park has some degree of effect on park resources or values, but that does not mean the impact is unacceptable or that a particular use must be disallowed. To determine if unacceptable impacts could occur to the resources and values of the parks, the impacts of proposed actions in this environmental assessment were evaluated based on monitoring information, published research, and professional expertise, and compared to the guidance on unacceptable impacts provided in *Management Policies* 1.4.7.1 that defines unacceptable impacts as impacts that, individually or cumulatively, would:

- Be inconsistent with a park's purposes or values, or
- Impede the attainment of a park's desired future conditions for natural and cultural resources as identified through the park's planning process, or
- Create an unsafe or unhealthful environment for visitors or employees, or
- Diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values, or
- Unreasonably interfere with:
    - Park programs or activities, or
    - An appropriate use, or
    - The atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park.
    - NPS concessioner or contractor operations or services.

A determination on unacceptable impacts is made in the conclusion statement of each impact topic for each alternative in the environmental consequences discussion.

4.2 WATER RESOURCES

Methodology

Impact analyses on water resources were based on previous studies or projects conducted within the same area, the hydrodynamic modeling conducted for this project, and assessment of potential changes in surface water and hydrology.

The thresholds of change for the intensity of an impact on water resources are defined as follows:

Negligible: Neither water quality nor hydrology would be affected, or changes would be non-detectable or, if detected, would have effects that would be considered slight. Chemical or physical changes to water quality would not be detectable, would be well below water quality standards or criteria, and would be within desired water quality conditions.

Minor: Changes in water quality or hydrology would be measurable, although the changes would be small. No mitigation measure associated with water quality or hydrology would be necessary. Chemical or physical changes to water quality would be detectable, but would be well below water quality standards or criteria and within desired water quality conditions.

Moderate: Changes in water quality would be measurable and readily apparent. Mitigation measures associated with water quality or hydrology would be necessary and the measures would likely succeed. Chemical or physical changes to water quality would be detectable, but would be at or below water quality standards or criteria.

Major: Changes in water quality or hydrology would be readily measurable and would have substantial consequences. Mitigation measures would be necessary and their success would not be guaranteed. Chemical or physical changes to water quality would be detectable and would be frequently altered from desired water quality conditions. Chemical, physical, or biological water quality standards or criteria would be locally exceeded on a short-term and temporary basis.

The thresholds of change for the duration of an impact on water resources are defined as follows:

Short-term: Short-term impacts would be resolved within one to three years.
Long-term: Long-term impacts would continue beyond three years.

4.2.1 Impacts of Alternative A (No Action)

Impacts Analysis

Under Alternative A, a breakwater system in Diablo East Harbor would not be constructed. This would represent no change in current conditions, and no additional impacts to water resources beyond background conditions would occur. North facing facilities in the harbor would remain exposed to wind and waves during storms. Damaging winds and waves would continue to cause damage to boats and harbor facilities, which could potentially cause some damaged structures to splinter off into the reservoir waters, releasing chemicals, oils and fuel, or causing turbidity. This is anticipated to be a negligible to minor adverse impact on water resources.

Cumulative Effects

The construction of Amistad Dam and the subsequent creation of Amistad Reservoir profoundly altered the riparian areas of the Devils River, Pecos River, and the Rio Grande (NPS, 2006a). For miles along the Devils River and the Rio Grande, riparian areas were permanently inundated. Riparian areas along the upper stretches of these streams and along the Pecos River are subject to periodic inundation. While past actions on these waterbodies have resulted in major impacts to water resources in the region, this alternative would contribute no new cumulative impacts.

Conclusion

Alternative A would result in negligible to minor direct and indirect impacts on Amistad water resources. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to water resources.

4.2.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis

Under Alternative B, two overlapping standard rock jetties (fixed breakwaters) would be constructed, which would create an extension of the existing peninsulas on the east and west sides of the Diablo East Harbor mouth. The opening width for vessel traffic would be 120 feet at the lowest expected operational water depth. The opening would be facing toward the west and south to prevent waves from entering the harbor and the minimum non-wave overtopping crest elevation of the fixed breakwater would be 1,133 feet above msl. Rock for the breakwater in this alternative would be obtained from a local rock quarry.

Construction would be land-based using dump trucks. A truck route for hauling of rock would be established on the eastern peninsula. A two track road going out to the end of the western peninsula is fairly well defined and would also be used as a truck route. General construction impacts associated with the construction of the proposed breakwater system could affect water resources as a result of sedimentation and contamination from construction activities entering the reservoir waters.

Sedimentation is a leading cause of water impairment in the U.S., and it can cause disturbances in aquatic ecosystems such as the degradation of fish spawning grounds, the potential reduction of recreational activities, increased cost of domestic water purification and decreased life span of dams. The National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act prohibits the discharge of any pollutant, including sediments, to waters of the United States. The development phase of the project would require coverage under USEPA's Region 6 NPDES Construction Permit for stormwater discharge from construction activities. The TCEQ Water Program is responsible for administering the USEPA NPDES program in the state, referred to as the Texas Pollutant Discharge Elimination System (TPDES). Components of the TPDES construction activities permit are posting and submitting a Construction Site Notice and development and adherence to a Stormwater Pollution Prevention Plan.

Because the Amistad Reservoir is a navigable U.S. waterway (as defined by the U.S. Army Corps of Engineers (USACE)), both a state water quality permit and federal USACE permits would be required for the breakwater construction activities. A federal Section 404 of the CWA permit would be required from the USACE for the discharge of dredged or fill material into waters of the U.S. Additionally, a Section 10 of the Rivers and Harbors Act permit would also be required from the USACE. When a 404 is required from the Corps, a Section 401 Water

Quality Certification must first be obtained from TCEQ. A 401 certification affirms that the discharge would not violate Texas' water quality standards. The Texas' 401 certification process for this proposal would likely involve a Tier II 401 Certification Questionnaire and an Alternative Analysis Checklist. In addition to state and federal requirements, the construction of a breakwater system in Amistad Reservoir would require the concurrence of the IBWC.

In order to protect the water quality of the Amistad Reservoir during construction activities taking place in or adjacent to the reservoir, any and all Best Management Practices (BMPs) required by the appropriate authority would be implemented and maintained. These BMPs could include such measures as the installation of double-walled silt curtain in the reservoir surrounding construction activities, the installation of silt fencing and other erosion and sediment control measures when working on the adjacent land, and additional structural practices and stormwater management controls as necessary. Vigorous use of appropriate BMPs would minimize erosion at the construction sites and sediment runoff to Amistad surface waters in the vicinity of the proposed construction areas.

As a result of the installation of a breakwater system, changes in the circulation patterns within the Diablo East Harbor are anticipated to occur. Changes in circulation patterns may have adverse effects on water quality in the harbor due to a potential decrease in water column mixing and a reduced exchange of water between the harbor and main body of the reservoir (Anchor QEA, 2010). A three-dimensional hydrodynamic model and a conservative tracer model were used to study each of the project alternatives to realistically simulate circulation in the harbor and reservoir. The model used for this study is the Environmental Fluid Dynamics Code (EFDC). EFDC is a well-tested, three-dimensional model that is approved and supported by the USEPA.

The impacts of each alternative breakwater system (Alternatives B-D) on the hydrodynamics of the Diablo East Harbor were qualitatively assessed relative to one another and relative to the baseline (No Action) conditions. A sensitivity analysis was also performed to increase confidence in the results of the modeling. The modeling results indicated that the current velocities would decrease near the gap between the fixed breakwaters if Alternative B was installed when compared to present conditions. As a result of the decrease in current velocities, a decrease in exchange of water between the harbor and the rest of the reservoir would take place. The decrease in the exchange of water under this alternative was conservatively estimated to be up to 65% to 75% (Anchor QEA, 2010).

Conservative tracer simulations were conducted for each alternative and for each wind condition in order to determine how a medium released in the harbor would be dispersed through the harbor over time. When compared to the present conditions, under Alternative B there would be an increase in time until a substance released into the harbor would reach normalized concentrations (Anchor QEA, 2010). This indicates that water dispersion and circulation within the harbor would decrease under Alternative B, when compared to existing conditions. If water circulation were to decrease, there would be an increased risk that potential contaminants in the harbor (including nutrients, heavy metals, and petroleum) could concentrate. As a result, dissolved oxygen concentrations in the water could decrease. If nutrient concentrations increased and dissolved oxygen levels decreased within the harbor under the lower

flow/circulation conditions of Alternative B, the possibility of algal blooms occurring in the harbor would increase.

Additionally, because the opening width for boats in the breakwater system is relatively small under this alternative, boats would have to spend more time idling before exiting and after reentering the harbor waters. Increased idling time would generate increased petroleum emissions in the harbor which would further exacerbate water quality concerns. That said, water quality is not anticipated to degrade to the point where any impacts are perceivable by park visitors (either visually or by smell).

Cumulative Effects

Any construction activities that may take place near the reservoir waters, such as the potential new trail and road improvements projects discussed under Section 4.1.2, could cause some sedimentation into the waters during the period of construction. New trails and roads could serve as areas of accelerated erosion once construction is complete. The infiltration capacity of road and trail surfaces is low, and little precipitation is required to generate runoff, which is then often channeled down the surface of the road or trail directly into surface waterbodies. However, because the relative holding and attenuation capacity of the Amistad Reservoir is so large and the areas of potential construction are small, any sedimentation and runoff impacts on water resources from the proposed construction activities would be minor.

The past and present increase of agricultural and urban land uses in the Rio Grande watershed have affected the water quality of Lake Amistad and its tributaries through increased erosion and sedimentation in the lake. Waste products resulting from increased industrialization in Mexico also may contribute to increased pollutant concentrations in the lake (NPS, 2006a). Cumulative, long-term moderate adverse impacts on water quality have resulted from past, present, and future actions in Lake Amistad and in the Rio Grande and its tributaries. Alternative B would contribute negligible to minor, adverse cumulative impacts on water resources. In combination, these actions would result in moderate, adverse cumulative impacts on water resources. These impacts would be lessened, however, as a result of employing appropriate mitigation measures to minimize the potential impacts to water quality from implementation of this alternative. Specific mitigation measures would be selected based upon findings in the Engineering Assessment for the alternative. If, however, dissolved oxygen levels were anticipated to decrease due to implementation of this alternative, mitigation measures would be employed that would increase water exchange between the harbor and the reservoir. Possible mitigation measures would include designing the fixed breakwater with openings to allow for the flow of water through it at varying depths. Additionally, large volume aerators could be used to mechanically oxygenate the water inside the harbor. Following implementation of the appropriate mitigation measures, cumulative impacts to water resources from this alternative would be minimal.

Conclusion

The direct impacts to water resources from implementation of Alternative B are anticipated to be adverse and minor in both the short- and long-term. However, the indirect impacts to water quality in the Diablo East Harbor as a result of decreased water circulation and water exchange under Alterative B would be adverse and moderate in the long-term. These impacts are anticipated to be lessened as a result of selection and employment of appropriate mitigation

measures. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to water resources. Therefore, implementation of this alternative would not cause an unacceptable impact to water resources.

4.2.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis

Under Alternative C, a floating breakwater would be installed inside the harbor and would provide land access from the central peninsula to a "Y" shaped floating breakwater dock system. The floating breakwater/dock system would be held in place with concrete, rock, or driven plate anchors. The floating docks would be made of concrete to provide the weight and strength necessary to attenuate waves. The anchor system would allow self adjustment with the lake level without the need for mechanical systems. The floating platforms would be six feet tall with sufficient density to have a 2-foot freeboard and 4-foot draft to adequately break down incoming waves up to four feet in height. The floating platforms would be twelve feet wide.

A very long and straight rolling fixed and floating walkway would connect the floating docks to the central peninsula at Diablo East, which would be needed to account for the very large fluctuations in lake level. The floating breakwater docks should be made out of precast reinforced concrete. A significant amount of weight, size, and strength is needed to dampen the most significant waves and be strong and flexible enough to be long lasting. The floating breakwater would be anchored using chain and a combination of steel plate and concrete anchors. This would allow for natural adjustment of the breakwater dock with fluctuating lake levels without use of winches and other mechanical devices that require maintenance.

The same permits and appropriate BMPs, as discussed for the construction of Alternative B under Section 4.2.2, would be applicable for the construction of Alternative C. However, due to the design and project materials proposed for this alternative, the risks of sedimentation would be slightly lower when compared to Alternative B.

Results of the EFDC modeling for Alternative C indicates that the current velocities for this floating breakwater system would be similar to the present condition velocities, with the proposed breakwater slightly affecting the counter-clockwise gyre predicted for the present conditions (Anchor QEA, 2010). As a result, no measurable decrease in the exchange of water between the harbor and main reservoir is anticipated to take place if this alternative were implemented (Anchor QEA, 2010).

When tracer simulations of the installed Alternative C breakwater system were conducted in the harbor and compared to the present conditions, a distribution similar to the present condition was found (Anchor QEA, 2010). This indicates that water dispersion and circulation within the harbor would not substantially change under Alternative C, when compared to existing conditions. Although the simulations show a negligible negative change in the Diablo East

Harbor's circulation pattern, it should also be noted that the simulation models are conservative. In particular, the simulations treat the floating breakwater as if it went from the reservoir's surface to the bottom, which it would not. As such, flow patterns beneath the surface would be even less encumbered than the simulation results suggest (Anchor QEA, 2010). As a result, water quality is not anticipated to be measurably impacted by implementation of this alternative.

Cumulative Effects

Any construction activities that may take place near the reservoir waters, such as the potential new trail and road improvements projects discussed under Section 4.1.2, could cause some sedimentation into the waters during the period of construction. New trails and roads could serve as areas of accelerated erosion once construction is complete. The infiltration capacity of road and trail surfaces is low, and little precipitation is required to generate runoff, which is then often channeled down the surface of the road or trail directly into surface waterbodies. However, because the relative holding and attenuation capacity of the Amistad Reservoir is so large and the areas of potential construction are small, any sedimentation and runoff impacts on water resources from the proposed construction activities would be minor.

The past and present increase of agricultural and urban land uses in the Rio Grande watershed have affected the water quality of Lake Amistad and its tributaries through increased erosion and sedimentation in the lake. Waste products resulting from increased industrialization in Mexico also may contribute to increased pollutant concentrations in the lake (NPS, 2006a). Cumulative, long-term moderate adverse impacts on water quality have resulted from past, present, and future actions in Lake Amistad and in the Rio Grande and its tributaries. Alternative C would contribute negligible adverse cumulative impacts on water resources. In combination, these actions would result in moderate, adverse cumulative impacts on water resources.

Conclusion

The direct and indirect impacts to water resources in the Diablo East Harbor from implementation of Alternative C are anticipated to be adverse and negligible to minor in both the short- and long-term. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to water resources. Implementation of this alternative would not cause an unacceptable impact to water resources.

4.2.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis

Under Alternative D, a combination of fixed and floating breakwaters would be constructed. The fixed breakwater would be placed on top of the existing east and west peninsulas at the mouth of the harbor with an opening of 400 feet. A concrete floating breakwater dock would be anchored approximately 120 feet inside the harbor entrance formed by the new fixed breakwaters. The floating dock breakwater would be positioned to block any waves missed by the rubble mound jetties.

The opening between the fixed breakwaters would be wider, estimated 400 feet at the average lake level. The rubble mound three layer fixed breakwater would be the same as under Alternative B. The floating docks would be constructed as under Alternative C and positioned to block any waves attempting to refract and directly push through the opening into the harbor. There would be no mechanical devices (winches or machinery) required; the system would rise up and down with the lake water level.

The same permits and appropriate BMPs, as discussed for the construction of Alternative B under Section 4.2.2, would be applicable for the construction of Alternative D. The risks of sedimentation associated with construction of this alternative would be comparable to those under Alternative B.

Results of the EFDC modeling for Alternative D indicate that the current velocities for this combined breakwater system would tend to slow down slightly when entering the breakwater opening, but not as much as compared to Alternative B (Anchor QEA, 2010). Specifically, a decrease in exchange of water by up to 50% between the harbor and the rest of the reservoir would take place under this alternative relative to present conditions (Anchor QEA, 2010).

Tracer simulations conducted for Alternative D indicate that under this alternative there would be an increase in time until a substance released into the harbor would reach normalized concentrations, but the time would not be as long as under Alternative B (Anchor QEA, 2010). As a result, water dispersion and circulation within the harbor would decrease under Alternative D, when compared to existing conditions. If water circulation were to decrease, there would be an increased risk that potential contaminants in the harbor could concentrate and that dissolved oxygen concentrations in the water could decrease. If nutrient concentrations increased and dissolved oxygen levels decreased within the harbor under the lower flow/circulation conditions of Alternative D, the possibility of algal blooms occurring in the harbor would increase. These risks are not as high under this alternative as they are under Alternative B, but they nonetheless exist. Although the tracer simulations show a negative change in the Diablo East Harbor's circulation pattern under this alternative, it should be kept in mind that the simulations are very conservative. In particular, the simulations treat this proposed breakwater system as if it went from the reservoir's surface to the bottom, which it would not. As such, flow patterns beneath the surface would be less encumbered than the simulation results suggest. Additionally, if this alternative were selected, appropriate mitigation measures would also be selected which would minimize the potential impacts to water quality. Specific mitigation measures would be selected based upon findings in the Engineering Assessment for the alternative.

Cumulative Effects

Any construction activities that may take place near the reservoir waters, such as the potential new trail and road improvements projects discussed under Section 4.1.2, could cause some sedimentation into the waters during the period of construction. New trails and roads could serve as areas of accelerated erosion once construction is complete. The infiltration capacity of road and trail surfaces is low, and little precipitation is required to generate runoff, which is then often channeled down the surface of the road or trail directly into surface waterbodies. However, because the relative holding and attenuation capacity of the Amistad Reservoir is so large and the

areas of potential construction are small, any sedimentation and runoff impacts on water resources from the proposed construction activities would be minor.

The past and present increase of agricultural and urban land uses in the Rio Grande watershed have affected the water quality of Lake Amistad and its tributaries through increased erosion and sedimentation in the lake. Waste products resulting from increased industrialization in Mexico also may contribute to increased pollutant concentrations in the lake (NPS, 2006a). Cumulative, long-term moderate adverse impacts on water quality have resulted from past, present, and future actions in Lake Amistad and in the Rio Grande and its tributaries. Alternative D would contribute negligible to minor adverse cumulative impacts on water resources. In combination, these actions would result in moderate, adverse cumulative impacts on water resources.

Conclusion

The direct impacts to water resources from implementation of Alternative D are anticipated to be adverse and minor in both the short- and long-term. The indirect impacts to water quality in the Diablo East Harbor as a result of decreased water circulation and water exchange under Alterative D would be adverse and minor to moderate in the long-term. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to water resources. Therefore, implementation of this alternative would not cause an unacceptable impact to water resources.

4.3 GEOLOGY AND SOILS

Methodology

Available information on soils and geology was compiled from recent assessments of the area by NPS staff, previous studies or projects conducted within the same area, and soil survey maps for Diablo East Harbor. Potential impacts from the alternatives were based on professional judgment and experience with similar actions.

The thresholds of change for the intensity of an impact on geology and soils are defined as follows:

Negligible: The effects on soils and geology would be below or at a very low level of detection. Any effects on productivity or erosion potential would be slight. Any changes or effects to cave and karst features are not visually detectable.

Minor: An action's effects on soils and geology would be detectable. The effects would change a soil's profile in a relatively small area, but would not appreciably increase the potential for erosion of additional soil. If mitigation were needed to offset adverse effects, it would be relatively simple to implement and would likely be successful. Any changes or effects to cave and karst features are visible under close examination, but they can be reversed or repaired.

Moderate: An action would result in a change in quantity or alteration of the topsoil and geology, overall biological productivity, or the potential for erosion to remove small quantities of soil. Changes to localized ecological processes would be limited. Mitigation measures would probably be necessary to offset adverse effects and would likely be successful. Any changes or effects to cave and karst features are plainly visible, but they can be reversed or repaired.

Major: An action would result in a change in the potential for erosion to remove large quantities of soil or in alterations to topsoil and geology and overall biological productivity in a relatively large area. Key ecological processes would be altered, and landscape-level changes would be expected. Mitigation measures to offset adverse effects would be necessary, extensive, and their success could not be guaranteed. Any changes or effects to cave and karst features are plainly visible, but are irreparable and irreversible.

The thresholds of change for the duration of an impact on geology and soils are defined as follows:

Short-term: Following implementation activities, recovery would take less than three years.
Long-term: Following implementation activities, recovery would take more than three years.

4.3.1 Impacts of Alternative A (No Action)

Impacts Analysis
No disturbance to geology and soils would occur because there would be no construction of a new breakwater. The Alternative A would have no effect on geology and soils.

Cumulative Effects
Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, fish tube, government boat slips, public marina, comfort stations, nature trail, and a ranger station, have resulted in impacts to geology and soils. Past impacts include soil compaction and erosion, and covering of soils and geological features with impervious surfaces. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in disturbance and loss of soil resources in the local area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on geology and soils. Alternative A would not contribute any cumulative impacts on geology and soils. In combination, these actions would result in moderate, adverse cumulative impacts on geology and soils.

Conclusion
Alternative A would have no impacts on geology and soils. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to geology and soils.

4.3.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis

Construction of a fixed breakwater would entail the driving of heavy equipment and trucks hauling rock along routes on the peninsulas east and west of the mouth of the harbor. A two-track road currently exists on the western peninsula, but a road and turn-around spots would need to be established on both peninsulas.

Soils on the western peninsula are already disturbed along the two-track road, thus any new disturbance from construction would be minimal. Although soils are thin on the peninsulas, any new areas that would be repeatedly compacted by heavy vehicles during construction would have adverse impacts on soils. If any natural soil horizons exist, they would likely be lost. Construction activities would compact and destroy the structure and function of the organic soil horizon and mineral soils. Exposed soils during construction would be subject to erosion until stabilized or revegetated. Possible soil erosion into the lake would be greatly reduced or eliminated by implementing BMP's as described in section *2.7 Mitigation Measures*. There would be approximately 5.8 acres of undisturbed and previously disturbed soils that would be impacted under this alternative.

Karst features exist on the western peninsula. Ladder Cave contains a large cavern room directly below the surface that can be accessed by all three of the surface openings located where the western peninsula access road would be located. It would be unwise to drive a large 20 cubic yard dump truck carrying rock between the openings since the roof of the cave would most likely collapse under the weight. Thus, where the existing road crosses over Ladder Cave, based on engineering assessments, either a temporary bridge would be installed so as not to put direct pressure on the surface to avoid collapse, or the road may be re-routed to the west by removing a limestone outcrop. With the use of a temporary bridge, there would be negligible adverse impacts on geology and soils. If the option to remove the limestone outcrop so that the road can be realigned is chosen, then there would be moderate adverse impacts.

Cumulative Effects

Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, fish tube, government boat slips, public marina, comfort stations, nature trail, and a ranger station, have resulted in impacts to geology and soils. Past impacts include soil compaction and erosion, and covering of soils and geological features with impervious surfaces. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in disturbance and loss of soil resources in the local area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on geology and soils. Alternative B would contribute minor to moderate, adverse cumulative impacts on geology and soils. In combination, these actions would result in moderate, adverse cumulative impacts on geology and soils.

Conclusion
Alternative B would have short-term, minor, localized, adverse impacts on geology and soils from compaction and erosion of soils during construction activities and from the possible use of a temporary bridge to span Ladder Cave. If a limestone outcropping is removed to reroute the road on the western peninsula, impacts on geology and soils would be long-term, moderate, localized and adverse. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to geology and soils.

4.3.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis
Construction of a floating breakwater would entail the driving of heavy equipment and trucks hauling materials on the central peninsula at Diablo East. Although a nature trail currently exists on the central peninsula along which soils have been disturbed, areas of undisturbed soils would be impacted as well by construction equipment. Additionally, the nature trail would need to be rebuilt after construction is completed.

Impacts on soils would be similar to those described under Alternative B. There would be approximately 0.8 acres of undisturbed and already disturbed soils that would be impacted under this alternative. Karst features, such as cave entrance sinkholes, have been found on the central peninsula, but appear minor in nature, and it is not expected that these karst features would be impacted.

Cumulative Effects
Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, fish tube, government boat slips, public marina, comfort stations, nature trail, and a ranger station, have resulted in impacts to geology and soils. Past impacts include soil compaction and erosion, and covering of soils and geological features with impervious surfaces. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in disturbance and loss of soil resources in the local area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on geology and soils. Alternative C would contribute negligible, adverse cumulative impacts on geology and soils. In combination, these actions would result in moderate, adverse cumulative impacts on geology and soils.

Conclusion
Alternative C would have short-term, minor, localized, adverse impacts on geology and soils from compaction and erosion of soils during construction activities. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park;

2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to geology and soils.

4.3.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis
Construction of a fixed and floating breakwater combination would have similar impacts to soils and geology as described for Alternative B. There would be additional truckloads bringing materials for the floating breakwater, in addition to the fixed breakwater, under this alternative. However, this would not appreciably change the level of impacts on geology and soils.

Cumulative Effects
Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, fish tube, government boat slips, public marina, comfort stations, nature trail, and a ranger station, have resulted in impacts to geology and soils. Past impacts include soil compaction and erosion, and covering of soils and geological features with impervious surfaces. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in disturbance and loss of soil resources in the local area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on geology and soils. Alternative D would contribute minor to moderate, adverse cumulative impacts on geology and soils. In combination, these actions would result in moderate, adverse cumulative impacts on geology and soils.

Conclusion
Alternative D would have short-term, minor, localized, adverse impacts on geology and soils from compaction and erosion of soils during construction activities and from the possible use of a temporary bridge to span Ladder Cave. If a limestone outcropping is removed to reroute the road on the western peninsula, impacts on geology and soils would be long-term, moderate, localized and adverse. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to geology and soils.

4.4 ARCHEOLOGY

Methodology

Impact analyses on archeology were based on recent assessments of the site by park staff, previous studies or projects conducted within the same area, and a Cultural Assessment report of the area.

The thresholds of change for the intensity of an impact on archeology are defined as follows:

Negligible: The impact on archeological sites or individual resources is at the lowest levels of detection, barely perceptible and not measurable.

Minor: The impact is measurable or perceptible, but it is slight and localized within a relatively small area of a site or group of sites. The impact would not have a permanent effect on the integrity of any archeological site.

Moderate: The impact is measurable and perceptible. The impact changes one or more character defining feature(s) of an archeological resource, but does not diminish the integrity of the resource.

Major: The impact on archeological sites is substantial, noticeable, and permanent. The impact is severe or of exceptional benefit. The impact changes one or more character defining feature(s) of a resource, diminishing the integrity of the resource.

The thresholds of change for the duration of an impact on archeology are defined as follows:

Short-term: Following implementation activities, recovery would take less than three years.
Long-term: Following implementation activities, recovery would take more than three years.

4.4.1 Impacts of Alternative A (No Action)

Impacts Analysis
No disturbance to archeological resources would occur because there would be no breakwater construction activities. The Alternative A would have no effect on archeology.

Cumulative Effects
Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station, may have resulted in disturbance, loss or other adverse impacts on archeological resources. Existing impacts are firmly established from decades of blading of the gravel road surfaces, bringing in fill, soil compaction from vehicle traffic, erosion, camping and probably surface collecting. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, may uncover archeological resources in the local area; however, mitigation measures would ensure that adverse effects are minimized.

Cumulatively, these past, present and future actions would have minor, adverse impacts on archeology. Alternative A would not contribute any cumulative impacts on archeology. In combination, these actions would result in minor, adverse cumulative impacts on archeology.

Conclusion
Alternative A would have no impacts on archeology. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to

the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to archeology.

4.4.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis

There is potential for impacts to archeological resources under Alternative B to occur as a result of the use of roads on the eastern and western peninsulas for construction of the fixed breakwater at the mouth of the harbor. It is recommended that known archeological sites be avoided, particularly the Viewpoint complex of sites on the eastern peninsula. Any construction activities that break the ground surface would require archeological monitoring. If previously undiscovered archeological resources are discovered during construction, all work in the immediate vicinity of the discovery would be halted until the resources can be identified, documented, and an appropriate mitigation strategy developed, if necessary, in consultation with the Texas State Historic Preservation Office (SHPO). If human remains, funerary objects, sacred objects, or objects of cultural patrimony are discovered during construction, provisions outlined in the Native American Graves Protection and Repatriation Act (25 USC 3001) of 1990 would be followed.

To get to the proposed eastern peninsula construction road, construction traffic would drive around and through archeological sites on the pre-existing park road. The creation of the proposed construction road has the potential to exacerbate existing impacts to archeological sites on the eastern peninsula. There are few ways to redirect vehicle traffic that would not simply increase the overall cumulative impacts to these sites. Therefore, it is recommended that the existing road system through the site continue to be used for the proposed construction roads, with the following mitigations to minimize impacts:

1) A layer of fill would be brought in to cover and protect the exposed portion of the sites.

2) Equipment operators would receive a briefing by park resource management personnel that there are sensitive archeological sites immediately adjacent to the established roadsides within the APE, that they are not to leave the established roads in these areas (anywhere within the Viewpoint loop), and that the most sensitive areas would be barricaded along the roadside.

3) The roadsides adjacent to the most sensitive areas would be barricaded (for example with cones or caution tape) to help equipment operators remember to avoid these areas

4) Park resource personnel would monitor construction activities to ensure compliance.

One site on the eastern peninsula is situated on a steep slope and thus subject to erosion. The most significant past human impact is an old nature trail (probably not used for the past two decades) that passes through the site. Present human impacts to the site are minor, mostly from bank fishermen traversing the site while walking out to the peninsula via numerous deer trails. Given the high levels of past and present modern activity in this area, it must be assumed that the site has been heavily collected by visitors. Because of the many diagnostic artifacts, excellent

probability of intact features, and research potential, the site is recommended eligible for listing in the National Register of Historic Places (NRHP). Construction of the road along the light scatter at the site perimeter would not cause disruption to the portions of the site with significant informational value. However, as the topography constricts at one edge of the site, the road must come close to midden deposits, which are within the 30-foot roadside buffer APE. Since fill would have to be brought in to this location anyway to ease the proposed road over some exposed limestone ledges, it is recommended that potential damage to the site be mitigated to minimize impacts in the same way as discussed above.

A shallow midden on the upper terrace of the Devils River is presently submerged beneath approximately 100 feet of water at the mouth of the merged drainages that make up what is now Diablo East Harbor. It is possible that the footing of the breakwater may cover this site. The one anticipated potential impact to the site from this project is the possibility of it becoming covered with rock fill associated with the construction of a fixed breakwater and would be sealed in a stable condition. No mitigation is recommended.

The route for the proposed construction road on the western peninsula, a pre-existing ranch road, passes through the middle of an archeological site consisting of two burned rock middens. It grazes the edge of one midden and then passes through the middle of the second midden. While the proposed construction road could conceivably follow the existing ranch road along the edge of the midden, to follow the existing road through the middle of the site would cause an unacceptable level of damage. It is recommended that the potential impacts to the site be mitigated to minimize impacts by diverting the proposed construction road to the west. The new path would take it around the site, keeping it outside the 30 foot APE buffer on the east side of the roadway. Should this mitigation not prove feasible, a second-choice alternative would be to use the mitigations discussed for the eastern peninsula (protective fill, operator briefings, barricades, and monitoring). This site could be considered potentially eligible for NRHP listing.

The proposed construction road would also have to follow the ridgeline occupied by another site. However, as the site is a light surface scatter lacking integrity and research potential, it is recommended ineligible for NRHP listing. No mitigations are suggested.

Cumulative Effects

Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station, may have resulted in disturbance, loss or other adverse impacts on archeological resources. Existing impacts are firmly established from decades of blading of the gravel road surfaces, bringing in fill, soil compaction from vehicle traffic, erosion, camping and probably surface collecting. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, may uncover archeological resources in the local area; however, mitigation measures would ensure that adverse effects are minimized.

Cumulatively, these past, present and future actions would have minor, adverse impacts on archeology. Alternative B would contribute minor cumulative impacts on archeology. In combination, these actions would result in minor, adverse cumulative impacts on archeology.

Conclusion
Alternative B would have minor long-term, local adverse impacts on archeology from use of construction roads that pass adjacent to or within known archeological sites on the eastern and western peninsulas. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to archeology.

4.4.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis
No archeological sites are known to occur on the central peninsula, which would provide the access point for construction of the floating breakwater. Thus no impacts to archeological resources are expected under Alternative C. However, any construction activities that break the ground surface would require archeological monitoring. If previously undiscovered archeological resources are discovered during construction, all work in the immediate vicinity of the discovery would be halted until the resources can be identified, documented, and an appropriate mitigation strategy developed, if necessary, in consultation with the Texas SHPO. If human remains, funerary objects, sacred objects, or objects of cultural patrimony are discovered during construction, provisions outlined in the Native American Graves Protection and Repatriation Act (25 USC 3001) of 1990 would be followed.

Cumulative Effects
Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station, may have resulted in disturbance, loss or other adverse impacts on archeological resources. Existing impacts are firmly established from decades of blading of the gravel road surfaces, bringing in fill, soil compaction from vehicle traffic, camping and probably surface collecting. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, may uncover archeological resources in the local area; however, mitigation measures would ensure that adverse effects are minimized.

Cumulatively, these past, present and future actions would have minor, adverse impacts on archeology. Alternative C would not contribute any cumulative impacts on archeology. In combination, these actions would result in minor, adverse cumulative impacts on archeology.

Conclusion
Alternative C would have negligible, long-term local adverse impacts on archeology from possible exposure of unknown archeological sites on the center peninsula during construction of the breakwater. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's

GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to archeology.

4.4.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis
Impacts to archeological resources under Alternative D would be the same as those described for Alternative B.

Cumulative Effects
Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station, may have resulted in disturbance, loss or other adverse impacts on archeological resources. Existing impacts are firmly established from decades of blading of the gravel road surfaces, bringing in fill, soil compaction from vehicle traffic, camping and probably surface collecting. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, may uncover archeological resources in the local area; however, mitigation measures would ensure that adverse effects are minimized.

Cumulatively, these past, present and future actions would have minor, adverse impacts on archeology. Alternative D would contribute minor cumulative impacts on archeology. In combination, these actions would result in minor, adverse cumulative impacts on archeology.

Conclusion
Alternative D would have minor long-term, local adverse impacts on archeology from use of construction roads that pass adjacent to or within known archeological sites on the eastern and western peninsulas. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to archeology.

4.5 FISH AND AQUATIC HABITAT

Methodology

Available information on fish and aquatic habitat was compiled from literature, recent assessments of the area by NPS staff, and previous studies or projects conducted within the same area. Potential impacts from the alternatives were based on professional judgment, experience with similar actions, and results of the recent hydrodynamic modeling (Anchor QEA, 2010).

The thresholds of change for the intensity of an impact on fish are defined as follows:

Negligible: There would be no observable or barely perceptible impacts to native species, their habitats, or the natural processes sustaining them. Impacts would be well within natural fluctuations.

Minor: Impacts would be detectable and would not be expected to be outside the natural range of variability of native species' populations, their habitats, or the natural processes sustaining them. Sufficient habitat would remain functional to maintain viability of all species. Mitigation measures, if needed to offset adverse effects, would be simple and successful.

Moderate: Breeding fish of concern are present; fish are present during particularly vulnerable life stages such as immediately after hatching or during juvenile stages; mortality or interference with activities necessary for survival would be expected on an occasional basis, but would not be expected to threaten the continued existence of the species in the park unit. Impacts on native species, their habitats, or the natural processes sustaining them would be detectable and would be outside the natural range of variability. Sufficient habitat would remain functional to maintain variability of all native species. Mitigation measures, if needed to offset adverse effects, would be extensive and likely successful.

Major: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable and would be expected to be outside the natural range of variability. Key ecosystem processes might be disrupted. Loss of habitat might affect the viability of at least some native species. Extensive mitigation measures would be needed to offset any adverse effects and their success could not be guaranteed.

The thresholds of change for the duration of an impact on fish are defined as follows:

Short-term: Impacts that occur at the site of the proposed project area during and immediately after the construction/installation of the proposed breakwater system. For this project, short-term impacts are defined as those tied to the first two years following project implementation.

Long-term: Those impacts lasting more than two years, and are generally affiliated with the operational phase of the project.

4.5.1 Impacts of Alternative A (No Action)

Impacts Analysis

Under Alternative A, there would be no changes to fish or aquatic habitat resources from current conditions. Fish populations, circulation patterns within the harbor, and biological community dynamics of the aquatic vegetation and benthic macroinvertebrates would be maintained at status quo. Mortality of largemouth bass caught and weighed during fishing tournaments would continue at the current rates.

Dr. Gary Saul, Director of the Inland Fisheries Division for TPWD, notes that while water temperature plays a significant role in the survival of largemouth bass caught, weighed, and released during fishing tournaments, how the fish are handled between capture and weigh-in often plays a greater role (Saul, 2010). Toward that end, fishing equipment and boat

manufacturers, tournament organizers, and the fishermen themselves can play key roles in increasing bass survivability.

Dr. Saul points out that bass boat and fishing equipment makers and designers have been allies in seeking ways to prevent and reduce post-catch mortality. Fishing equipment manufacturers have made a number of design and product developments to reduce the stress on fish after being caught, from various hook designs (barbless, circle hooks, etc.) to commercial livewell additives to help calm fish and reduce their respiration rates. Boat manufacturers have contributed through the development of livewells that have better aeration and water exchange systems to help reduce oxygen and temperature stress on fish contained in the livewell. These designs are vastly improved over those from just a few years ago. As newer boats come into use, and older boats are removed from the fishing roles, there should be a corresponding improvement in the survival rate of tournament caught fish. This is expected to be a steady, but relatively slow process.

A number of measures that tournament organizers can take (and in some cases have already begun to implement) to reduce bass mortality include:

- Reduce the length of tournaments. Over a five-year period from 2004 through 2008, most tournaments on Amistad Reservoir averaged two days (67%) in length, followed by one-day tournaments (29%), and those three days or longer (4%) (NPS and TPWD, 2009). Obviously the more days a tournament lasts, the more fish may potentially be caught and therefore, become susceptible to post-catch mortality.
- Reduce daily bag limits. A reduction in the number of fish allowed to be weighed could reduce the number of fish subjected to long-term stressors while held in a boat's live-well. Data from tournaments in 2004 and 2005 indicate that none of the reporting tournaments had bag limits of less than five fish per person or team. Since 2006, the number of tournaments having daily bag limits of three fish or less has steadily increased, from 8 tournaments in 2006, to 20 in 2007, to 22 in 2008 (based on those tournaments that reported bag limit data)(NPS and TPWD, 2009). That data suggest that by 2008, tournaments with daily bag limits of three fish or fewer had grown to 30 percent of the bass tournaments reporting bag limit data. This growing trend toward fewer fish in the daily bag limit should continue to be encouraged.
- Reduce the number of fish brought to the official end-of-the-day weigh-in. This process, already in use at the Toyota Texas Bass Classic, stipulates that only one fish (typically the largest) be brought to the weigh-in at the end of the day, although all bass caught during the day are weighed at the boat. Such a process increases the cost of the tournament, as each boat must have a judge in attendance throughout the day to weigh each fish. The result, however, is that the vast majority of fish are caught, weighed, and released within minutes, rather than being hauled for hours in a livewell.
- Schedule tournaments during cooler months. According to tournament data collected at Amistad Reservoir from 2004 through 2008, the vast majority of tournaments (72 percent) are held between October and May, while 28 percent are held during the warmer months of June, July, August, and September (NPS and TPWD, 2009). Since the mortality of caught bass increases with water temperature, maximizing the number of tournaments held at times of the year when the water temperature is near or below 70^{o} F would significantly reduce the post-catch mortality of bass caught and released at the tournaments.

- Change the location of the weigh-in. Locating the tournament weigh-in to alternative marinas or boat ramps located outside the Diablo East Harbor may preclude water quality concerns in the harbor, particularly during warmer months, provided that the alternative location could accommodate the tournament weigh-in.

These five mitigation measures to reduce fish mortality during tournaments are being studied at this time, but NPS does not intend to implement these suggested changes until additional scientific data from further studies confirm that these actions would actually reduce fish mortality of the released tournament fish. NPS would then discuss the proposed changes with the tournament directors before implementing any of the changes.

Finally, anglers can contribute to bass survivability by:

- Familiarizing themselves with proper techniques for handling, unhooking, caring for and/or releasing fish.
- Maintaining livewells in proper working order and monitor fish:
    - Ensuring aerators are on and fully functioning.
    - Making sure water exchangers are operative or manually replace water regularly.
    - Using ice to reduce elevated water temperature in the livewell.
- Identifying and treating bass exhibiting the characteristics of depressurization illness (also known as barotrauma or catastrophic decompression syndrome). Siepker et al. (2007) note that bass caught from deep water may suffer from distended abdomens, overinflated air bladders, everted esophagus and stomachs, hemorrhaging and clotting, and gas bubble formation in the blood and tissue. Without treatment, such symptoms usually result in the death of the fish. Data collected during five tournaments held at Amistad Reservoir during 2009 indicated that between 25 percent and 46 percent of the fish caught exhibited signs of depressurization illness (Meyers, 2010). Of those that received proper treatment using a process called "fizzing" (the artificial deflation of the swim bladder with a hypodermic needle) survival rates increased, even in warm waters. The data showed survival rates ranging from 43 percent (at a water temperature of 83^{o} F) to 83 percent (water temperature 79 to 80^{o} F) to over 90 per cent (at water temperatures below 70^{o} F).

Cumulative Effects

Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, comfort stations, nature trail, and a ranger station, have had no impacts on fish and aquatic habitat. Past actions, including construction of boat ramps, installation of the fish tube, installation of government boat slips, and construction and installation of a public marina, have had only very local, negligible or minor adverse and some positive impacts. Past adverse impacts include runoff into the reservoir during the construction phase, increased fishing pressure, providing facilities for more boats and therefore the potential for more oil or fuel spills or leaks into the water. Positive impacts include the addition of cover and shade structures from the marinas and boats using the marinas. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in negligible disturbances of fish and aquatic habitat in the local area.

Cumulatively, these past, present and future actions would have minor, adverse impacts on fish and aquatic habitat. Alternative A would not contribute any cumulative impacts on this resource. In combination, these actions would result in minor, adverse cumulative impacts on fish and aquatic habitat.

Conclusion

Under Alternative A, the baseline conditions would not change. No construction of a breakwater system would occur and, therefore, no impacts on fish or aquatic habitat resources would result from Alternative A. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to fish and aquatic habitat.

4.5.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis

In the short-term, minor impacts may occur during construction and use of the proposed truck route on the eastern peninsula from soil, oils, etc. contained in run-off from the site. Minor impacts may also occur as the rock is placed in the reservoir to build the fixed breakwater. There is the potential for fish and aquatic invertebrates to be crushed by the rock, along with minor sedimentation and temporary turbidity. Such impacts, however, would be localized, and should have insignificant impacts on Lake Amistad's overall aquatic community. Further, during construction activities, it is likely that fish and other non-sessile organisms may vacate the immediate area, further limiting any adverse impacts.

Over the long-term, all construction-related impacts would be negligible having no discernable lasting impact on the fish or aquatic resources. The proposed vegetation scheme for the breakwater would mirror that which currently exists. Operationally, the fixed breakwater would have some impacts on the circulation pattern within the harbor. As previously discussed, the hydrodynamic model results (Anchor QEA, 2010) indicate that the fixed breakwater would result in an estimated 65-75 percent decrease in the exchange of water between the reservoir and the harbor. Reduced circulation could potentially result in lower dissolved oxygen levels than under the current conditions, which could affect the benthic macroinvertebrate community by reducing abundance through mortality or suppressed emergence, and shifting community structure towards more tolerant taxa. Effects of reduced dissolved oxygen on benthic communities would be most pronounced during the summer months, when temperatures are the highest and dissolved oxygen levels are the lowest. This effect would likely be less pronounced on more mobile species (fish), which could relocate to more suitable conditions.

The above impacts would be lessened, however, as a result of employing appropriate mitigation measures to minimize the potential impacts to water quality from implementation of this alternative. For example, regarding release of bass caught during fishing tournaments, in addition to those measures that can be taken by tournament organizers and anglers described in Section 4.5.1, tournaments could also release fish on the reservoir-side of the fixed barriers,

either manually, through the use of release boats, or by redesign and direction of the fish tube. Specific mitigation measures, however, would be selected based upon findings in an Engineering Assessment for the alternative. If, however, dissolved oxygen levels were anticipated to decrease due to implementation of this alternative, mitigation measures would be employed that would increase water exchange between the harbor and the reservoir. Possible mitigation measures would include designing the fixed breakwater with openings to allow for the flow of water through it at varying depths. Additionally, large volume aerators could be used to mechanically oxygenate the water inside the harbor. Following implementation of the appropriate mitigation measures, impacts to water resources from this alternative would be minimal.

Additionally, a negligible positive long-term impact would occur in that the breakwater would provide for additional structure and shoreline habitat for aquatic species (fish, invertebrates, and plants). It has been long established that structure, whether natural or man-made, attracts fish by providing shade, nesting, and refuge opportunities (Abdoul and Downing, 1994; Bolding et. al., 2004). The resultant additional fish habitat would also provide additional fishing opportunities for both shoreline and boating fishermen.

Cumulative Effects

Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, comfort stations, nature trail, and a ranger station, have had no impacts on fish and aquatic habitat. Past actions, including construction of boat ramps, installation of the fish tube, installation of government boat slips, and construction and installation of a public marina, have had only very local, negligible or minor adverse and some positive impacts. Past adverse impacts include runoff into the reservoir during the construction phase, increased fishing pressure, providing facilities for more boats and therefore the potential for more oil or fuel spills or leaks into the water. Positive impacts include the addition of cover and shade structures from the marinas and boats using the marinas. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in negligible disturbances of fish and aquatic habitat in the local area.

Cumulatively, these past, present and future actions would have minor, adverse impacts on fish and aquatic habitat. Alternative B would contribute minor, adverse cumulative impacts on fish and aquatic habitat through the deposition of rock and sediments onto existing habitat. In the long-term, however, the creation of new habitat in terms of increased structure, cover, foraging and nesting habitat, may offset minor impacts that may occur during the construction phase. In combination, these actions would result in both adverse and positive, minor cumulative impacts on fish and habitat.

Conclusion

Alternative B would have short-term, minor, localized, adverse impacts on fish and aquatic habitat during the construction phase from runoff from roads used to deliver breakwater materials, and from the construction of the breakwater. Alternative B would have long-term impacts during the operational phase including negligible positive impacts through increased fish habitat, and minor adverse impacts related to the alteration of circulation patterns in the harbor. Because there would be no major adverse or unacceptable impacts to a resource or value whose

conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to fish and aquatic habitat.

4.5.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis

During the construction phase of Alternative C, there may be short-term, negligible adverse impacts to bottom habitat associated with the construction of anchor points using steel plates and concrete anchors. During the operational phase, long-term impacts are anticipated to be negligible as well. Based on the hydrodynamic model results (Anchor QEA, 2010), the circulation pattern for the harbor under Alternative C would be essentially the same as under current conditions. Although the model shows a negligible negative change in the Diablo East Harbor's circulation pattern, it should be kept in mind that the model is very conservative in its assumptions. In particular, the model treats the floating breakwater as if it went from the reservoir's surface to the bottom, which it would not. As such, flow patterns beneath the surface would be less encumbered than the model suggests. Regardless, based on the hydrodynamic model, this alternative would have the least impact on circulation and therefore the least impact on dissolved oxygen levels, fish and the biological communities of aquatic vegetation and benthic macroinvertebrates. Negligible positive, impacts would occur as the floating breakwater itself would create new fish structure/cover, thereby increasing fish habitat. In addition, the breakwater and the floating walkway extending from the center peninsula would create a fishing "pier" from which shoreline fishermen can pursue recreational fishing.

Cumulative Effects

Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, comfort stations, nature trail, and a ranger station, have had no impacts on fish and aquatic habitat. Past actions, including construction of boat ramps, installation of the fish tube, installation of government boat slips, and construction and installation of a public marina, have had only very local, negligible or minor adverse and some positive impacts. Past adverse impacts include runoff into the reservoir during the construction phase, increased fishing pressure, providing facilities for more boats and therefore the potential for more oil or fuel spills or leaks into the water. Positive impacts include the addition of cover and shade structures from the marinas and boats using the marinas. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in negligible disturbances of fish and aquatic habitat in the local area.

Cumulatively, these past, present and future actions would have minor, adverse impacts on fish and aquatic habitat. Alternative C would contribute negligible, adverse and positive cumulative impacts on fish and aquatic habitat. During the construction phase, habitat would be altered to provide attachments for the anchoring system. In the long-term, however, the creation of new habitat in terms of increased structure and cover from the floating breakwater, may offset minor impacts that may occur during the construction phase. Mortality rates of largemouth bass caught and released during fishing tournaments under this alternative would not be expected to change

from that under Alternative A, the No Action Alternative. As such, the same mitigation measures described in Section 4.5.1 would be applicable for this alternative. In combination, these actions would result in both adverse and positive, minor cumulative impacts on fish and habitat.

Conclusion

Alternative C would have negligible short-term and long-term impacts on fish and aquatic habitat during both the construction and operational phases. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to fish and aquatic habitat.

4.5.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis

The potential impacts under Alternative D would be a blend of those impacts already discussed for Alternative B and Alternative C. In the short-term, there would be minor negative impacts from the construction of the fixed breakwater, as well negligible negative impacts from construction of the anchor system for the floating breakwater. In both cases, however, the impacts would be less than those in the separate alternatives (B and C), since Alternative D would construct smaller fixed breakwaters and have a smaller anchoring system for the reduced size of the proposed floating breakwater. In the long-term, there would be minor changes to the circulatory pattern, with the overall effect closer to Alternative B, than to alternative C. Positive, though negligible, impacts would still occur as the proposed breakwaters would provide structure and aquatic habitat, and the smaller floating breakwater would still provide cover. These positive benefits, however, would not be as great as Alternative C because there would be less overall cover/structure, and there would be no walkway connecting the floating breakwater to the shoreline, thus eliminating access to non-boating fishermen.

Hydrodynamic model results (Anchor QEA, 2010) indicate that the fixed and floating breakwater combination would distinctly reduce circulation in the harbor, resulting in an estimated 50 percent reduction in water exchange between the harbor and the reservoir. As discussed in Section 4.5.3, however, the model treats the floating wave barrier as a wall, and therefore presents a more impaired view of the circulation pattern than may actually occur. Nevertheless, the circulation pattern would be expected to be more encumbered than by either Altenative A or Alternative C. The reduced circulation could result in lower dissolved oxygen levels than under current conditions. Impeded circulation would cause dissolved oxygen levels to be reduced, which could affect the benthic macroinvertebrate community by reducing abundance through mortality or suppressed emergence, and shifting community structure towards more tolerant taxa. Effects of reduced dissolved oxygen on benthic communities would be most pronounced during the summer months, when temperatures are the highest and dissolved oxygen levels are the lowest. Additionally, if this alternative were selected, appropriate mitigation measures would also be selected which would minimize the potential impacts to water

quality. For example, regarding release of bass caught during fishing tournaments, in addition to those measures that can be taken by tournament organizers and anglers described in 4.5.1, tournaments could also release fish on the reservoir-side of the fixed barriers, either manually, through the use of release boats, or by redesign and direction of the fish tube. These changes are only being considered by NPS at this time; specific mitigation measures would be selected based upon findings in an Engineering Assessment for the alternative.

Cumulative Effects

Past actions, such as construction of existing facilities in Diablo East, including roads, parking areas, comfort stations, nature trail, and a ranger station, have had no impacts on fish and aquatic habitat. Past actions, including construction of boat ramps, installation of the fish tube, installation of government boat slips, and construction and installation of a public marina, have had only very local, negligible or minor adverse and some positive impacts. Past adverse impacts include runoff into the reservoir during the construction phase, increased fishing pressure, providing facilities for more boats and therefore the potential for more oil or fuel spills or leaks into the water. Positive impacts include the addition of cover and shade structures from the marinas and boats using the marinas. Future projects at Diablo East, such as construction of the joint operations facility, construction of a new trail, and nearby road improvements, would result in negligible disturbances of fish and aquatic habitat in the local area.

Cumulatively, these past, present and future actions would have minor, adverse impacts on fish and aquatic habitat. Alternative D would contribute minor, adverse cumulative impacts on fish and aquatic habitat through the deposition of rock and sediments onto existing habitat and the altering of benthic habitat for anchoring of the floating breakwater. In the long-term, however, the creation of new habitat in terms of increased structure, cover, foraging and nesting habitat, may offset minor impacts that may occur during the construction phase. In combination, these actions would result in both adverse and positive, minor cumulative impacts on fish and habitat.

Conclusion

Alternative D would have short-term, minor, localized, adverse impacts on fish and aquatic habitat during the construction phase from runoff from roads used to deliver breakwater materials, and from the construction of the breakwaters, similar to Alternative B, above. Alternative D would have long-term impacts during the operational phase including negligible positive impacts through the increased fish habitat, and minor adverse impacts related to the alteration of circulation patterns in the harbor. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to fish and aquatic habitat.

Overall Conclusion related to all Alternatives

Lake Amistad's fluctuating water levels seem to have a dominant effect on the reservoir's fishery. The reservoir's water levels can change dramatically due to seasonal weather patterns and/or discharges from the dam. For example, due to remnants of Hurricane Alex, Amistad's lake level rose 15 feet in a five day period (from 1114 feet msl on Friday July 2, 2010 to over

1129 feet msl on Tuesday, July 6, 2010). The resultant lake level was 12 feet above conservation level and the highest since 1974 (NPS, 2010c). Conversely, during summer and drought conditions the reservoir's levels may drop considerably. It has been reported that at a temperature of 100°F, 3,000 acre/feet or 131,000,000 gallons/day evaporate from Lake Amistad (NPS 2010d).

The effect of such changes in water levels on fish and fishing has been noted by TPWD. For example, strong year classes of largemouth bass were produced in 2003 and 2004 coincident with the 2003-2004 dramatic water level increase. As the increased water level inundated shoreline, it provided more underwater cover and structure to protect fingerlings. As those fish matured to catchable sizes, fishing pressure increased. TPWD recorded that the angling effort in 2007 was nearly double that of 2002-2003 (Meyers and Dennis, 2008). It is believed, therefore, that none of the alternatives would impact the reservoir's fisheries resources over and above the impact of currently fluctuating water levels.

4.6 SPECIAL STATUS SPECIES

Methodology

Impact analyses on special status species were based on species accounts by park staff, previous studies or projects conducted within the same area, USFWS and TPWD species lists, and professional judgment.

The thresholds of change for the intensity of an impact on special status species are defined as follows:

Negligible: The action would result in a change to a population or individuals of a species, but the change would be of barely perceptible consequence and would be well within natural variability. In the case of federally listed species, this impact intensity equates to a USFWS determination of "may affect, not likely to adversely affect."

Minor: The action would result in a change to a population or individuals of a species. The change would be measurable, but small and localized, and not outside the range of natural variability. Mitigation measures, if needed, would be simple and successful. In the case of federally listed species, this impact intensity equates to a USFWS determination of "may affect, not likely to adversely affect."

Moderate: Impacts on special status species, their habitats, or the natural processes sustaining them would be detectable and occur over a large area. Breeding animals of concern are present, and animals are present during particularly vulnerable life stages; mortality or interference with activities necessary for survival would be expected on an occasional basis, but is not expected to threaten the continued existence of the species in the park unit or conservation zone. Mitigation measures would be extensive and likely successful. In the case of federally listed species, this impact intensity equates to a USFWS determination of "may affect, likely to adversely affect."

Major: The action would result in noticeable effects to the viability of the population or individuals of a species. Impacts on special status species or the natural processes sustaining them would be detectable, both inside and outside of the park. Loss of habitat might affect the viability of at least some special status species. Extensive mitigation measures would be needed to offset any adverse effects and their success could not be guaranteed. In the case of federally listed species, the impact intensity equates to a USFWS determination of "may affect, likely to jeopardize the continued existence of a species."

The thresholds of change for the duration of an impact on special status species are defined as follows:

Short-term: Following implementation activities, recovery would take less than one year.
Long-term: Following implementation activities, recovery would take more than one year.

4.6.1 Impacts of Alternative A (No Action)

Impacts Analysis
There would be no new impacts to special status species under Alternative A. Existing disturbance and impacts to special status species from human activity in the area would remain unchanged.

Cumulative Effects
Past actions, such as use of the project area for parking, roads, boat ramps, and other recreation facilities, have resulted in loss of suitable habitat for Texas horned lizard, Texas indigo snake, and Texas tortoise within a portion of the project area and adjacent land. Planned future projects, such as construction of a joint operations facility, road improvement, and installation of a new trail, would result in temporary and permanent vegetation removal that provides potential habitat for special status species. Past, present, and future human noise and activity in and near the project area, including traffic, tournament fishing, boating, NPS operations, new construction, and marina activities, have the potential to disturb and displace special status species from the area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on special status species. Alternative A would not contribute any cumulative impacts on special status species. In combination, these actions would result in moderate, adverse cumulative impacts on special status species.

Conclusion
Alternative A would have no new impacts on special status species. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to special status species.

4.6.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis

Alternative B would introduce noise and human disturbance during construction that could cause displacement and disturbance of special status species. Currently, noise and human activity in and near the project area occur as a result of traffic and high visitor use. Construction of a fixed breakwater would generate noise and disturbance greater than current activities from heavy equipment, dumping of rock, and other construction activity. However, this increase in noise and activity would be temporary as it would only last for the 18-24 month duration of the project and only during daylight working hours. Species are expected to return to the area after project activities are completed.

Changes in available wildlife habitat may also occur. There would be no permanent loss of native vegetation or habitat. However, there would be temporary habitat disturbance on the eastern and western peninsulas along the truck routes, particularly where new tracks and turnaround areas need to be established. Such habitat disturbance would occur on approximately 5.8 acres. Some species may be prevented from using the resources on the peninsulas due to alteration of habitat until it recovers. Additionally, there would be creation of new habitat on the new breakwater which would be vegetated with native plants after construction is complete, providing new resources and habitat for wildlife.

It is possible that the brown pelican may fly over, or even forage in, the project area. On the infrequent occasions that this may occur during the construction period, individual birds could be disturbed or prevented from using the area. However, the brown pelican is expected to be able to use the area again after the project is complete. It is expected that this alternative may affect, but is not likely to adversely affect the brown pelican.

Construction of a breakwater in Diablo East Harbor would have no effect on breeding interior least terns as they are known to nest on islands two miles or more away from the project area. Interior least terns, which on rare occasions have been seen actively feeding inside Diablo East Harbor in small numbers, would likely be disturbed and displaced from the project area during the construction period. However, the interior least tern is expected to be able to use the area again after the project is complete. It is expected that this alternative may affect, but is not likely to adversely affect the interior least tern.

The foraging behavior of cave myotis, Brazillian free-tailed bat, pale Townsend's big-eared bat, and Yuma myotis would potentially be disturbed and displaced by increased noise and human disturbance during construction. Mitigation measures, such as limiting construction to daylight hours, would reduce potential for disturbance to these species. The project would result in a temporary disturbance of 5.8 acres of potential foraging habitat for these bat species. However, this short-term habitat loss would be negligible as compared to the amount of habitat available in the surrounding area. In the long-term, new foraging habitat would exist on the new vegetated

breakwaters. Bats would be expected to be able to use the area again after the project is complete.

The Texas horned lizard, Texas indigo snake, and Texas tortoise could be disturbed by noise and human activity or crushed by construction equipment. To protect these species, a survey of the project area would be conducted prior to construction. If the survey identifies any of these three species, the area would be avoided (if practicable), mitigation measures would be implemented to minimize impacts, or affected animals would be relocated or allowed to leave on their own. Habitat disturbed on the eastern and western peninsulas would occur for the short-term but would be expected to recover; and sufficient habitat would be available in the surrounding area during the interim.

Potential effects on sensitive plant species are unlikely because of the lack of suitable habitat in the project area. Sensitive plant surveys would be conducted prior to disturbance of any potentially suitable habitat. If any sensitive plant species are identified during surveys, mitigation measures would be implemented as described in Section *2.7 Mitigation Measures*. Thus, no adverse impacts to sensitive plant species are anticipated.

Cumulative Effects

Past actions, such as use of the project area for parking, roads, boat ramps, and other recreation facilities, have resulted in loss of suitable habitat for Texas horned lizard, Texas indigo snake, and Texas tortoise within a portion of the project area and adjacent land. Planned future projects, such as construction of a joint operations facility, road improvement, and installation of a new trail, would result in temporary and permanent vegetation removal that provides potential habitat for special status species. Past, present, and future human noise and activity in and near the project area, including tournament fishing, boating, NPS operations, new construction, and marina activities, have the potential to disturb and displace special status species from the area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on special status species. Alternative B would contribute minor, adverse and negligible, beneficial cumulative impacts on special status species. In combination, these actions would result in moderate, adverse cumulative impacts on special status species.

Conclusion

Alternative B would have short-term, minor, localized, adverse impacts on special status species from disturbance and displacement during construction and temporary habitat disturbance. There would also be long-term, negligible, localized, beneficial impacts from creation of new habitat on the breakwaters. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to special status species.

4.6.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis
Impacts under Alternative C would be similar to those described for Alternative B. Differences between the two alternatives are that habitat disturbance would occur on the central peninsula over 0.8 acres, rather than on the eastern and western peninsulas; impacts on special status species would occur over a 12-18 month construction period; rather than 18-24 months; and there would be no new habitat created since the floating breakwater would not be vegetated.

Cumulative Effects
Past actions, such as use of the project area for parking, roads, boat ramps, and other recreation facilities, have resulted in loss of suitable habitat for Texas horned lizard, Texas indigo snake, and Texas tortoise within a portion of the project area and adjacent land. Planned future projects, such as construction of a joint operations facility, road improvement, and installation of a new trail, would result in temporary and permanent vegetation removal that provides potential habitat for special status species. Past, present, and future human noise and activity in and near the project area, including tournament fishing, boating, NPS operations, new construction, and marina activities, have the potential to disturb and displace special status species from the area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on special status species. Alternative B would contribute minor, adverse cumulative impacts on special status species. In combination, these actions would result in moderate, adverse cumulative impacts on special status species.

Conclusion
Alternative C would have short-term, negligible to minor, localized, adverse impacts on special status species from disturbance and displacement during construction and temporary habitat disturbance. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to special status species.

4.6.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis
Impacts under Alternative D would be the same as those described for Alternative B. Additionally, there would be somewhat more construction noise and disturbance under this alternative with the installation of a floating breakwater in addition to the fixed breakwater, but it would still be short-term only during construction activities.

Cumulative Effects
Past actions, such as use of the project area for parking, roads, boat ramps, and other recreation facilities, have resulted in loss of suitable habitat for Texas horned lizard, Texas indigo snake, and Texas tortoise within a portion of the project area and adjacent land. Planned future projects, such as construction of a joint operations facility, road improvement, and installation of a new trail, would result in temporary and permanent vegetation removal that provides potential habitat

for special status species. Past, present, and future human noise and activity in and near the project area, including tournament fishing, boating, NPS operations, new construction, and marina activities, have the potential to disturb and displace special status species from the area.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on special status species. Alternative B would contribute minor, adverse and negligible, beneficial cumulative impacts on special status species. In combination, these actions would result in moderate, adverse cumulative impacts on special status species.

Conclusion
Alternative D would have short-term, minor, localized, adverse impacts on special status species from disturbance and displacement during construction and temporary habitat disturbance. There would also be long-term, negligible, localized, beneficial impacts from creation of new habitat on the breakwaters. Because there would be no major adverse or unacceptable impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the Park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to special status species.

4.7 VISITOR USE AND EXPERIENCE

Methodology

Public scoping input and NPS staff observations of visitation patterns, combined with an assessment of amenities available to visitors under current park management, were used to assess the effects of the alternatives.

The thresholds of change for the intensity of an impact on visitor use and experience are defined as follows:

Negligible: Changes in visitor use and/or experience would be below or at the level of detection. The visitor would not likely be aware of the effects associated with the alternative.

Minor: Changes in visitor use and/or experience would be detectable, although the changes would be slight. The visitor might be aware of the effects associated with the action, but would likely not express an opinion about the changes.

Moderate: Changes in visitor use and/or experience would be readily apparent. The visitor would be aware of the effects associated with the alternative and would likely be able to express an opinion about the changes.

Major: Changes in visitor use and/or experience would be readily apparent and severely adverse or exceptionally beneficial. The visitor would be aware of the effects associated with the alternative and would likely express a strong opinion about the changes.

The thresholds of change for the duration of an impact on visitor use and experience are defined as follows:

Short-term: Occurs only during project construction.
Long-term: Continues after project construction.

4.7.1 Impacts of Alternative A (No Action)

Impacts Analysis

There would be no change in the nature and quality of the visitor experience or recreational opportunities within Amistad under Alternative A. Visitors would continue to be subject to unsafe conditions in Diablo East Harbor during storms. Visitors in personal boats and rented houseboats would continue to experience rough water conditions inside the harbor as they attempt to launch boats or bring in boats, possibly causing damage to boats and injuries to people. Many visitors would continue trying to retrieve their boats at the same time during storms, creating stress and an unpleasant experience. Additionally, visitors may be required to postpone launching boats after storms if damage to the NPS and marina dock require time for repairs. The marina may need to make repairs as well to boat slips and houseboats, possibly delaying trips for some visitors.

Cumulative Effects

Past actions, such as construction of nearby parking areas, roads, boat ramps, and other recreation facilities, have resulted in benefits to the visitor experience by providing access to recreational activities. The opportunities for fishing tournaments, boat and bank fishing, hiking, and other recreational activities at Diablo East have also benefited the visitor experience and increased visitor use. Reasonably foreseeable future projects, such as construction of a new joint operations facility, road improvements, and construction of a new trail, would have beneficial effects on visitor use and experience by providing improved facilities and additional recreation opportunities.

Cumulatively, these past, present, and future actions would have moderate, beneficial impacts on visitor use and experience. Alternative A would contribute minor, adverse cumulative impacts on visitor use and experience. In combination, these actions would result in moderate, beneficial cumulative impacts on visitor use and experience.

Conclusion

Alternative A would have long-term, moderate, adverse impacts on visitor use and experience due to the continued unsafe and stressful conditions in Diablo East Harbor during storms. There would be no unacceptable impacts to visitor use and experience.

4.7.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis

Visitor experience and visitor access would be temporarily adversely affected by construction of a fixed breakwater. Visitors to the Diablo East area may be inconvenienced by the sight of construction work, construction noise, and traffic. During construction, some visitor access may

be impeded, due to an increase in construction traffic, particularly on Viewpoint Road as heavy equipment and trucks hauling rock travel to the eastern peninsula. Boats would not be able to travel near the area of construction in the harbor, but sufficient space would remain for them to maneuver. To minimize adverse impacts on visitors during the 18 to 24 month construction period, the park would inform visitors in advance of construction via a number of sources so they can plan their schedule and activities. Access to boat ramps, comfort stations, the marina and other facilities at Diablo East are expected to remain open throughout construction. The level of visitor use at Diablo East during construction would not be expected to change. Any disruptions of the user experience would be confined to the period of construction.

Following construction, there would be long-term beneficial effects on visitor use and experience. A new breakwater would aid in protecting life and property as there would be a safer environment in which park visitors can launch and retrieve their recreational boats at the Diablo East boat ramp during storm conditions. Currently, many people attempt to retrieve their boats at the same time during storms, creating traffic and a poor visitor experience. A breakwater would change this by eliminating large waves, and visitors would be able to more safely retrieve their vessels. On the other hand, with the mouth of the harbor entrance restricted to 120 feet, there is the possibility of congestion as dozens of boats all attempt to return to the safety of the harbor at the same time when a storm initially hits the lake. If boaters are attempting to leave the harbor at the same time, the mouth of the harbor would become a critical bottleneck for boating traffic during the critical initial minutes after a storm hits.

A new breakwater would also increase fishing opportunities for the non-boating public who would be able to walk out on the breakwater to fish. The breakwater would allow for activities such as bird watching as visitors would have more access to the water. Additionally, there would be a beneficial aesthetic component with a vegetated breakwater that blends in with the surrounding peninsulas that people can walk out on.

Cumulative Effects

Past actions, such as construction of nearby parking areas, roads, boat ramps, and other recreation facilities, have resulted in benefits to the visitor experience by providing access to recreational activities. The opportunities for fishing tournaments, boat and bank fishing, hiking, and other recreational activities at Diablo East have also benefited the visitor experience and increased visitor use. Reasonably foreseeable future projects, such as construction of a new joint operations facility, road improvements, and construction of a new trail, would have beneficial effects on visitor use and experience by providing improved facilities and additional recreation opportunities.

Cumulatively, these past, present, and future actions would have moderate, beneficial impacts on visitor use and experience. Alternative B would contribute minor, adverse and moderate, beneficial cumulative impacts on visitor use and experience. In combination, these actions would result in moderate, beneficial cumulative impacts on visitor use and experience.

Conclusion

Alternative B would have short-term, minor, adverse impacts on visitor use and experience due to noise, traffic, and access during construction of the breakwater. There would also be long-

term, moderate, beneficial impacts due to improved conditions in the harbor and new recreational opportunities with the presence of a new breakwater. Long-term, minor, adverse impacts could occur as boaters attempt to return through the restricted breakwater opening during storms. There would be no unacceptable impacts to visitor use and experience.

4.7.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis

Effects on visitor use and experience under Alternative C would be similar to the effects described under Alternatives B. Over the short-term, adverse impacts would last for a shorter period of time, 12-18 months rather than 18-24 month construction period. Also, traffic and access would not occur on Viewpoint Road, as in Alternative B, but around the parking area and central peninsula road at Diablo East.

Long-term benefits would be similar to Alternative B as well. However, instead of walking out on a fixed breakwater, visitors would walk out onto the floating breakwater from the tail of the Y off the central peninsula. There they would be able to engage in activities such as fishing and bird watching. The floating breakwater would introduce an unnatural aesthetic component into the harbor as it would not be vegetated to blend in like the fixed breakwater. This factor may detract from the visitor experience for some people. Additionally, people accessing the breakwater via the Nature Trail (which would be reconstructed after breakwater construction is completed) may alter the experience for visitors who just use the Nature Trail for walking and exploration.

Cumulative Effects

Past actions, such as construction of nearby parking areas, roads, boat ramps, and other recreation facilities, have resulted in benefits to the visitor experience by providing access to recreational activities. The opportunities for fishing tournaments, boat and bank fishing, hiking, and other recreational activities at Diablo East have also benefited the visitor experience and increased visitor use. Reasonably foreseeable future projects, such as construction of a new joint operations facility, road improvements, and construction of a new trail, would have beneficial effects on visitor use and experience by providing improved facilities and additional recreation opportunities.

Cumulatively, these past, present, and future actions would have moderate, beneficial impacts on visitor use and experience. Alternative C would contribute minor, adverse and moderate, beneficial cumulative impacts on visitor use and experience. In combination, these actions would result in moderate, beneficial cumulative impacts on visitor use and experience.

Conclusion

Alternative C would have short-term, minor, adverse impacts on visitor use and experience due to noise, traffic, and access during construction of the breakwater. There would also be long-term, moderate, beneficial impacts due to improved conditions in the harbor and new recreational opportunities with the presence of a new breakwater. There would be no unacceptable impacts to visitor use and experience.

4.7.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis

Effects on visitor use and experience under Alternative D would be similar to the effects described under Alternatives B and C. Visitors would be able to walk out on the fixed breakwater off which they could engage in activities such as fishing and bird watching. Also, as in Alternative C, the floating breakwater would introduce an unnatural aesthetic component into the harbor as it would not be vegetated to blend in like the fixed breakwater, which may detract from the visitor experience for some people.

The addition of a floating dock breakwater along with the fixed rock jetty under this alternative increases the width of the harbor entrance (400 feet under alternative D and only 120 feet under alternative B), greatly facilitating boat traffic into and out of the harbor, thereby increasing the desirability of the harbor facility for both boat renters and private boat owners using slips at the harbor marina.

Cumulative Effects

Past actions, such as construction of nearby parking areas, roads, boat ramps, and other recreation facilities, have resulted in benefits to the visitor experience by providing access to recreational activities. The opportunities for fishing tournaments, boat and bank fishing, hiking, and other recreational activities at Diablo East have also benefited the visitor experience and increased visitor use. Reasonably foreseeable future projects, such as construction of a new joint operations facility, road improvements, and construction of a new trail, would have beneficial effects on visitor use and experience by providing improved facilities and additional recreation opportunities.

Cumulatively, these past, present, and future actions would have moderate, beneficial impacts on visitor use and experience. Alternative D would contribute minor, adverse and moderate, beneficial cumulative impacts on visitor use and experience. In combination, these actions would result in moderate, beneficial cumulative impacts on visitor use and experience.

Conclusion

Alternative D would have short-term, minor, adverse impacts on visitor use and experience due to noise, traffic, and access during construction of the breakwater. There would also be long-term, moderate, beneficial impacts due to improved conditions in the harbor and new recreational opportunities with the presence of a new breakwater. There would be no unacceptable impacts to visitor use and experience.

4.8 PARK OPERATIONS

Methodology

Existing and potential effects on park operations were identified with the help of NPS staff and evaluated in the impact analysis. The potential for project implementation to alter park operations was evaluated.

The thresholds of change for the intensity of an impact on park operations are defined as follows:

Negligible: The effects would be at low levels of detection and would not have appreciable effects on park operations.

Minor: The effects would be detectable and would be of a magnitude that would not have appreciable effects on park operations. If mitigation is needed to offset adverse effects, it would be simple and likely successful.

Moderate: The effects would be readily apparent and result in a change in park operations that would be noticeable to park staff and the public. Mitigation measures would be necessary to offset adverse effects and would likely be successful.

Major: The effects would be readily apparent; would result in a substantial change in park operations in a manner noticeable to staff and the public; and would be markedly different from existing operations. Mitigation measures to offset adverse effects would be needed and extensive, and success could not be guaranteed.

The thresholds of change for the duration of an impact on park operations are defined as follows:

Short-term: Effects lasting for the duration of the project.
Long-term: Effects continuing after the project has been completed.

4.8.1 Impacts of Alternative A (No Action)

Impacts Analysis

Under Alternative A, a new breakwater would not be constructed, and the adverse effects of storms would continue on facilities and visitors at Diablo East. The level of park operations dealing with effects of storms would not change from current levels over the long-term. The maintenance and ranger staff would continue to spend time fixing and re-anchoring the main dock after significant storm events. Maintenance staff would also continue to make repairs to the dock and boat slips two to three times a year due to damage from smaller storm events. Ranger staff would continue assisting injured visitors and directing traffic six to eight times a year during storm events.

Cumulative Effects

The park has maintained park facilities at Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station. It has also provided recreational opportunities for park visitors, such as fishing tournaments, bank fishing, ranger led nature trail tours, and NPS led environmental education for kids on houseboats. All of these activities have contributed to personnel time and effort. Park operations are expected to become more efficient

by consolidating law enforcement, maintenance, administration, and visitor outreach facilities at one central location with the planned future construction of a joint operations facility.

Cumulatively, past, present, and future actions would have minor, beneficial impacts on park operations. Alternative A would contribute negligible, adverse cumulative impacts on park operations. In combination, these actions would result in minor, beneficial cumulative impacts on park operations.

Conclusion
Alternative A would have long-term, minor adverse impacts on park operations due to the continued need for dock repairs and visitor assistance at Diablo East during storms. There would be no unacceptable impacts to park operations.

4.8.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis
The construction of a breakwater under Alternative B would decrease the amount of time maintenance staff and rangers spend on activities during and post storms over the long-term. There should only be a need for occasional maintenance associated with the fixed breakwater over the long-term, such as repair or replacement of navigational lights which mark the breakwater.

Over the short-term, park operations would see an increase in demands on staff time during the 18-24 month construction period. A buoy system can be installed to close off the breakwater construction area to boating. Additionally, rangers may be involved with some traffic control or other activities as needed during construction; however, the majority of traffic control would be provided by the construction contractor. It is also likely that a park staff member would need to oversee the construction contractor for the duration of project implementation.

Cumulative Effects
The park has maintained park facilities at Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station. It has also provided recreational opportunities for park visitors, such as fishing tournaments, bank fishing, ranger led nature trail tours, and NPS led environmental education for kids on houseboats. All of these activities have contributed to personnel time and effort. Park operations are expected to become more efficient by consolidating law enforcement, maintenance, administration, and visitor outreach facilities at one central location with the planned future construction of a joint operations facility.

Cumulatively, past, present, and future actions would have minor, beneficial impacts on park operations. Alternative B would contribute minor, beneficial cumulative impacts on park operations over the long-term. In combination, these actions would result in minor, beneficial cumulative impacts on park operations.

Conclusion
Alternative B would have long-term, minor, beneficial impacts on park operations due to the diminished need for dock repairs, visitor assistance at Diablo East during storms, and little to no

maintenance for the remaining lifetime of the breakwater. This alternative would also have short-term, minor, adverse impacts on park operations due to the need for increased staff time required to manage visitors and contractors during project implementation. There would be no unacceptable impacts to park operations.

4.8.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis

The construction of a breakwater under Alternative C would decrease the amount of time maintenance staff and rangers spend on activities during and post storms over the long-term. As the floating breakwater is a self-adjusting attenuating system consisting of platforms/docks anchored to the bottom, there would be no mechanical systems to maintain. However, it would most likely need to be replaced in its entirety after 25 years of use.

Over the short-term, park operations would see an increase in demands on staff time during the 12-18 month construction period. A buoy system can be installed to close off the breakwater construction area to boating. The majority of traffic control would be provided by the construction contractor. It is likely that a park staff member would need to oversee the construction contractor for the duration of project implementation.

Cumulative Effects

The park has maintained park facilities at Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station. It has also provided recreational opportunities for park visitors, such as fishing tournaments, bank fishing, ranger led nature trail tours, and NPS led environmental education for kids on houseboats. All of these activities have contributed to personnel time and effort. Park operations are expected to become more efficient by consolidating law enforcement, maintenance, administration, and visitor outreach facilities at one central location with the planned future construction of a joint operations facility.

Cumulatively, past, present, and future actions would have minor, beneficial impacts on park operations. Alternative C would contribute minor, beneficial cumulative impacts on park operations over the long-term. In combination, these actions would result in minor, beneficial cumulative impacts on park operations.

Conclusion

Alternative C would have long-term, minor, beneficial impacts on park operations due to the diminished need for dock repairs and visitor assistance at Diablo East during storms. This alternative would also have short-term, minor, adverse impacts on park operations due to the need for increased staff time required to manage contractors during project implementation. There would be no unacceptable impacts to park operations.

4.8.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis

Effects on park operations under Alternative D would be similar to the effects described under both Alternatives B and C over the long-term and over the short-term 18-24 month construction period.

Cumulative Effects

The park has maintained park facilities at Diablo East, including roads, parking areas, boat ramps, comfort stations, nature trail, and a ranger station. It has also provided recreational opportunities for park visitors, such as fishing tournaments, bank fishing, ranger led nature trail tours, and NPS led environmental education for kids on houseboats. All of these activities have contributed to personnel time and effort. Park operations are expected to become more efficient by consolidating law enforcement, maintenance, administration, and visitor outreach facilities at one central location with the planned future construction of a joint operations facility.

Cumulatively, past, present, and future actions would have minor, beneficial impacts on park operations. Alternative D would contribute minor, beneficial cumulative impacts on park operations over the long-term. In combination, these actions would result in minor, beneficial cumulative impacts on park operations.

Conclusion

Alternative D would have long-term, minor, beneficial impacts on park operations due to the diminished need for dock repairs and visitor assistance at Diablo East during storms. This alternative would also have short-term, minor, adverse impacts on park operations due to the need for increased staff time required to manage contractors during project implementation. There would be no unacceptable impacts to park operations.

4.9 SOCIOECONOMICS

Methodology

Socioeconomic effects occur when people's lives are noticeably altered by a proposed action. Impacts may be either beneficial or adverse and may be evaluated in terms of their duration and intensity. The thresholds of change for the intensity of an impact on socioeconomics are defined as follows:

Negligible: The effect is not detectable or is sufficiently small that there would be no measurable effect on socioeconomic resources.

Minor: The effect would be detectable, but would be small and would not have an appreciable effect on socioeconomic resources.

Moderate: The effect would be clearly detectable and would result in a discernable change in socioeconomic resources.

Major: The effect would be substantial and readily detectable and would have a substantial, highly measurable and potentially permanent influence on socioeconomic resources.

The thresholds of change for the duration of an impact on socioeconomics are defined as follows:

Short-term: Occurs only during construction and development
Long-term: Continues beyond construction and development

4.9.1 Impacts of Alternative A (No Action)

Impacts Analysis

Alternative A assumes that conditions in Diablo East Harbor would remain as they are presently. No construction of a breakwater would be undertaken and the harbor and associated marina would continue to be exposed to adverse weather conditions. As a result, visitors and marina tenants would continue to experience adverse impacts from storm and wind events over the longer term.

Minor storm and wave damage occurs to both the harbor area and marina facilities, on average, about three times a year. These events sometimes result in closure of the marina for short periods. Severe storm or wind events occur about every two years causing closure of the marina for significantly longer periods for safety reasons and to affect repairs to marina facilities. During the most recent severe storm event, late June to early July of 2010, the marina was forced to close for a period of six days (Reilly, 2010). Loss of revenue to the marina operator, as well as lost work time for marina employees and loss of access by visitors who use the facilities normally occurs during these events.

Damage to boats and other facilities at the marina is a routine consequence. Privately owned boats have been damaged and some have sunk at the public boat dock during storms. Estimates indicate approximately $1 million in damage over a five year period or about $200,000 annually (Garetz, 2010b).

Damage to the public boat dock does not prevent NPS or Border Patrol personnel from effectively carrying out their responsibilities. However, during significant storm events, NPS personnel are required to provide additional safety or other assistance to boaters and other park visitors. Occasionally, the Government boat slips where NPS emergency response boats are kept have broken free of shore anchor points and floated into the cove, preventing land access to emergency response boats during storm events (Garetz, 2010b).

Alternative A may result in a steady decline in site visitation and use of the marina and other facilities in the Diablo East area. Diablo East is one of the more popular recreation locations in the Amistad NRA; accounting for approximately 28 to 45 percent of all park visitation in 2008 and 2009 (see Section 3.8.2). Should a decline in visitation occur, the levels of visitor spending in the economies of the region and surrounding local communities may be affected, as well as the continuing ability of the marina operator to profitably rent boats and slips to marina users.

Cumulative Effects

Previous developments, including roads, parking areas, public boat ramps and the marina facilities of the Lake Amistad Resort and Marina have contributed substantially to the general public uses available in the Diablo East area. These developments have resulted in an increased level of visitation, and a corresponding increase in the level of visitor spending in the park itself, at the associated park concessions, and in the surrounding local community.

Proposed or planned future projects, such as the construction of a new joint operations facility, road improvements, and construction of a new trail, would be expected to have the beneficial effect of increasing the desirability of the Diablo East area, thereby increasing visitor use and spending in the area and increasing revenues to the marina concession. Ongoing recreational programs, including the scheduled fishing tournaments, ranger led school tours and educational programs and other events hosted in the Diablo East area also contribute to an increased level of visitor use and a corresponding increased level of visitor spending in the park and the surrounding local economy.

Past, present and future actions taken by NPS and the private marina concessionaire would be expected to have a long-term, minor to moderate, beneficial impact on the level of visitation and use of the park's socioeconomic resources. However, the continuing damage to boats, docks and other marina facilities may interfere with the user experience as well as scheduled park events such as fishing tournaments. Other park activities, such as NPS educational programs may also be affected. The result may have an adverse impact on visitor use of the Diablo East area and declining visitor totals, both in the Diablo East area and in the park. A corresponding adverse impact to the revenues generated by the Marina through rentals and other visitor spending may be anticipated, as well as a general decline in overall visitor spending in the park and surrounding local economy.

Conclusion

Socioeconomic impacts associated with Alternative A would be expected to be minor to moderate, depending on the frequency and severity of storm events in any given year. Alternative A may result in long-term, continuing damage to park and marina resources and may result in minor impacts to the level of visitor use and spending in the park, at park concessions and in the local economy by creating an unsafe environment for visitors or employees, as well as interfering with visitor opportunities to make use of the marina and other park facilities, park programs and other organized public activities. Alternative A would not be expected to result in unacceptable levels of impact to socioeconomic resources associated with the Diablo East area or the park.

4.9.2 Impacts of Alternative B (Fixed Breakwater)

Impacts Analysis

The construction of a fixed breakwater under Alternative B between the two harbor peninsulas would require a small temporary workforce as well as the transportation of more than 500,000 cubic yards of quarried rock from local quarries. Potential disturbance during construction may have a tendency to decrease the desirability of the Diablo East area for certain visitor uses, resulting in a temporary decline in visitor usage and a corresponding decline in revenues to park concessions and in overall visitor spending in the surrounding local economy. However, any

potential adverse effect to the level of visitor spending in the park, at the local marina concessions and in the larger economic area would be both temporary and minor and would not be expected to have a substantial effect on overall longer term visitor spending.

During construction of the jetties, it may be necessary to suspend operations at the marina for short periods lasting a few minutes at a time during construction as the rocks are being off loaded from trucks into the water. This would not require the full closure of the marina or the elimination or loss of any marina services or facilities during the construction period. However, the marina would be requested to monitor rental boat traffic into and out of the harbor while rocks are being placed in the jetties. Although these temporary disruptions in marina activity would have a minor effect on marina operations, they could be easily mitigated through scheduling modifications, and public information efforts to make boaters and other users aware of the need for the temporary stoppage of boats through the harbor. Any economic impact on marina rental and sales would be expected to be minor.

Actions proposed under this alternative would have the substantial effect of reducing potential storm and wave damage to the marina and boating operations in the harbor. This effect would be longer term in duration and would benefit the private operator of the marina through reduced need for marina closure to repair storm damage and protect public safety, as well as eliminating much of the expense associated with loss of revenue during closure and the costs of repairs to boats and marina facilities.

Cumulative Effects

In general, the actions proposed by Alterative B are in keeping with the existing site character and do not introduce any new or incompatible structures that might have a longer term effect on other planned or reasonably foreseeable actions within the park, or on scheduled park activities, levels of visitor usage or the corresponding levels of visitor spending in the recreation area or in the surrounding local economy. Temporary disruptions during the 18 to 24 month construction period would have a minor effect on scheduled park events such as fishing tournaments. Other park activities, such as NPS educational programs may also be affected. With careful scheduling, any potential for disruption can be avoided or minimized.

In conjunction with other past, present or foreseeable future actions, completion of the proposed fixed breakwater would be expected to have the substantial beneficial impact of increasing the usability and availability of the marina and surrounding area for park related activities by reducing the level of damage associated with large waves generated by storm or high wind events and decreasing the number of closures of the marina for repairs or safety considerations. As a result, the actions proposed under this alternative would be expected to have a moderate, beneficial and long-term cumulative effect on socioeconomic resources associated with the Diablo East area.

Conclusion

Implementation of this alternative would be expected to have a minor, short-term adverse effect on marina operations during the construction period. The effect would not be expected to substantially impact visitor levels in the Diablo East area or the users and tenants of the Lake Amistad Resort and Marina. As a result, any potential adverse impact on visitor spending or the

levels of revenue generated by park concessions, including the Lake Amistad Resort and Marina would be expected to be minor. Potential effects could be easily mitigated through appropriate scheduling and increased public information explaining the need for temporary disruptions of boat traffic during construction and outlining necessary changes in marina operations and safety precautions. A moderate benefit attaches to the potential reduction in damage and associated cost to repair public and private dock facilities. There would also be a moderate benefit from the substantial elimination of the need to close the marina for long periods while storm damage is being repaired, reducing losses to the private operator of the marina. No unacceptable impacts to socioeconomic resources, either in the park or in the surrounding economic region would be anticipated under this alternative.

4.9.3 Impacts of Alternative C (Floating Breakwater – Preferred Alternative)

Impacts Analysis

The floating breakwater proposed under this alternative would be expected to have a substantial, long-term beneficial effect on site visitation, marina operations and the regional economy similar to that described for Alternative B. Closure of the marina or the temporary suspension of operations for short periods during construction would not be necessary under this alternative. As a result, construction of the floating docks would be expected to have a negligible to minor temporary impact on marina operations, visitor use and spending in the park and the surrounding regional economy. Some beneficial effect would also accrue to marina operations from the reduction in costs for repairs and the loss of revenue associated with decreased boat rentals and slip fees. Users would no longer seek other alternatives for boating and other water based recreation in response to losses during storm events. Some temporary inconvenience may be experienced by marina operators and users during the construction period.

Although some visitors may find the concrete floating breakwater to be a noticeable intrusion into their experience and might seek other venues for recreational opportunities, thereby reducing the levels of visitor use and spending in the Diablo East area, visitors would not be expected to avoid the harbor in any great numbers as a result. The harbor already supports a private marina and public boat facilities. The proposed breakwater is in keeping with the character of the docks, and other structural facilities normally associated with larger marina operations. As a result, visitors would not be expected to avoid the harbor area as a consequence of the introduction of the floating breakwater, but may be drawn to visit more frequently as a result of the increased utility afforded by the new construction. It is probable that this floating breakwater would become a major draw to park visitors and would become the most popular public fishing dock at Amistad National Recreation Area. Increased visitor use of the area would be directly related to an increase in spending and associated revenues to park concessions, including the marina. Expanded public access for these activities may be expected to increase, rather than decrease public use of the harbor and associated facilities, thereby increasing potential activity at the marina as well.

Cumulative Effects

When considered with other past, present, or reasonably foreseeable future actions to be taken by NPS and others in the Diablo East area, the construction of a floating breakwater proposed under Alternative C would add only a minor temporary disruption to other ongoing park and marina

activity during the 12 to 18 month construction period. Any associated adverse impact to visitor use and spending and revenues to park concessions would also be expected to be minor. Any disruptions of scheduled events or ongoing park programs could be mitigated by appropriate advanced scheduling so that no park activities would be adversely affected.

When completed, the breakwater would have the substantial, long-term beneficial impact of increasing the usability and availability of the marina and surrounding area for park related activities by reducing the level of damage associated with large waves generated by storm or high wind events and decreasing the number of closures of the marina for repairs or safety considerations. As a result, both visitor use and associated visitor spending in the Diablo East area and the park would be expected to increase. The increased public access and the expanded floating dock would represent a beneficial effect by increasing the range of public uses to be made of the marina and dock facilities. As a result, it would be anticipated that annual visitation and visitor spending, especially for certain events, may increase.

Conclusion

Actions proposed under Alternative C would be expected to have a negligible to minor, short-term adverse impact to socioeconomic resources during the proposed construction period. Over the long-term, a moderate beneficial impact would be realized in increased visitor use and spending both at park concessions, especially the Lake Amistad Marina and Resort, and in the surrounding local economy. This alternative would not be expected to result in any unacceptable impacts to the socioeconomic resources of the park.

4.9.4 Impacts of Alternative D (Fixed and Floating Breakwater Combination)

Impacts Analysis

Actions proposed under this alternative would result in a combination of impacts similar to those discussed for Alternatives B and C. Similar to Alternative B, construction of the fixed breakwater would require the temporary suspension of marina operations for brief periods when rocks are deposited in the water. However, no actual closure of the marina would be necessary during construction. Any potential adverse effect to the level of visitor spending in the park, at the local marina concessions and in the larger economic region would be both temporary and minor. Temporary disruptions could be mitigated through scheduling and public education regarding the need for operations to be suspended and outlining safety procedures near the construction site. No other adverse effects to marina operations or visitor use and spending would be associated with the construction period.

The addition of a floating breakwater would result in impacts similar to those discussed under Alternative C. The proposed floating breakwater component of Alternative D is in keeping with the boating and dock facilities already present in the harbor and would not introduce any incompatible uses or structures to the surrounding area. As a result, any decrease in visitor use and spending that may be associated with a change in the qualities of the harbor area would be expected to be negligible to minor and would be balanced by increased use anticipated from the improved harbor facilities. No substantial losses in revenue during construction operations would be anticipated. A substantial economic benefit associated with reduced costs for marina

maintenance and reduction in the number of days during which the marina must be closed would be anticipated under this alternative.

Cumulative Effects

As with Alternative B and C, this alternative would be expected to present a generally beneficial, long-term, moderate impact on marina operations when considered as a part of other ongoing operations in the Diablo East area by decreasing both the cost of needed repairs following storm events and the need to close the marina for short periods for safety reasons and to affect repairs. The increased availability of marina facilities, access to the public boat landing, and protection for boats docked in the harbor would also have the potential to increase the levels of user activity in the harbor, and correspondingly to increase revenues for the operator of the marina facility.

Temporary disruptions during the 18 to 24 month construction period would have a minor adverse effect on scheduled park events such as fishing tournaments. Other park activities, such as NPS educational programs may also be affected. Some potential for loss of revenue associated with decreased visitor activity and use of facilities during these events at the marina may be anticipated. However, with careful scheduling of park activities, any potential for disruption can be avoided or minimized. Upon completion, this alternative would be expected to have the substantial beneficial impact of increasing the usability and availability of the marina and surrounding area for park related activities by reducing the level of damage and other associated risks resulting from large waves associated with storm or high wind events and decreasing the number of closures of the marina for repairs or safety considerations.

Conclusion

Alternative D would be expected to have a minor, short-term effect on visitor use and spending during the construction period. Long-term effects would be considered to be moderate and beneficial. The potential for reduction in storm and wave damage, in conjunction with the decreased need to close the marina during, and immediately after storm events, for public safety reasons and to make necessary repairs represents a substantial beneficial economic impact for the marina operator, as well as for overall park operations. This alternative would not likely be expected to result in any unacceptable impacts of park socioeconomic resources.

5.0 CONSULTATION AND COORDINATION

5.1 PUBLIC INVOLVEMENT

Scoping is the effort to involve agencies and the general public in determining the scope of issues to be addressed in the environmental document. Among other tasks, scoping determines important issues and eliminates issues not important; allocates assignments among interdisciplinary team members and/or other participating agencies; identifies related projects and associated documents; identifies other permits, surveys, consultations, etc. required by other agencies; and creates a schedule which allows adequate time to prepare and distribute the environmental document for public review and comment before a final decision is made. Scoping includes any interested agency, or any agency with jurisdiction by law or expertise (including the Advisory Council on Historic Preservation, the State Historic Preservation Officer, and Indian Tribes) to obtain early input.

A scoping newsletter describing the project and requesting public input on the proposed alternatives was issued to private parties and State, Federal, and local agencies. The public scoping period for the project began on April 26, 2010 and ended on May 26, 2010. There were five comment letters received from individual members of the public during this period. No comments were received from organizations, and three comment letters were received from agencies (U.S. Customs and Border Protection, TPWD, and the U.S. Fish and Wildlife Service). Six comment letters specifically expressed support for the project, and no letters were in opposition. Specific issues and concerns brought up included boater safety, protection and safety of government and marina facilities, protection of federal and state listed species, wetlands, migratory birds, soil erosion and compaction, sediment loading, and landscaping.

5.2 PREPARERS AND CONTRIBUTORS

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APPENDIX A: SCOPING LETTER

United States Department of the Interior
NATIONAL PARK SERVICE
Amistad National Recreation Area
4121 Veterans Blvd.
Del Rio, TX 78840-9350

In Reply Refer To:
File Code L76

April 26, 2010

Subject - Preparation of an Environmental Assessment for a Breakwater System at the Diablo East Harbor at Amistad National Recreation Area

Dear Friends and Neighbors:

The National Park Service (NPS) is proposing to construct a new breakwater system in the Diablo East Harbor to protect the public boat dock at the Diablo East boat ramp, the government boat slips, and the marina floating docks from damaging waves during storm events. The breakwater would also provide a safer environment in which park visitors can launch and retrieve their recreational boats at the Diablo East boat ramp during storm conditions. Possible breakwater systems being considered include a fixed breakwater at the mouth of the harbor, floating breakwater platforms at various locations and in various configurations, or combinations of fixed and floating breakwaters. Figure 1 shows the Diablo East Harbor project area.

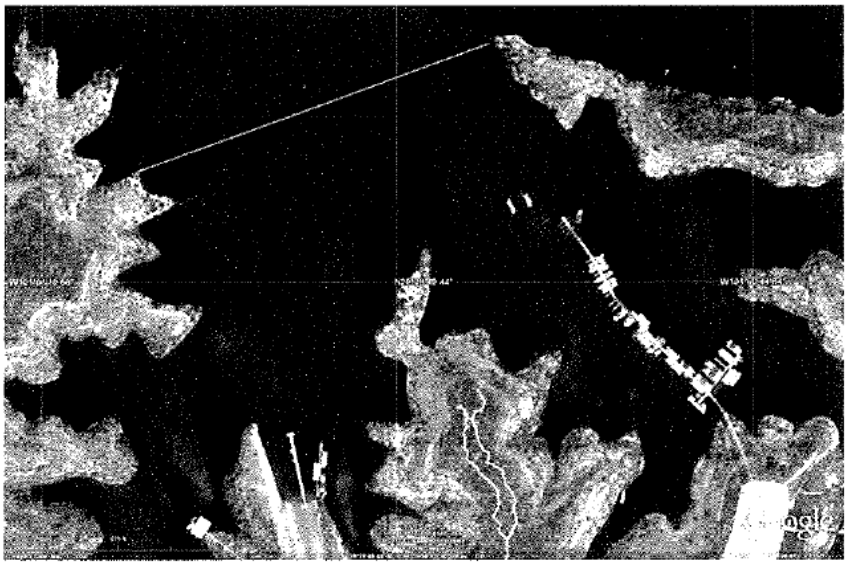

Figure 1. Diablo East Harbor project area showing locations of the government boat slips, the public boat ramp, and the marina boat docks. A white line is drawn at the mouth of the harbor.

An Environmental Assessment will be prepared in compliance with the National Environmental Policy Act (NEPA) to provide the decision-making framework that 1) analyzes a reasonable range of alternatives to meet project objectives, 2) evaluates issues and impacts to park resources and values, and 3) identifies mitigation measures to lessen the degree or extent of these impacts. The Environmental Assessment will consider impacts to topics such as water quality, fish, threatened and endangered species, archeology, visitor use, geology, park operations, and socioeconomics.

The Park encourages public participation throughout the planning process. There will be two opportunities to comment formally on the project—once during initial project scoping and again following release of the Environmental Assessment. The Park is currently in the scoping phase of this proposed project, and invites the public to submit written suggestions, comments, and concerns regarding the proposed project online at the NPS Planning, Environment, and Public Comment (PEPC) website at: http://parkplanning.nps.gov/.

If you are not able to submit comments electronically through this website, you may submit written comments at the address on this letterhead. Please provide comments by May 26, 2010. These comments will be considered during preparation of the Environmental Assessment.

We look forward to hearing from you.

Sincerely,

Alan W. Cox
Superintendent

APPENDIX B: ALTERNATIVE B CALCULATIONS – FIXED BREAKWATER AT MOUTH OF HARBOR

Note: There are two primary options for constructing the breakwater.

1. *One is the standard rubble mound. This method requires placement of gravel and rock in a layered fashion from the bottom to the top in a stable shape that prevent collapse (e.g., trapezoid cross-section).*
2. *The other is more vertical and uses caisson style construction techniques. This method uses interlocking coated sheet piles (AZ shape is normally used along the water front) or prefabricated panels locked into H-shaped piles. This method would require extensive analysis to determine thickness and sand/gravel core material, pile type and thickness, and shape (box or circular units) matched to the depth of water and expected static and dynamic loading.*

A. Calculate the height, slope, and configuration of a non wave overtopping rubble mound breakwater at the entrance (50+ year storm design).

Desired Top Elevation = 1115 feet rounded up normal conservation lake elevation + 8 foot flood condition + 7 foot wave height rounded up + 3 feet cover = 1133 feet above sea level (non-wave overtopping breakwater at normal lake elevation).

The expected run-up is calculated from figure 7-15 Wave run-up on impermeable riprap 1:1.5 slope.

$R/H_0 = 0.4$
R= 0.4 (6.5 feet) = 2.6 feet. (Some run up is ok because the top of the wall is wide enough to ensure no water gets to the other side).

Assumptions, we would use:

a) Only rocks for the breakwater construction used that meet Texas and National Highway Standard rock material, that are found in the local quarry, and transport easily to the site using standard highway trucks or barges.

b) Material to be dumped from standard trucks starting at each spit end building out to their new end points just like building a new road.

c) A crest width wide enough to facilitate easy truck movement overtop of the mound; and

d) A rubble mound cross section would be a standard three layer cross section with a quarry core stone center and outer armor stone layer. With the outer layer being the armor layer (weight of stone = W), middle protection and energy absorption

layer (weight of stone = W/10), and foundation layer (weight of stone – W/200 to W/4000).

Calculate desired slope based on no over topping and minor run-up:

Desired slope = 1:1.5 (Vertical distance to Horizontal distance).

B. Calculate the weight of armor rock (W) and minimum thickness of each layer using equation 7-105 page 7-169.

$W = (w_r H^3)/[K_D(Sr-1)^3]$ where:
W = the mean weight of individual armor units in pounds (lbs),
w_r = assumed unit weight of rock (saturated dry surface unit) = 100 lbs/cu.ft.
H = 6.5 ft
K_D = 4.5 = design stability coefficient (varies with roughness and type of armor unit) for rubble mound foundations and toe protection from table 7-6 page 7-170 assuming two layers of thickness and rough angular quarry stone randomly placed for non breaking wave condition.
Unit weight of water = 62.4 lbs/cu.ft. (for fresh water).
Sr = specific unit weight relative to the water on site = 100/62.4 = 1.60

$W = ((100 \text{ lbs/cu.ft})(6.5 \text{ ft})^3)/[4.5(1.6-1)^3] = 650/0.972 = 669$ lbs. (outer layer)
W/10 = 67 lbs (outer middle layer)
W/200 = 3.3 lbs (inner middle layer)
W/4000 = 0.2 lbs (base foundation material and toe protection)

Minimum crest width = $B = nk_d (W/w_r)^{1/3}$ (equation 7-107 page 7-196)
Where n = number of stone layers (minimum three) = 3
k_d = layer coefficient (porosity) from Table 7-10 page 7-196 = 1.15 (for percent porosity of 37 percent)
W = 669 lbs
w_r = 100 lbs/cu.ft
$B = 3(1.15)(6.69)^{1/3}$ = 6.5 feet wide at the crest
This crest width is not wide enough for safe 5-ton truck driving.

Assume AASHTO rules apply to the top of the wall in order to build the rubble mound from the shore line. The top width would be a minimum width to allow two trucks (in bound and outbound) to pass safely.

The top crest width would be 15 feet wide.
The thickness of the outer armor layer is estimated to be 6.5 Feet.

C. The channel entrance width between the east and west breakwater jetties equals the beam of the largest vessel to transit the opening times five to allow for space between inbound and outbound vessels and the breakwater at the average most probable water depth.

If we assume that the maximum beam is 7 feet for a trailer able fishing boat, the opening would be at least 35 feet wide. This seems narrow and does not allow a safety factor for large houseboats, possible fast boat movement and poor seamanship. Add a safety factor of 2.

Use a minimum opening of 70 feet at the lakes lowest level.

D. As shown in Figure A-1, the objective is to keep a safe navigable separation between incoming vessels, outgoing vessels, and the breakwater at all lake levels. The minimum calculated distance is 70 feet for safe two way traffic transit at the lake's lowest level. Because the rubble mound breakwater has a minimum 1V:1.5H slope, the opening becomes approximately 120 feet wide at normal lake level.

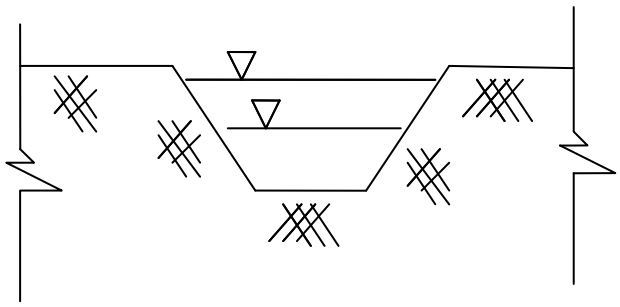

Figure A-1. Overlapping Breakwater Channel Entrance Cross-Section

APPENDIX C: ALTERNATIVE C CALCULATIONS – FLOATING BREAKWATER INSIDE HARBOR

A. Alternative C is a self-adjusting attenuating system consisting of breakwater platforms/docks anchored to the bottom. The docks would float with the lake level and storm wave conditions. There would be no mechanical systems to maintain. The estimated floating breakwater platform characteristics are:

(a) Minimum 6-foot tall with sufficient density to have a 2-foot freeboard and 4-foot draft to adequately breakdown the incoming waves.

(b) Minimum 12-foot wide so that they can double as fishing platforms for use by the general public.

(c) Ability to float with the lake level.

(d) With a land accessible walkway that is connected to a floating breakwater dock Y- section.

B. This breakwater is considered an energy transfer breakwater. Caisson breakwaters or wide dock breakwaters, usually made of concrete, are of this type.

"To be effective, a rigid pontoon or caisson breakwater will have to be positioned with its beam or length exposed to waves. Almost by definition, the structure is placed in harms way. An ill considered design will be less effective, require more maintenance, and will likely sustain more damage than necessary…. The complete design must include an examination of not only the motion response, but also intact stability, hull girder strength, and wave impact strength. The design should have integrated floatation for buoyancy to prevent tanks or compartments becoming flooded."

C. Following this guidance, the placement must be aligned with the wave angle of attack (North-Northwest).

D. Some additional dampening of the wave energy can be achieved by special anchorage and pile securing methods recommended by the manufacturer of the floating docks.

E. For the floating docks, the desired wave transmission coefficient is Ct where

$$Ct = \frac{\text{Height of transmitted wave}}{\text{Height of incident wave}} = \frac{Ht}{Hi} = \frac{1.0 \text{ feet}}{4.0 \text{ feet}} = 0.25$$

F. Using the recommended graph shown in Figure A-2, this results in a L/w = 2.25 and a resulting floating breakwater width = w = 82/2.25 = 36.4 feet wide.

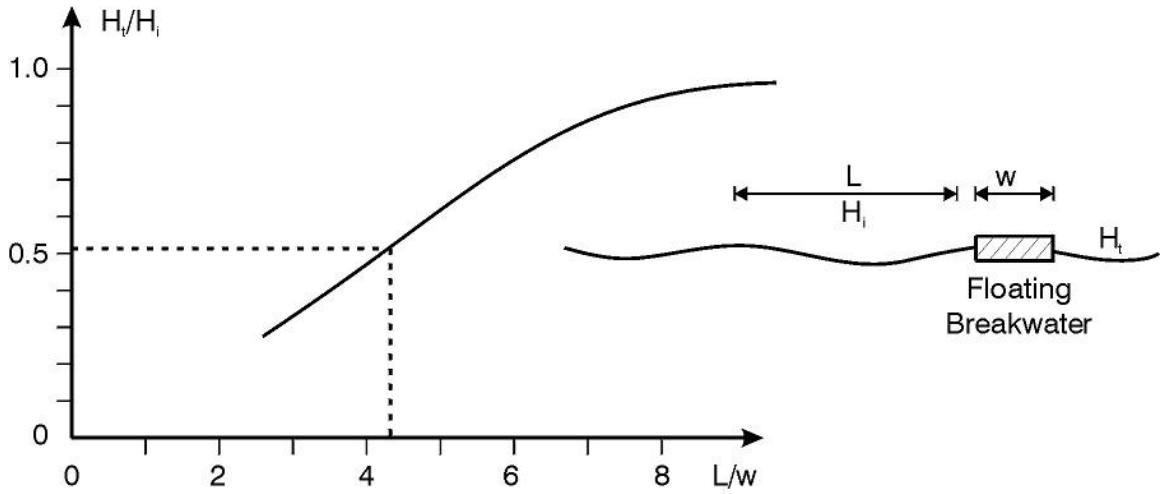

Figure A-2. Recommended graph showing energy absorbing relationship of the incident wave to the floating breakwater and the resulting wave.

G. If we try Ht/Hi = 0.5…. then L/w = 4.2…. with w = 19.5 feet. This has the length of the (concrete) floating dock facing wave as most floats are delivered by truck and must meet the 8 foot maximum highway transportation width limits. Figure A-2 shows the potential lengthwise alignment of the floating breakwater docks to the north-northwest swell.

H. In water depths to 40 feet, an estimated 12-inch diameter steel pipe piles with black coal tar epoxy coating for corrosion protection are desired to support shore access. Steel piles are easily driven into a variety of soils. In water deeper than 40 feet, the breakwater would be floating and secured using anchors. Additional geotechnical information and soil samples are needed to calculate the necessary piles needed to support a portion of the walkway.

APPENDIX D: ALTERNATIVE D CALCULATIONS – FIXED AND FLOATING BREAKWATER COMBINATION

Combine Alternatives B and C without land access to a floating breakwater. The floating breakwater is placed to block wave entering through the a wider mouth harbor entrance (400 feet) between two non-overlapping rubble mound fixed breakwaters placed on top of the existing east and west spits. The floating breakwater is almost in the center of the harbor with sufficient spacing from the rubble mound jetties to allow for safe inbound and outbound two-way vessel navigation.

The calculations for Alternatives B and C apply.

The concrete floating (wave attenuating system) breakwater structure would be held in place with plate anchors and cables sized to match expected loads and bottom soil conditions. The concrete floating breakwater would be sized as discussed in Alternative C in order to adequately break down the incoming waves.

The anchoring system would be sized for the floating docks and subsequent wind and wave loads which depend on a combined vessel and dock load condition. This system is ideal for deeper water and easily adjusts to varying lake levels.

The concrete floating breakwater dock would be accessible by boat only.