National Park Service
U.S. Department of the Interior

Organ Pipe Cactus
National Monument

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Emergency Actions to Stabilize Quitobaquito Pond, and Related Activities

Final Project Report and Revised Biological Assessment
ESA Emergency Consultation #22410-2008-FE-0273
July 2008

Summary:
In 2006 and 2007, the surface elevation of Quitobaquito Pond fell to extremely low levels, unprecedented in the history of the pond since it was dredged and deepened in 1962. Normally averaging about 25" to 40" deep and about 27,000 ft^2 in surface area, by late 2007 the pond averaged 4.5" deep and 70% of its normal surface area. This loss of surface area and total water volume presented imminent threats to the endangered Quitobaquito pupfish (*Cyprinodon eremus*) and the Sonoyta mud turtle (*Kinosternon sonoriensis longifemorale*), a candidate species. Initial evaluations and management actions were based on a belief the water deficit was caused by long-term drought affecting spring discharge, and overdue maintenance of the spring collection system. While those factors contributed to diminished water supply, by late 2007 additional evaluation and rapid water loss indicated substantial loss of water from the pond itself, over and above normal evaporation and plant transpiration. A leak in the retaining berm forming the pond, or elsewhere in the pond margin or bottom, was strongly suspected.

As the water level reached new record lows in October 2007 and April 2008, Quitobaquito pupfish and Sonoyta mud turtles were evacuated to temporary holding facilities at monument headquarters, the Arizona-Sonora Desert Museum, Cabeza Prieta National Wildlife Refuge, and the Phoenix Zoo. Also in autumn 2007 and spring 2008, trees and shrubs were removed from the retaining berm to allow access to, and inspection of, the berm. In April-May 2008, a diaphragm wall was installed down the centerline of the retaining berm, in an attempt to stop suspected subsurface leaks and seepage. Diaphragm wall construction included excavating a trench 1 ft wide and 5.5 to 6 ft deep, using a small "cat track" excavator Then, plastic pond liner material was suspended against the "outside" (away from the pond) wall of the trench, as a supplemental water barrier. The trench was then backfilled with a dry concrete mix, to a level averaging about 14" below the original berm surface, an elevation approximately equal to the pond outflow pipe. The top of the backfilled concrete was wetted, then the trench was filled the rest of the way with earth excavated from the trench. The trench was then compacted by driving a 3.5 ton "bobcat" loader over it. The berm was then re-contoured to approximate the original, although excess spoil earth resulted in the berm being slightly wider, and in some areas higher, then the original. The diaphragm wall is approximately 341 feet long, running from the west bench to the east bench. During trenching, damp earth was excavated from the berm interior, along the western 220 feet of the berm. Trenching also revealed two areas of saturated soil and/or tree roots; one at the "leaning cottonwood" and the other adjacent to the "bee willow." These trees were two of the points most suspected as possible areas where leaks may be occurring. These findings encourage

optimism that the diaphragm wall may substantially reduce water seepage from Quitobaquito Pond.

The diaphragm wall project was carried out primarily by NPS staff on base park funding. The NPS Water Resources Division provided a generous emergency contingency fund allocation for materials, equipment, supplies, and other project-related costs.

Compliance

Endangered Species Act: This project was carried out under the emergency provisions of Section 7 of the ESA. An emergency consultation (#22410-2008-FE-0273) was established with the USFWS, and a preliminary biological assessment submitted. This document serves as the final post-project biological assessment.

National Environmental Policy Act: This project was carried out under categorical exclusion 3.4C(3): Routine maintenance and repairs to non-historic structures, facilities, utilities, grounds, and trails. (NPS Director's Order 12). Although the berm is considered to be an historic structure, effects on the structure were not significant, as defined by NEPA. This finding allowed use of a categorical exclusion. Compliance documents for this project are stored in the NPS' Planning, Environment, and Public Comment (PEPC) online database, project number 21711.

National Historical Preservation Act: Because cultural resources are present, but the action will be undertaken to preserve cultural (and natural) resources, a No Adverse Effect assessment is warranted. Under the current PA between the NPS and NCSHPO, a short test trench was excavated under Programmatic Exclusion IV.B.4 (archeological monitoring and testing). The longer trenching along the length of the berm was conducted under Programmatic Exclusion IV.B.1 (preservation maintenance). A professional archeologist was present during all trenching activity; a report on his discoveries is part of the administrative record for the project.

Project Area

The project area is Quitobaquito Pond, in Organ Pipe Cactus National Monument (Figure 1). The Quitobaquito area, which includes the springs, stream and pond, lies on the international border, within the Rio Sonoyta watershed, approximately 14 miles west of Lukeville, Arizona. Quitobaquito springs originate from the Aguajita Wash aquifer and rise from the fractured granite and gneiss of the Quitobaquito Hills. The two largest springs are captured and conducted into a manmade (gunnite) stream channel, which flows south approximately 800 feet (244 m) to the pond. Other springs in the immediate area result in small natural seeps with no significant pooled water. During heavy rains, outflow from the pond joining with adjacent arroyos and surface sheet flow may temporarily establish a surface water link between Quitobaquito Pond and the Rio Sonoyta, one mile to the south. Although Quitobaquito lies mostly within designated wilderness, Mexico Highway 2 also lies approximately 100 meters (328 ft) to the south and is primary land transportation link between mainland Mexico and the Baja California peninsula. Quitobaquito is internationally recognized as a unique, rare desert oasis supporting an exceptional assemblage of wetland organisms including endangered, rare, endemic, and cultural heritage species, and a locally high biodiversity. The Quitobaquito area has traditionally been used by Native American Indian tribes, park visitors, scientists, and as an illegal border crossing point. The latter use currently ranges from serving as a *de facto* rest stop along Highway 2, to functioning as a staging point for smuggling and illegal immigration. Currently, the Quitobaquito area is closed to the general public, due to safety concerns.

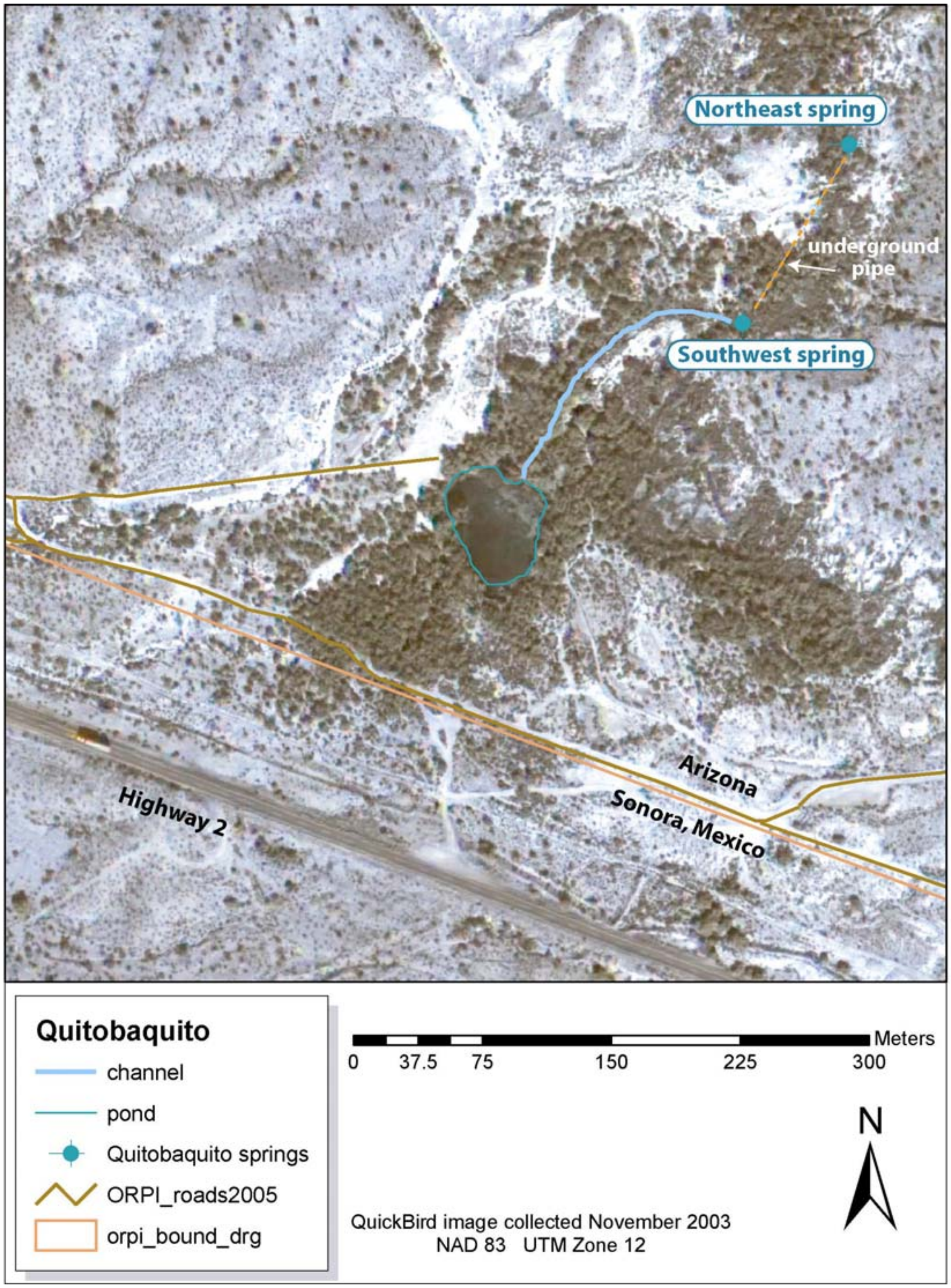

Figure 1. Quitobaquito Springs and Pond, Organ Pipe Cactus National Monument, Pima County, Arizona.

Ground disturbance took place only at the retaining berm forming the southwestern edge of Quitobaquito Pond (Figure 1). We consider the project area to be part of critical habitat designated for the desert pupfish (March 31, 1986 (51 FR 10842). The designation includes:

> "Quitobaquito Spring, approximately 25 miles (sic) WNW Lukeville, Arizona, in Organ Pipe Cactus National Monument, Pima County, Arizona. T17S, R8N; and a 100-foot riparian buffer zone around the spring."

The following endangered species occur in the project area:

Quitobaquito pupfish (*Cyprinodon eremus*)
Sonoran pronghorn (*Antilocapra americana sonoriensis*)
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuanae*)

Background

Quitobaquito Pond was last dredged, deepened, and the retaining berm enlarged, in 1962. Since then the pond has averaged about 25" (north shore) to 40" deep (south shore) and approximately 27,000 square feet in surface area. The maximum surface elevation is controlled by an outflow pipe placed in the retaining berm. Until the early 1990s, water commonly flowed through the outflow pipe most of the year. A long-term drought began in the early-mid 1990s, and continues today. With diminished rainfall, spring discharge has also gradually diminished, from approximately 25-30 gpm in the early 1990s to 15-19 gpm in recent years. With diminishing spring input and extending drought, water has rarely flowed through the outflow pipe after 1997. Minor seasonal fluctuations in surface elevation were common, with the pond level lowering slightly during the spring and autumn dry seasons. Seasonal reductions were typically 2" to 4", with the pond rarely dropping to more than 6" below the outflow pipe. In July 2005, a record low level of 11.5" below the outflow pipe was recorded. The pond then quickly recovered to minus 4" after summer rain input.

In 2006 and 2007, the surface elevation of Quitobaquito Pond fell to extremely low levels, unprecedented in the history of the pond in its current configuration. Until 2006, the pond typically averaged about 27,000 ft^2 in surface area, and about 34" to 40" deep at the south shore (O" to 6" below the outflow pipe). In 2006 and 2007, the surface elevation reached new record low levels, of minus 18" and minus 23.25" respectively. The latter level was reached when the pond level fell more than 15" in 45 days in September-October 2007, a time when the pond experienced rain input and reduced evaporation losses. This low level resulted in the pond bottom being exposed in some areas, with additional areas only 1" to 2" deep. This loss of surface area and total water volume presented imminent threats to the endangered Quitobaquito pupfish (*Cyprinodon eremus*) and the Sonoyta mud turtle (*Kinosternon longifemorale sonoriensis*), a candidate species. With loss of the pond seeming imminent, 1,048 Quitobaquito pupfish and 13 Sonoyta mud turtles were evacuated to temporary holding facilities at the Arizona-Sonora Desert Museum.

In 2006 and early 2007, initial evaluations and management actions were based on a belief that the water deficit was caused by long-term drought (affecting spring discharge) and overdue maintenance of the spring collection system. While those factors certainly contribute to diminished water supply, by late 2007 additional evaluation and rapid water loss indicated substantial loss of water from the pond itself, over and above normal evaporation and plant transpiration. Water budget calculations for the Quitobaquito system resulted in an estimate of over 9 gallons of water per minute being lost to an unknown cause, in March 2008 (Attachment

I). A leak in the retaining berm forming the pond, or elsewhere in the pond margin or bottom, was strongly suspected.

Throughout 2007 and early 2008, Organ Pipe staff carried out extensive examination, monitoring, and management of the Quitobaquito system. The monument was substantially assisted in this process by hydrogeologists and hydrologists from the NPS Water Resources Division and Intermountain Region/Inventory and Monitoring network (SODN). We also consulted additional authorities in a variety of state, federal, and Tribal agencies. In April 2007, the northeast spring collecting pipe was replaced. It had last been replaced in 1989. Once excavated, no apparent occlusions or other problems were found in the old pipe. After installing a new collecting pipe, no net increase in spring discharge was achieved. Through summer 2007, NPS staff cleared emergent vegetation from the southwest spring (an open trench) and the stream channel. Several locations were located where water was being lost from the stream channel, due to ground subsidence changing the vertical alignment of the channel. Some of these areas were repaired, by building new, higher concrete rims on the channel. These actions reduced the net loss of water from springheads to pond, from about 5 gpm to just over 1 gpm. By July 11 2007, the pond level had gradually lowered to a new record low of minus 20.2". With the onset of summer rains, the pond level recovered to minus 8.1" by September 6. However, between September 6 and October 22, the pond level fell precipitously to -23.25" at a steady rate of 0.33" per day. After estimating losses to evaporation and plant transpiration, this lowering level was estimated to be due to loss of approximately 14,000 gallons/day, or 9.6 gpm, due to unknown causes, (Spring input was approx. 19,440 gallons/day, and pan evaporation rate estimated to be 3,871 gal/day). While evaporation and transpiration losses were potentially coarse estimates, the precipitous loss of water during autumn months was unprecedented, when compared with other years having similar rates of spring input, and losses to transpiration and direct evaporation (Appendix I).

Quitobaquito Pond reached minus 23.25" on October 22, 2007, and held at that level through November 27 (47 days). That stable surface elevation, immediately following a 45-day-long precipitous drop, led NPS staff to believe there was likely a leak in the pond perimeter at or near the minus 23.25" level, which was maintaining the pond surface at that level. The pond level increased to minus 20.5" from November 27 to January 8, 2008. This increase corresponded with over 3" of rain in the area. Staff speculated that rain input, combined with slightly increased spring input and reduced winter evaporation and transpiration may have allowed system inputs to temporarily exceed the rate of a leak.

In October-December 2007, NPS staff made numerous detailed examinations of Quitobaquito Pond in attempts to locate a leak. We removed extensive vegetation from the retaining berm to allow close inspection of the berm. We examined the land and vegetation adjacent to the pond on all sides, searching for damp earth or unusual, local "greenup" of vegetation, or other indications of seepage. We inspected the inside bank of the entire pond perimeter for possible leaks. No leak was located. We did not interpret those negative findings as disproving the likelihood of a leak. Instead, we suspected a significant leak could take place entirely below the ground surface, with water moving down into the earth leaving no surface evidence. A major suspected source for this type of leak is the presence of large trees on the retaining berm. After the 1962 berm enlargement, no effort was made to control vegetation growth on the berm. As a result, by January 2008 there were 18 medium-to large mesquite trees, both live and dead, rooted on the berm. There was also one large (but decadent) Goodding's willow, several large wolfberry, and a large, decadent Freemont cottonwood, all growing on the berm. The latter tree, subject of many photographs, is rooted in the crest of the berm, and has progressively leaned into the pond to the point where now the trunk is oriented horizontally for about 5 meters, at the typical water surface elevation. The tree is decadent, with open cavities observable and palpable in the main trunk and root base.

Growth of trees on earthen dams is a well-known threat to their structural integrity (Please see: www.fema.gov , document: fema_1263[1].pdf; http://www.dcr.virginia.gov/dam_safety_and_floodplains/dsveget.shtml; http://www.deq.state.ms.us/MDEQ.nsf/page/L&W_FAQs_for_Dam_Safety?OpenDocument; http://dnrc.mt.gov/About_Us/publications/damnews05.pdf http://www.in.gov/dnr/water/dam_levee/inspection_man/pdf/Part4-FactSheets/03-09TreesandBrush.pdf

The presence of 26 live and dead trees along the approximately 90-meter (340 feet) length of the berm presented a strong possibility that roots of at least one tree may have created a conduit for water to flow out of the pond into the surrounding earth. Quitobaquito Pond is underlain by highly fractured bedrock at fairly shallow depth. It is possible water could be moving through the berm and down into the bedrock at a relatively steep angle, leaving no surface evidence.

Park staff also investigated the possibility of theft of water from Quitobaquito; no evidence of this was found.

The apparent large-scale loss of water from Quitobaquito Pond was a direct and imminent threat to multiple resources. As aquatic organisms the Quitobaquito pupfish and Sonoyta mud turtle were most imminently threatened. With the 2008 spring dry season approaching with temperatures exceeding 100°F, the pond was expected to lower in surface elevation again. On January 16, 2008, the pond surface was at minus 20.5", more than 13" lower than ever recorded in January of any year. At this low level, there was no margin of comfort. In the previous 2 years, the pond had lowered more than 12" during the spring dry season, March-June. If Quitobaquito Pond were to lower by 12" from minus 20.5", the pond will essentially cease to exist (Figure 2). All that would remain would be a small pool of approximately 300 square feet, 10" deep, in the southeast corner. Very large losses of Quitobaquito pupfish would occur – possibly 7,000 to 10,000 individuals of the 12,000 to 15,000 we estimated to be present in September 2007 (approximately 50% to 85% of the Quitobaquito population). About 2000 to 3000 will remain in the channel system, where water supply remains stable. Similarly the Sonoyta mud turtle would face loss of perhaps 75% of the population. Beyond these impacts on special-status wildlife, Quitobaquito supports other important resources. The area presents cultural, aesthetic, archaeological, and visitor-experience resources which are all closely connected to presence of Quitobaquito Pond. If the pond was not stabilized and re-established, these resources would be substantially impaired.

In April-May 2008, we discovered another threat to Quitobaquito pupfish resulting from low water levels. During this time, the pond surface was 24" to 26" below the outflow pipe, leaving most of the remaining pond only 1" to 4" deep. This made pupfish vulnerable to piscivorous birds, in a way they are not when the water is deeper (Figure 3). During this time period (during the diaphragm wall construction described below), we observed mixed groups of wading birds feeding heavily on pupfish, a phenomenon seen rarely if at all at normal water levels. Depradating birds included great egret, snowy egret, green heron, black-crowned night heron, black-necked stilt, and white-faced ibis. The latter two species are known more for feeding on invertebrates. However, at Quitobaquito they methodically took smaller pupfish from very shallow water. With up to 15 or 20 predatory birds sometimes present, we estimated up to 100 pupfish per hour were being predated during some parts of the day. This predation problem diminished in May, after the bird migration season had passed.

Figure 2. Quitobaquito Pond at minus 26” level. May 2, 2008. Panoramic view looking southeast from the west viewing bench. The exposed brown flats of mud and detritus would normally be covered by 18” to 26” of water. Most of remaining pond is 1” to 4” deep. Organ Pipe Cactus National Monument, Arizona.

Figure 3. Snowy egret, great egret, and white-faced ibis feeding on Quitobaquito pupfish in abnormally shallow water. May 1, 2008. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

Emergency Actions

On April 4, 2008, in a letter and biological assessment submitted to the U.S. Fish and Wildlife Service, we proposed to take a series of actions, described and updated below. The goals of these actions were to restore a stable water level in Quitobaquito Pond, adequate to prevent imminent losses of Quitobaquito pupfish and Sonoyta mud turtles, for the near term (1 – 3 years). Specific actions included removing trees from the retaining berm, reinforcing the retaining berm by installing a diaphragm wall, evacuating additional Quitobaquito pupfish temporarily, and temporarily damming the “turtle moat” to create a refuge pool for pupfish and mud turtles. Following these interim actions, the monument will develop a long-term management plan for Quitobaquito Springs. The actions described below were developed after extensive consultation with hydrologists, hydrogeologists, ecologists, biologists, and additional authorities in a variety of state, federal, and Tribal agencies. The actions were devised to attempt to address the low-water issue using the least intrusive means possible, to correct the most likely cause of water loss – a defect in the retaining berm. It is possible these actions will not correct the problem of water loss from Quitobaquito. If water is being lost through the bottom on the pond, these actions will not correct the problem. However, these actions constituted important and overdue maintenance of the berm, and will strengthen it for the future. During project execution, moist earth and saturated, rotting tree roots were found in the berm interior. These observations provide encouragement that the diaphragm wall may actually stop substantial leakage that was occurring. If the actions described below do not correct the water loss, the monument and its cooperators will need to consider the next level of action(s), which could include more intrusive measures, such as draining, lining, sealing, and/or substantially reconfiguring Quitobaquito Pond.

Temporarily Damming the Turtle Moat

The “turtle moat” was constructed in the northeastern shore of Quitobaquito Pond in 1989, as part of the springhead renovation and spring channel construction. The turtle moat is a shallow portion of the pond perimeter, separated from the rest of the pond by a small island. Typically, the moat water is an area approximately 120 feet in length and 3 to 5 feet wide. Water depth in the moat varies with pond elevation, but is always relatively shallow, e.g. 8” to 10”at normal pond levels. Having open, shallow water exposed to full sun, the moat has traditionally supported high densities of pupfish. The spring channel from the springs empties into the moat, thus supplying the pond.

At pond levels below approximately minus 21” (as in March 2008), the moat no longer provides pupfish habitat. It consists of flats of exposed mud, detritus, and algae, with little or no open water. At the west end of the moat, the channel water flows through as a narrow, high-gradient stream en route to the pond. The stream channel flow formerly entered the moat at a low gradient at the water surface. At pond levels below approximately minus 21”, the stream channel flow enters the moat in a stairstep series of small cascades, 2” to 4” high, which may not be navigable by pupfish. That is, pupfish are probably not able to move between the pond/moat system, and the stream channel.

We proposed to re-establish pooled water in the moat, providing a refuge pool for pupfish and mud turtles, while the pond level is at extremely low levels. This action was carried out April 22, 2008, prior to constructing the diaphragm wall. This was accomplished by damming the east and west ends of the moat (Figures 4 and 5). Damming the moat at both ends allowed it to fill to a depth of approximately 9 inches at the west end, and 16 inches at the east end. The moat was dammed using bricks and concrete blocks, forming obstructions approximately 12” to 18” high in both ends of the moat. These block obstructions were then covered with 45 mil pond liner material, to make them water-impermeable. The pond liner material was weighted down with additional bricks and blocks placed on top of the material to hold it in place. The dams worked, re-establishing the moat as a pool perched slightly above the current pond level.

Damming the moat re-established the moat pupfish habitat – approximately 600 to 900 square feet of water, at depths ranging from 9” to 16”. This was intended to provide a net increase in the habitat available to pupfish, during the current low-water situation. This action created a refuge pool of sufficient size to support at least 2,000 to 4,000 pupfish. To initiate re-population of the moat, 823 pupfish were moved from the pond to the moat (647 on April 23, and 176 on May 7). Pupfish were captured in the pond using minnow traps, which were emptied into 5-gallon buckets with pond water, and immediately carried to the moat and released.

Originally, we anticipated that once the moat filled to the top of the dams, water would resume flowing freely from the moat into the pond, at a rate comparable to typical channel flow (17 gpm). We anticipated either allowing the water to simply cascade into the exposed mudflats of the north side of the pond, or the outflow from the moat would be directed through a length of 3” or 4” diameter PVC pipe, cut in half lengthwise to form an open trough. The trough would conduct the water farther out toward the former center of the pond, to deliver it to the shrinking remains of open water. As it turned out, the moat re-filled to a depth barely reaching the top of the eastern dam, then stabilized. At that point, it appeared the imperfect seal of the pond liner material on the dams and adjacent bulrush was allowing water to seep around the dams and flow into the pond margin. A small quantity of water spilled over the top of the eastern dam.

When the moat was dammed April 23, the pond level was minus 24.5”, having fallen 0.8” since April 1, or about 0.036” per day. By April 30, the pond had fallen to -26.0”, or 0.214” per day. Although temperatures increased during this period (increasing evaporation), we became concerned that not enough of the channel flow was passing through the moat to the pond, resulting in a drop in the pond level. The pond held at -26.0” May 1 through May 7, diminishing our concerns with this. However, during this period we became aware of indications the north side of the pond, adjacent to the moat, was experiencing increased moisture in the ground and mats of dead bulrush. Fresh green bulrush shoots were seen, and hand-dug holes revealed water under the ground surface. By May 21, the pond had fallen again, to -28.5", the all-time record low at this time. On that day, we lowered the west moat dam by approximately 8". This lowered the water surface level of the moat to below the top of the pond liner material installed in the moat in 1989. As a result, beginning May 21 the moat remained impounded, but at a shallower water depth – approximately 6" at the west end and 10" at the east. May 21 and 27, the water flowing over the west moat dam was approximately equal to the stream channel (spring input) flow. Between May 21 and May 27, the pond level rose from -28.5" to -27.2"and then higher to -26.75 by June 4. An anomalous rain event May 22-23, totaling 0.69" at Quitobaquito, accounted for some, but not all of this increase of 1.75". We believe adjusting the moat dam to restore full channel flow to the pond was also a likely factor.

Originally, we proposed that the temporary moat dams would be left in place until the pond level rises above – 19.00" either in response to berm repairs (see below) or summer rain input. This plan remains essentially unchanged. The only change is to note that the -19" level is an approximation of the pond level that would begin to re-inundate the moat. Our intent is to remove the moat dams when the rising pond reaches the moat, whatever actual level that may be --19" or -17.5". Also, we may further modify the dams, or remove them, if there is further indication that the moat impoundment is depriving the pond of too much water.

Figure 4. Impounded moat, view over eastern dam to remaining pond.
Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

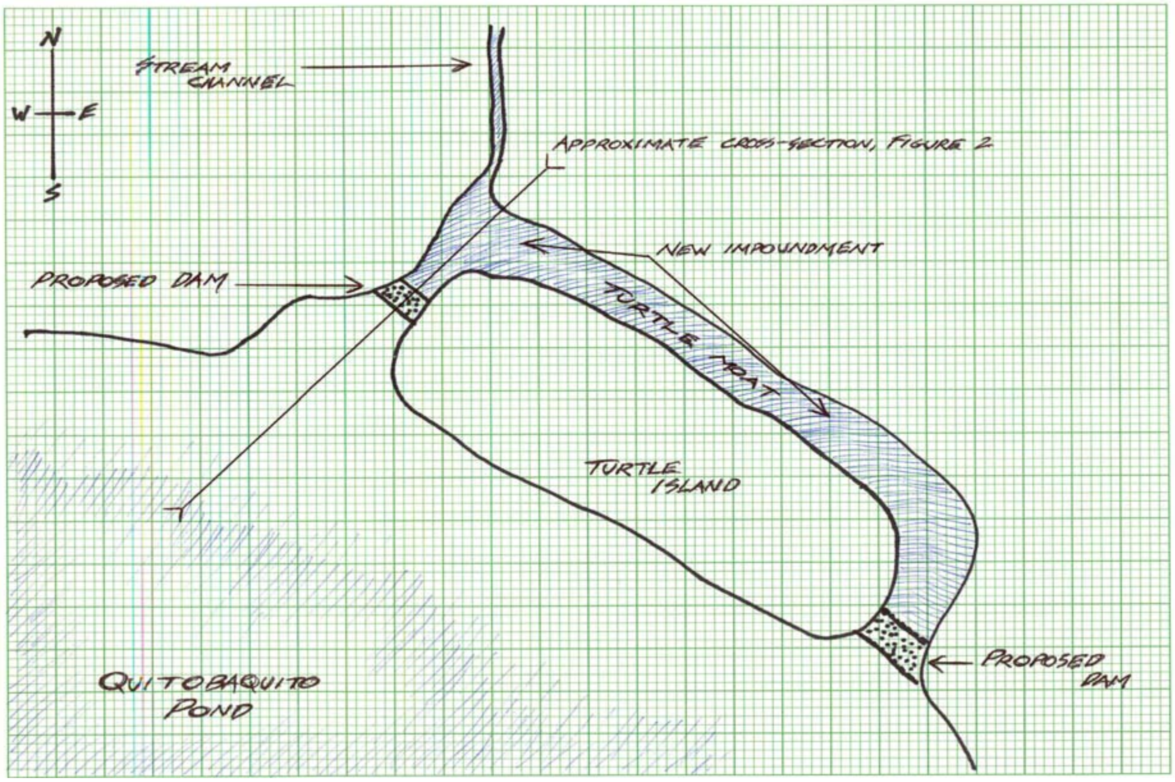

Figure 5. Schematic overhead view of temporary impoundment of turtle moat, Quitobaquito Pond. Organ Pipe Cactus National Monument, Arizona. Not to scale.

Removing Trees From Quitobaquito Retaining Berm

All trees growing on the retaining berm were removed, except the large leaning Fremont cottonwood (Figures 6a and 6b). Cutting down these trees and preventing regrowth will prevent additional growth of their root systems into the berm and new diaphragm wall. Removing the existing trees was viewed as catching up on overdue maintenance, because the trees should not have been allowed to establish on the berm at all. Chainsaws and handsaws were used to cut trees down, and into pieces that could be carried by hand, wheelbarrow, and hand-cart to the west parking area. The “bee willow” at the southeastern corner of the pond was removed first, to eliminate the recurring problem with Africanized honeybees in the work area. This tree had numerous large interior cavities, some extending deep into the root system. Following installing the diaphragm wall, the larger portions of this tree’s root mass were dug out with a backhoe, and soil was packed into the resulting void at the pond edge (Figure 7). All other trees were cut off flush with ground level, except three mesquites at the pond edge of the berm, whose root masses were also pulled out with a backhoe. Cut trees were carried out to trucks and removed from Quitobaquito. Smaller branches were taken to the monument’s brush dump. Intermediate-sized branches (3” to 4” diameter) were saved for possible use in reconstructing corrals at historic ranching structures in the monument. Large pieces (e.g. > 6” diameter) are stored at a brush storage site. Future tree regrowth will be controlled manually, and/or by herbicide (e.g. Garlon or Roundup), applied using only compounds and methods that will pose no potential harm to Quitobaquito pupfish, Sonoyta mud turtles, and other aquatic organisms. For example, to eliminate wind drift, herbicides would be applied from within 6 to 8 inches using hand-held spray bottles. Some tree branches fell from the berm into the southwestern edge of Quitobaquito Pond; all such branches were immediately removed from the pond.

Figure 6a. The retaining berm, view to the northwest from near the spillway. Note the leaning cottonwood in upper right. Understory shrubs and dead lower tree branches had been removed to allow this view. Note large mesquite trees rooted in the berm. November 15, 2007. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

Figure 6b. The retaining berm after clearing trees and shrubs and installing the diaphragm wall. View is from approximately the same point as Figure 6a. Note leaning cottonwood tree in upper right. May 1, 2008 Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

Figure 7. Removing "bee willow" stump and roots from the inner side of the retaining berm. May 5, 2008. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

All maintenance and refueling of chainsaws was done downslope of Quitobaquito Pond, that is, in the west-side parking area downslope of the pond's edge, or below the toe of the outer slope of the retaining berm. No leaks of fuel or oil occurred. During sawing, the bar oil regulator was set at a minimum flow, to reduce oil being introduced into the environment.

The horizontal trunk of the leaning cottonwood was to some extent sealed and supported by building an earthen pier or peninsula around and underneath the trunk (Figure 8). Sufficient earth was packed around the trunk to isolate it from open water in the pond. Approximately 5 cubic yards of material were used in this action. Earth used in this action was spoil dirt from the berm trench (see below), and spoil earth from the April 2007 northeast springhead renovation.

The area immediately adjacent to the tree trunk, and beneath it, was inspected for Sonoyta mud turtles prior to building the earthen pier. None were found.

Originally, we identified a possible need to construct a small vinyl coffer dam to complete this step, to isolate the earthworks from the pond water, to avoid excess sedimentation and turbidity in the pond. As it turned out, this was not necessary or desired. The pond around the cottonwood consisted of about 2" clear water lying over approximately 24" depth of flocculent detritus. The disturbed detritus did not result in sedimented, turbulent water anywhere except in the immediate work area, i.e. within about 3 feet. Building a vinyl coffer dam would simple have resulted in yet another area of disturbed detritus and sediment, in an arc concentric to the work area. Finally, building a vinyl coffer dam would have required driving stakes into the firm bottom of Quitobaquito Pond. With the water loss still not completely located, we were reluctant to perforate the pond bottom with support stakes.

Figure 8. The leaning cottonwood, after packing earth around the lower trunk.May 7, 2008. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

Installation of a Diaphragm Wall

By late 2007, monument staff strongly suspected a defect in the retaining berm as a likely area for the loss of water from Quitobaquito Pond. In late 2007 and early 2008, available information and knowledgeable authorities were consulted to develop alternatives for dealing with water loss via the retaining berm. Alternatives considered included:

1. Taking no action.
2. Rebuilding the berm, by digging up the existing berm, removing all tree roots, and rebuilding a new berm in the same location using the original material and/or imported material.
3. Widening the berm by building a new inner face of imported material, to cover over leakage areas.
4. Installing a "diaphragm wall," a water-impermeable barrier within the existing berm.

We selected the diaphragm wall alternative, for a number of reasons. These included:

1. A diaphragm wall would have a good chance of effectiveness.
2. A diaphragm wall installation would involve no disturbance in the pond, and no need to drain the remaining pond, thus avoiding impacts on pupfish and mud turtles.
3. A diaphragm wall would have the least impact on the cultural and aesthetic landscape of Quitobaquito.
4. Installing a diaphragm wall would involve excavating a slit trench down the length of the berm, allowing examination of the berm interior for water movement, berm construction, and other possible defects.
5. A diaphragm wall would be relatively inexpensive.

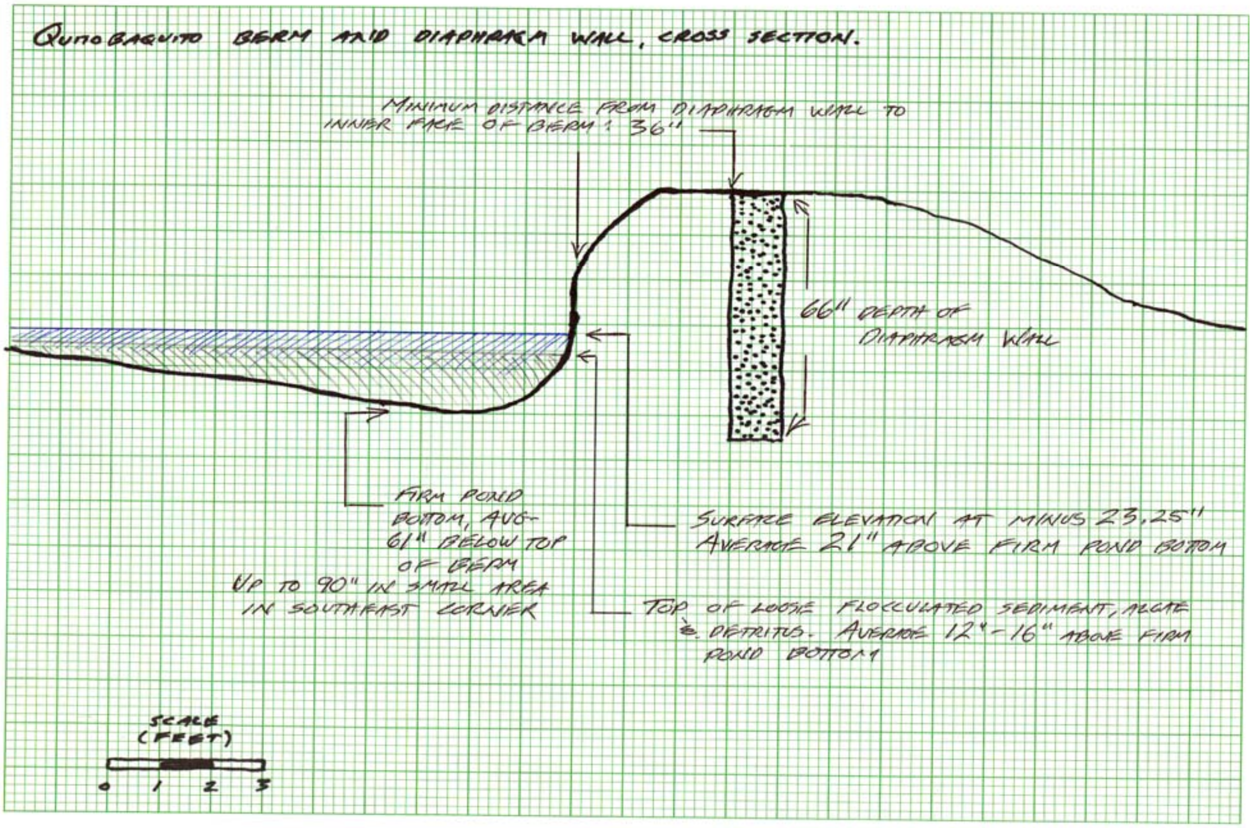

Figure 9. Schematic cross-section of retaining berm at Quitobaquito Pond, including diaphragm wall. Diagram illustrates water level of 23.25” below outflow pipe. The diaphragm wall as built is 66” to 72” deep. Organ Pipe Cactus National Monument, Arizona.

Once the monument elected to construct a diaphragm wall, the National Park Service Water Resources Division generously provided emergency contingency funding to cover expenses for equipment, material, supplies, and related costs. The project was carried out April 28 through May 6, by staff from Organ Pipe Cactus National Monument, Petrified Forest National Park, and Cabeza Prieta National Wildlife Refuge. A day-by-day project summary including building the diaphragm wall is presented in Appendix I).

The intent of the “diaphragm wall” was to: 1) Repair some damage caused by tree root infiltration, 2) Sever tree roots that pass through the berm, and; 3) Reinforce the berm with a water-impermeable wall, placed along the plane where tree roots are severed. This action, or a similar action, would have been necessary in the near future, regardless of the current low water situation. The berm has been essentially unmaintained for almost 50 years, so some form of maintenance and/or repair was needed to preserve the structure.

The diaphragm wall consists of an unreinforced wall of concrete, backed on one side by pond liner material, approximately 1 foot wide, 4.5 to 5 feet high in a trench 5.5 to 6 feet deep, and 341 feet long (Figure 9). The wall was constructed down the center of the retaining berm, working from the observation bench at the pond’s west bank, to the bench on the east bank. The construction sequence was:

1. A small track-cat trencher on rubber tracks excavated a trench 1 foot wide and 5.5 to 6 feet deep. During project planning, we anticipated that the walls of this trench would likely collapse to some degree, resulting in a "V"-shaped trench with somewhat uneven sides. We recognized a potential danger to the overall integrity of the berm from this effect, and were prepared to modify or suspend the project if the problem became unmanageable. Fortunately, the berm material and skill of the trencher operator resulted in a trench that was identical to our ideal plan. The trench was a uniform slit trench 1 foot wide and 5.5 to 6 feet deep. The trench ran 341 feet in length, and was 3 to 5 feet from the the inner face of the berm (Figure 10). Small deviations from a straight line were made to avoid trenching directly through the center of tree root masses. By passing next to, rather than through root mass centers, we discovered the trench could be excavated neatly, cutting through the subsurface roots. An archaeologist was present during trenching to examine excavated material for artifacts (Beckwith 2008). Excavated earth was placed on the outer, downstream (southwest) face of the berm. Little or no excavated material fell over the inner face of the berm, so no sedimentation/turbidity issue existed for the pond water. At the current low level the water's edge was 1 to 5 feet from the inner face of the berm. Materials for shoring up the trench walls were available on site, but were not necessary. The trench walls remained intact, and no workers entered the trench once it was deeper than about 4 feet.

Figure 10. Excavating trench for installing a diaphragm wall in the retaining berm. April 29, 2008. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

2. As tree roots were encountered during trenching, smaller roots were simply torn up as the soil was excavated. Their remaining loose ends were cut with pruners and loppers, flush with the inner trench walls (Figure 11). Larger roots were sawn through with handsaws and chainsaws. Originally, the route of the trench was expected to deviate around the base of the leaning cottonwood tree, curving down the berm face, to the base of the berm, to swing wide around the tree. The intent of this was to avoid severing large cottonwood roots that may be holding the tree up. However, trenching proceeded carefully along the berm top, curving slightly outward to avoid the base of the cottonwood. No large roots were encountered, so the diaphragm wall alignment stayed essentially on top of the berm, immediately adjacent to the point where the cottonwood trunk emerges from the berm top surface.

Figure 11. Worker on the right is using pole pruner to trim roots in the trench for diaphragm wall in the retaining berm. Worker standing on the left is an archaeologist monitor examining excavated earth for cultural resources. April 29, 2008. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

3. The pond outflow pipe was maintained intact, to preserve the pipe as a constant fixed reference point to measure the pond surface elevation.

4. Originally, we planned for the trench to divert around the outer (southern) edge of the concrete spillway in the southeast corner. However, the trench was excavated along the inner face of the spillway. This was done because it was feasible with the small cat-track trencher, and this route avoided approximately 20 extra linear feet of trenching that would have resulted from going around the spillway. The direct route across the inner face of the spillway also avoided cultural resources.

5. After about 30 feet of trench were excavated, a water-impermeable curtain was placed against the wall of the trench farthest from the pond (Figure 12). For the western 170 feet, a relatively thin (20 mil) but stiff pond liner/ground cover material was used (Permalon high-density polyethylene). For the eastern 171 feet, a thicker (45 mil), more pliable pond liner of EPDM (ethylene propylene diene monomer) was used. The material was cut into 5-foot wide strips, in lengths ranging from 10 to 20 feet. The material was hung against the trench wall by attaching large plastic alligator-type clips to the top of the curtain. An 8-ft cord was attached to each clip at one end, and was then tied to a rebar stake placed in the excavated soil on the south side of the trench. The 5-ft high vinyl curtain was hung so it reached the bottom of the trench, with the top of the curtain approximately 6" below the top of the berm (well above highest possible pond surface elevation). The ends of adjacent strips were overlapped by 12" to 18". No glue was used.

Figure 12. Pond liner material is suspended against the outer wall of the trench, to form a supplemental water barrier. April 30, 2008. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

6. After 10 to 20 linear feet of the pond liner material was in place in the trench, backfilling with concrete was done. An “amended mortar” dry concrete mix of approximately 4:1 ratio (gravel to cement) was prepared in the eastern (public) parking area. This mix was then transported to the western parking area adjacent to the pond. From there, a small “bobcat” loader carried the mix along the berm. The mix was poured from the bobcat’s bucket into a “V” shaped funnel formed by one or two workers holding plywood sheets on either side of the trench (Figure 13). This funnel prevented spills of concrete mix outside of the trench, and also directed the mix so that none fell between the pond material curtain and the trench wall. The dry concrete mix was backfilled to a depth approximately 14” from the top surface of the berm, or the approximate elevation of the outflow pipe (Figure 14). Once backfilled to that elevation, the concrete mix was wetted by spraying with a water truck hose. The trench was then backfilled to the approximate original level of the berm surface, using the original excavated material and hand shovels. The plastic alligator clips were removed from the pond liner material at this point. This soil was also then wetted, and the bobcat driven over the filled trench repeatedly, to compact the backfilled material. Final smoothing and contouring of the berm surface was done using the bobcat, rakes, and shovels. At the northwest end of the berm where its elevation above the ground south of the pond is greatest, the exposed new soil slope was covered with jute erosion fabric and mesquite branches (Figure 15).

The diaphragm wall is 341 feet long, 1 foot wide, and approximately 5 feet high, for a total volume of 1,705 cubic feet (63 cubic yards). Building the wall required 75 tons (40 cubic yards) of aggregate gravel, and 9,975 lbs of Portland cement (210 bags at 47.5 lbs each).

The trench was left open no longer than about 2 hours in any section, with most areas open approximately one hour or less. At the end of each workday, almost all fully-excavated trench was backfilled. Most work days, a trench about 6 to 10 feet long, sloping down to 6 feet depth remained unfilled. At the end of each work day, this trench was covered with plywood.

Figure 13. Pouring dry concrete mix into diaphragm wall trench. April 29, 2008. Retaining berm, Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

Figure 14. Progression of diaphragm wall construction. Trench in background is being excavated, in the middle ground is ready for backfilling, and in foreground has been backfilled with dry concrete. April 30, 2008. Organ Pipe Cactus National Monument, Arizona.

Figure 15. Jute erosion matting and mesquite branches placed to minimize erosion on outside face of the retaining berm. View is to northwest. Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

Findings

The trench served partly as an exploratory excavation, allowing inspection of the berm interior for water movement. The trench walls and excavated earth were inspected during excavation, to look for evidence of water movement. Particular attention was given to tree roots transected by the trench. No single, dramatic water leak was observed; that is, at no point was water flowing into the trench. However, two areas of very moist to saturated material were found: at the "leaning cottonwood" and the "bee willow." At the cottonwood, several saturated, rotted remains of roots were transected by the trench. The roots appeared to have originally been approximately 2" in diameter. At the bee willow, saturated soil was excavated from within and adjacent to the root mass. These two areas may have constituted major leaks from the pond. It is possible that at the time of this project, the pond had fallen to a level just below the major leak(s), thus reducing the flow of water through the leaks. The saturated materials at both the leaning cottonwood and the bee willow were 2 to 3 feet below the top of the berm – i.e. at elevations comparable to those where the pond has lost water rapidly in the last 2 years. In addition to the two discrete wet areas located, the berm interior was damp, at various depths, along much of the 220 feet from the west bench to the west edge of the spillway. This suggests the berm, built of sandy material, has been losing moisture along a broad front, if at a slow rate. From the west edge of the spillway to the east bench, all excavated earth was very dry.

These findings provide for some optimism regarding the success of the project. First, we found clear evidence the berm has been wicking water away from the pond along much of its length. The diaphragm wall should reduce this form of water loss. Secondly, trees were removed from the berm, and numerous root masses were transected by the diaphragm wall. The project should therefore reduce losses to transpiration, prevent future damage to the berm by roots, and terminate any water loss that was taking place along those roots. Finally, the wet areas found at the bee willow and the leaning cottonwood may have been significant leaks, especially at higher pond levels. The diaphragm wall transected both of these areas, and should greatly reduce or eliminate leaks associated with these two trees.

Temporary Evacuation of Quitobaquito Pupfish and Sonoyta Mud Turtles

The low water levels observed in 2006 and 2007 led managers to make contingency plans to evacuate Quitobaquito pupfish and Rio Sonoyta mud turtles, to safeguard some numbers of both species. In autumn 2007, a precipitous drop in water level (15 inches between September 6 and October 22) indicated the possibility the pond would be largely gone within weeks. October 25, 2007, NPS and AGFD biologists trapped 1,048 pupfish, which were then transported by AGFD (under their ESA permit) to the Arizona-Sonora Desert Museum in Tucson for temporary safekeeping (Table 1). Several days later, an initial group of mud turtles were also evacuated to ASDM (Table 1). Fortunately, the precipitous drop of September-October stopped at – 23.25". Through the winter of 2007-2008, the level held at this level, then slightly increased with modest rain input. While that pond level provided little room for additional water loss, it did provide extensive shallow-water habitat which was used by the remaining pupfish and mud turtles. However, in March 2008 the level began falling again, and on April 1 2008, it fell below -23.25", demonstrating this was not a firm lowest-possible level. With loss of the pond once again seeming possible, additional pupfish and mud turtles were evacuated to temporary holding facilities at monument headquarters (Figure 16), Cabeza Prieta National Wildlife Refuge, and the Phoenix Zoo (Table 1).

No pupfish mortalities were detected during translocations. At tank #1 at monument headquarters, 24 mortalities were noted during the first 75 days after translocation, among the 589 pupfish placed in that tank. That mortality rate was considered unremarkable, and consistent with what was observed after initial stocking of the "La Cienega" refuge pond at the visitors' center. At tank #2 however, at least 116 mortalities were confirmed in the first week after the 500 pupfish were placed in that tank. When the mortalities were discovered, chicken wire was placed over the tank to prevent birds from moving between the two tanks, potentially transmitting a water-borne pathogen. In addition, a passive solar water heating system was set up (circulation hose laid on exposed sunny ground), raising the tank temperature about 3° C. This was done because tank #2 is situated under a mesquite tree in partial shade. No mortalities were seen after the initial week. Discussions with fish biologists and pathologists with the USFWS and AGFD considered bacterial or viral infection, thermal shock, and water quality problems as potential causes. Those pupfish were removed from Quitobaquito Pond at a water temperature of about 27° C, and the tank water was approximately 19° C when they were stocked one hour later. That temperature difference, plus the stress of capture and relocation may have been sufficient to cause weaker fish to succumb. The fact that the mortalities stopped after a few days, with surviving fish being very active and eating, suggests capture/thermal stress is a more likely culprit than pathogens (pers. comm..J. S. Foott, USFWS, June 2008). Current plans are that evacuated individuals at all temporary holding facilities will be returned to Quitobaquito Pond, when it appears the pond water level is relatively stable somewhere above the minus 16" level. The 100 pupfish placed in the existing refuge ponds at Cabeza Prieta NWR and the monument (50 each) were moved for genetic maintenance purposes, and will not be returned to Quitobaquito. The 2008 pupfish evacuations were carried out under an emergency amendment to the monument's ESA permit (# TE819458-0), granted on April 2, 2008.

In addition to temporarily evacuating pupfish from the Quitobaquito system, in 2008 we also relocated pupfish from the diminishing pond up into the more stable system of the spring channel and moat. We moved a total of 1,557 pupfish from the pond to these upstream areas. On April 15, 2008 we moved 734 pupfish from the pond into various pools along the spring channel. After the moat impoundment was created (described above), we stocked it with 647 pupfish from the pond on April 23, 2008, and another 176 pupfish on May 21.

Table 1. Evacuations of Quitobaquito pupfish and Sonoyta mud turtles from Quitobaquito Pond, 2007-2008.

Species	Date	# Evacuated	Holding Location	Status
Quitobaquito pupfish	10/25/07	1,048	ASDM: 1,048	Stable
	04/08/08	668	ORPI Tank #1: 332	Stable, 24 mortalities over 1st 75 days
			ORPI LaCienega: 50	Stable
			CPNWR North: 50	Stable
			CPNWR South: 236	Stable
	04/15/08	257	ORPI Tank #1: 257	Stable, 24 mortalities over 1st 75 days
	05/07/08	500	ORPI Tank #2: 500	>116 mortalities in 1st week; stable since
Sonoyta mud turtle	10/29-30/07	13	ASDM: 13	12 lost to raccoon
	04/22/08	31	Phoenix Zoo: 31	Stable

Figure 16. Temporary holding tanks for Quitobaquito pupfish in headquarters area. May 2008. Organ Pipe Cactus National Monument, Arizona.

<u>Species Descriptions, Analysis, and Determination of Effects:</u>

Please see the original biological assessment of April 4, 2008, for species decriptions.

<u>Analysis of Effects on Quitobaquito Pupfish</u>

The tree removal and diaphragm wall installation took place adjacent to, but not within Quitobaquito pupfish habitat. These activities did not disrupt or disturb water flow in the springs, stream channel, or pond. Project activities did not harm or harass pupfish in any detectable manner.

One potential impact on pupfish was not anticipated in the original biological assessment. As the dry concrete mix was being poured into the trench, airborne dust was created. Some portion of this dust would have been Portland cement dust, a potential toxin or other adverse effect on pupfish. This situation was immediately noted and monitored. On most workdays, calm air prevailed or breezes blew the dust away from the pond. Several windy days also blew dust away from, or parallel to the pond. Several days, small quantities of dust drifted over the pond. We examined the water surface for evidence of accumulation, and monitored pupfish for signs of stress, abnormal behavior, or mortalities. None were observed.

Packing earth around the base of the leaning cottonwood took place in the currently-watered portion of Quitobaquito Pond. On the day this project element was completed, the area adjacent to the tree consisted of approximately a 24"depth of flocculent detritus, overlain by 0.5" to 1.5" of clear water. As workers waded into the area, the few pupfish occupying the area moved away, leaving little or no likelihood they would be covered over and trapped beneath the earth. Packing earth around the base of this tree displaced approximately 5 cubic yards of flocculent detritus and water, with a like volume of compacted earth. While this did remove a small amount of open-water habitat immediately adjacent to the tree, the water displaced there should have cause a proportional rise in the pond overall. A 0.2" rise in the pond was measured the day after this project element was done. Therefore there is not likely to have been any net loss of pupfish habitat as a direct effect of packing earth around the base of the tree. It is possible this project element may have resulted in burying pupfish egg masses. We have insufficient information to estimate how many eggs may have been buried.

Damming the turtle moat took place in pupfish habitat, but served to re-establish habitat that had been lost due to the lowering pond level. After being dammed, the moat filled to a depth of 8" to 16" within several hours. We stocked the re-established moat habitat with 823 pupfish trapped in the pond (Table 1). We incurred no incidental mortalities during this local relocation. As described above, we suspect that damming the moat resulted in a drop in the pond level, possibly as much as an inch. A 1" drop in the pond level would have resulted in some net loss of pupfish habitat, since at the current low level a 1" drop would have reduced the pond slightly in surface area. At the same time, this reduction was caused by re-establishing approximately 600-900 square feet of pupfish habitat of varying depths in the moat. We do not have sufficient information to evaluate whether loss of habitat in the pond was completely offset by gains in the moat. Nor do we have sufficient information to evaluate any net effect on the pupfish population. We view the moat habitat as being superior to pond habitat, under the current conditions. First, it is hydrologically more secure; the moat impoundment can be maintained while the pond continues to fluctuate, with a general trend of reduced habitat. Second, pupfish in the moat are less vulnerable to piscivorous birds than pupfish in the pond. The moat water is deeper, with extensive cover under floating algae and among bulrush shoots. Ultimately, we chose a compromise of lowering one moat dam to lower the surface elevation of the moat water, bringing it back down below the level of the plastic liner that was installed in the moat in 1989. As a result, the spring-channel water flowed more directly through a short section of moat, over the dam, and into the pond.

To date, no effort has been needed or undertaken to address re-sprouting of trees cut from the berm. When re-sprouting trees are addressed, they will be controlled manually, and/or using herbicide (e.g. Garlon or Roundup). Such herbicides would be applied using only compounds and methods that will pose no potential harm to Quitobaquito pupfish, Sonoyta mud turtles, and other aquatic organisms. All but two of the subject trees were rooted on the crest of the berm, or on the downslope face. That is, they are approximately three to 18 feet from the former pond edge. The two trees close to the inside face of the berm will be treated using mechanical means only. For the remaining trees, to eliminate wind drift herbicides will be applied from within 6 to 8 inches using hand-held spray bottles. As noted, the ground slope around these trees is generally away from the pond edge. Considering these factors, we conclude the methods to control tree re-sprouting will have no adverse effects on pupfish.

The monument concludes that an unknown number of Quitobaquito pupfish were harmed as a result of the project activities described above. That harm took place in two ways:

1. At least 116 of the 500 Quitobaquito pupfish evacuated to holding tank #2 died due to unknown causes. A combination of thermal shock and capture/relocation stress is suspected.

2. An unknown number of Quitobaquito pupfish eggs may have been buried under compacted earth when material was packed around the base of the leaning cottonwood. It is assumed eggs buried in this way would not have hatched.

The actions described above were undertaken on an emergency basis, to attempt to prevent what appeared to be the imminent loss of Quitobaquito Pond. Based on our 2007 population estimate, loss of the pond would equate to loss of 8,000 to 10,000 Quitobaquito pupfish, or nearly 75% of the entire Quitobaquito population. While the losses noted above are regrettable, we viewed them as being part of the cost of safeguarding a temporarily captive pupfish population, and stabilizing the Quitobaquito Pond water level, thus safeguarding the remaining wild population. We believe if we had taken no action, a greater number of pupfish would have been lost due to the moat drying up and the pond diminishing in size, and we would have no refuge population in temporary captivity. At this date (July 2008) it is too early to evaluate the success of the diaphragm wall. Early indications are encouraging; the pond still exists, although very shallow and approximately half its normal surface area. The surface level is holding relatively stable at minus 27.5”, under the years’ maximum evaporation rates of June-July. We are optimistic that imminent summer rains will raise the water level sufficiently for us to evaluate the effectiveness of the diaphragm wall at reducing or elimination the water loss.

Critical Habitat

The proposed action would take place within designated critical habitat for the Quitobaquito pupfish. The “constituent elements” of critical habitat are “ . . .clean unpolluted water that is relatively free of exotic organisms, especially exotic fish. . . small, slow-moving desert streams and spring pools with marshy backwater areas . . .” (USFWS 1986).

The project actions did not modify Quitobaquito Pond, stream channel, or springs. The retaining berm which forms Quitobaquito Pond is a key component in maintaining

Quitobaquito Pond, where the majority of the pupfish at Quitobaquito exist. Best professional judgements on the low-water situation of 2006-2008 are that the retaining berm has been compromised by infiltrating tree roots, and perhaps simple aging. As a result, water was no longer being effectively impounded, and the critical habitat of the pond was in imminent jeopardy. The primary project action, the diaphragm wall, was intended to reinforce the berm, and seal it against lateral water movement through the berm. We conclude that the availability of water, and habitat overall, was not reduced by this project. As noted above, re-establishing the moat habitat may have caused a slight reduction in pond habitat. However, we believe the tradeoff was at worst neutral; no net loss of habitat. We feel it was more likely a net gain of more stable habitat, with better protection against predators.

The only constituent element that could possibly be perceived as affected would be "clean unpolluted water," in that small amounts of soil may have been spilled into the pond edge from the retaining berm during excavation. Also, very localized, temporary turbidity resulted from damming the turtle moat, and packing earth around the base of the leaning cottonwood. Also, small quantities of wind-drift concrete dust may have fallen into the pond. Tolerance of desert/Quitobaquito pupfish for turbid water is not discussed in the available literature or recovery plan – neither as a potential threat nor as a condition pupfish tolerate. However, regional pupfish authorities advised the monument that temporary turbidity associated with the 2007 springhead renovation should be no concern for pupfish (Dr. C. Minckley, USFWS in lit. February 26, 2007; Dr. P. Marsh, Arizona State University and author of desert pupfish recovery plan, in lit. February 26, 2007, J. Stefferud, Desert Fishes Team, in lit. February 28, 2007). Staff experience at the monument is consistent with that advice. Monument staff have observed Quitobaquito pupfish to be apparently unaffected by short-term periods (20 minutes to 3 hours) of turbidity. Such turbidity occurs at Quitobaquito during heavy rain, when downslope surface runoff introduces sediment into the channel. In extreme rain events, suspended sediment can also cause the pond to become turbid. No mortalities of pupfish have been observed during or immediately after the events of this type that have been witnessed. Temporary, localized sediment suspension also occurs as the result of removing emergent vegetation from the channel, moat, and the refuge pond at monument headquarters. No mortalities have been observed during or after these habitat maintenance activities, and no incidental mortalities were detected during the 2007 springhead renovation project. Our observations were that the turbidity caused by the actions discussed here was far less than that of the 2007 springhead project, and less than routine channel maintenance or rainfall events. Based on the above analysis of potential impacts by sediment, we conclude that water which is temporarily turbid with local soil and sand is still "clean unpolluted water" in the context of pupfish biology. As discussed, the hypothetical problem of concrete-dust wind-drift did not reach a scale that raised concerns, and no effects on pupfish were seen. Therefore we conclude the project actions did not adversely modify critical habitat for the Quitobaquito pupfish. The project goals were specifically to re-establish and safeguard critical habitat for the Quitobaquito pupfish. The success of the project will be borne out in time, but we are cautiously optimistic the actions will prove successful.

Determination of Effects on Quitobaquito Pupfish:

The project actions *adversely affected* the Quitobaquito pupfish, by resulting in incidental take of at least 116 pupfish that died in holding tank #2, and unknown numbers of pupfish eggs that may have been buried under the leaning cottonwood..

The project actions resulted in *beneficial effects* on the Quitobaquito pupfish, by: 1) Evacuating 2,473 pupfish from what appeared to be imminent loss at Quitobaquito Pond, and relocating them to temporary, secure holding facilities; 2) Re-establishing the moat habitat as stable pupfish habitat, and re-stocking it with 823 pupfish taken from the pond where loss appeared to be imminent; 3) Installing a diaphragm wall in the retaining berm which may allow Quitobaquito Pond to re-establish as a large pupfish habitat area, no longer subject to extreme seasonal reductions in size

The project actions *did not adversely modify* critical habitat for the Quitobaquito pupfish.

Analysis of Effects on Sonoran Pronghorn

The proposed project would take place in an area where available information indicates Sonoran pronghorn occur rarely or never. The project would be carried out using motorized equipment, including chainsaws, a small excavator, and a mixer. The sounds of that equipment and the manual labor of the project should be overwhelmed by the sound of truck traffic on Highway 2 nearby in Mexico. Project activities would be relatively quiet and non-intrusive.

Determination of Effects on Sonoran Pronghorn

The proposed action will have *no effect* on the Sonoran pronghorn.

Analysis of Effects on Lesser Long-nosed Bat:

The proposed project will take place in April through July, during the time of year when the lesser long-nosed bat is present in the area (Organ Pipe Cactus National Monument 2006b). The project will take place only during daylight hours, when bats would be in day-roosts. The project will not take place near any known roosts for this bat. The large maternity roost in the monument is approximately 18 miles from the proposed project area, and will not be affected by project activities. Finally, the proposed project will not damage or remove any foodplants for the lesser long-nosed bat.

Determination of Effects on Lesser Long-nosed Bat

The proposed action will have *no effect* on the lesser long-nosed bat.

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Appendix I
Water Input / Loss at Quitobaquito Pond, March 2008

Approximate normal pond surface area: 27, 971 sq ft
Approximate pond surface area clear water at -23.25” level: 19,950 sq ft. Calculations use “normal” figure because exposed algae/mud flats are saturated and evaporate water.
Cubic foot = 7.481 gal
Spring input (just above moat) March 19, 2008: 18.3 gal/min

Spring Input
18.3 gpm x 60 x 24 = 26,352 gal/day =3,522 cu ft per day would raise pond 1.5”/day

Evaporation Loss
Pan evaporation estimated as average of Tucson, Tempe, Sacaton, and Yuma, AZ (http://www.wrcc.dri.edu/htmlfiles/westevap.final.html)
Pan evap = 0.210”/day (= 0.0175 ft) x 27,971 sq ft = 489 cu ft = 3,658 gal/day
Summer pond evaporation is 84% of pan (Sellers & Hill 1974 in Fisher 1989) so
PE = 0.84 x 0.210” = 0.176”/day (=0.0147 ft) x 27971 sq ft = 410 cu ft = 3,073 gal/day

Subtotal Net Daily Input, spring input minus evaporative loss
26,352 gal (spring input) – 3,073 gal (pond evap) = 23,279 gal/day or 1.33” rise per day

Observed Pond Level Drop
0.5” per week = 0.071”/ day (= 0.00591 ft) x 27,971 sq ft = 165 cu ft = 1,237 gal/day

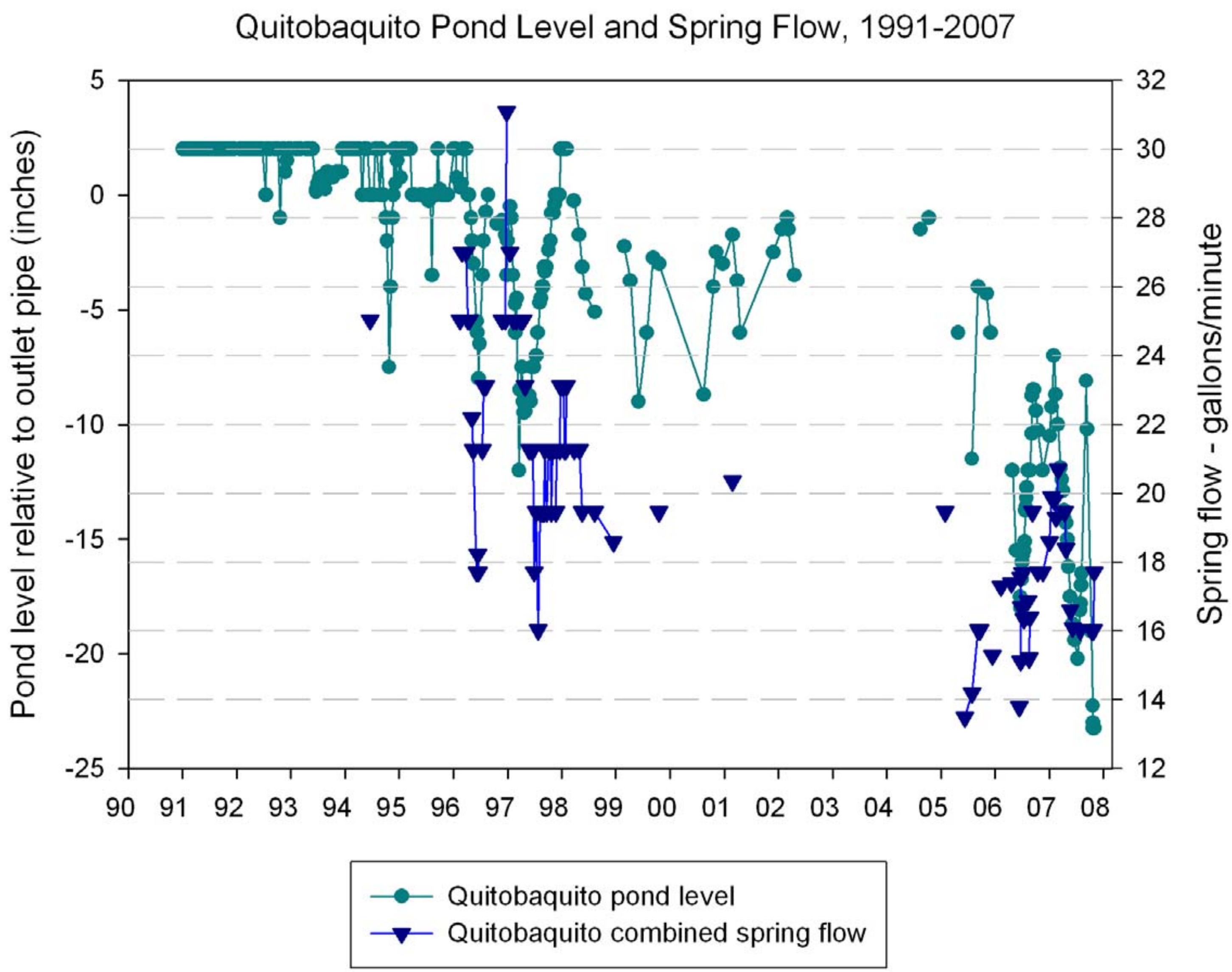
Net Daily Loss (Including transpiration)
Potential net input rise (1.33”) plus observed drop (0.071”) = 1.401”
1.401” = 0.117 ft x 27,971 sq ft = 3,272 cu ft = 24,477 ga/day

Expected net gain (23,279 gal) plus observed net loss (1,237) = 24,516 gal/day

Apparent net loss is approx 24,500 gal/day = 1021 gph = 17.01 gpm

Transpiration Loss (Adapted from Fisher 1989)
TL = 1.2 x (Pond evap, per unit area) x (area riparian vegetation)
TL = 1.2 x (3,073 gpd / 27,971 sq ft = 0.1098 gal/ft sq/day) x (area riparian vegetation)
TL = 1.2 x 0.1098 = (0.1317 gal/ft sq/day) x (area riparian vegetation)
TL = 0.1317 gal/ft sq/day x 80,172 ft sq (Avg of 15m and 40 m belts)
TL = 10,558 gal/day

Net Unknown Daily Loss
24,500 gal/day (net daily loss) – 10,558 gal/day (estimated transpiration) =
13,942 gal/day Unknown Loss = 581 gal/hr = 9.61 gpm


Quitobaquito Pond Level and Spring Flow, 1991-2007
Pond level relative to outlet pipe (inches)
Spring flow - gallons/minute
5
0
-5
-10
-15
-20
-25
32
30
28
26
24
22
20
18
16
14
12
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08
Quitobaquito pond level
Quitobaquito combined spring flow

Appendix II
Summary of Field Activities During Final Month of Project Implementation

Date: April 8, 2008
Pond Level: Minus 24.1"
Activities: Evacuated 668 pupfish, placed in 1) ORPI holding tank 2) ORPI refuge pond 3) both CPNWR ponds

Date: April 15, 2008
Pond Level: Minus 24.25"
Activities: Removed trees from berm. Cut material removed from Quitobaquito area. Moved 734 pupfish from pond to various channel pools. Moved additional 257 pupfish from pond to temporary storage tank at ORPI maintenance. Snowy egret, great egret, white-faced ibis, green heron, belted kingfisher were all eating pupfish, vulnerable in the shallow water. Eating up to 100/hour or more.

Date: April 22, 2008
Pond Level: Minus 24.5" New record low.
Activities: Constructed low dams to impound moat to depth of about 12". Captured 31 mud turtles, transferred via AGFD to Phoenix Zoo for temporary holding.

Date: April 23, 2008
Pond Level: Minus 24.5"
Activities: Moved 647 pupfish from pond into moat impoundment. Finish removing last trees from berm.

Date: April 29, 2008
Pond Level: Minus 25.5" New record low.
Activities: Begin constructing diaphragm wall, working east from west bench. 70 ft completed. Trenching excavates damp earth from berm interior through most of this length. Approx. 1800 gallons of water added to pond.
Notes: 15+ black-necked stilts present most of the day, feeding on pupfish when not disturbed by project activity. Pupfish are only vulnerable to this predation at extremely low pond levels.

Date: April 30, 2008
Pond Level: Minus 26" New record low.
Activities: Constructed 101 ft diaphragm wall. Trenching excavates damp earth from berm interior through most of this length. At the leaning cottonwood, several dead, decayed, saturated roots are transected, 1" to 3" in diameter. Approx. 1800 gallons of water added to pond.
Notes: Black-necked stilts and green heron present most of the day, feeding on pupfish when not disturbed by project activity.

Date: May 1, 2008
Pond Level: Minus 25.5" (Likely measuring error due to new line-level method)
Activities: Constructed 115 ft diaphragm wall. Trenching excavates damp earth from berm interior through much of this length. Localized area of saturated earth among roots of the "bee willow." All earth excavated from face of spillway and to east is very dry. Approx. 1800 gallons of water added to pond.
Notes: Some pupfish stranded in isolated open water pockets among exposed mud/detritus flats. Black-necked stilts, green heron, snowy egret, white-faced ibis present occasionally, feeding on pupfish when not disturbed by project activity.

Date: May 2, 2008
Pond Level: Minus 26"
Activities: Constructed 55 ft diaphragm wall, to east bench, completing diaphragm wall. Trenching excavates very dry earth throughout this length. Began final contouring of berm surface. Began packing earth and rocks beneath and around trunk of leaning cottonwood. Approx. 1800 gallons of water added to pond. Pomegranate trees pruned.
Notes: 2 adult turtles seen in pond. Single snowy egret feeding on pupfish. Pupfish still numerous in remaining pond, but most appear to be small/young. Some pupfish stranded in isolated open water pockets among exposed mud/detritus flats.

Date: May 5, 2008
Pond Level: Minus 26"
Activities: Mop-up: Final contouring of berm surface. Continue packing earth and rocks beneath and around trunk of leaning cottonwood. No water added to pond.
Notes: 2 adult turtles seen in pond. >22 black-necked stilts present, but feeding apparently is inhibited by high winds.

Date: May 6, 2008
Pond Level: Minus 26"
Activities: Mop-up, continued: Completed contouring berm surface. Complete packing earth beneath and around trunk of leaning cottonwood. Approx. 1000 gallons water added to pond.
Notes: 1 adult turtle seen in pond. >12 black-necked stilts, 5 white-faced ibis, 2 black-crowned night herons, 1 green heron, 2 snowy egrets present. Feeding activity is inhibited by project activity and windy conditions.

Date: May 7, 2008
Pond Level: Minus 25.8" Rise possibly due to placing 4 cubic yards of earth around base of cottonwood and adding 1000 gallons water previous day.
Activities: Captured 500 pupfish, relocated to stock temporary tank #2 at headquarters area. 176 extra pupfish captures translocated from pond into moat/channel. No incidental capture/transport mortalities.
Notes: 1 adult turtle seen in pond. 1 green heron at pond, no other pupfish predators seen.

Appendix III
Quitobaquito Berm Stabilization Project and Related Activities
Personnel

Organ Pipe Cactus National Monument

Hunter Bailey	Security
Lee Baiza	Planning & preparation, Worker, Superintendent
Amanda Barnard	Worker
Daren Belskis	Security
Bob Bryant	Equipment Operator, Planning & preparation, Worker
Alex Bustamante	Equipment Operator, Worker
Kelsey Cassidy	Security
Charles Conner	Worker, Project preparation
Janet Kellogg	Facilitation, Acquisitions
Andy Fisher	Worker
Matt Fisher	Security
Kyle Greene	Security
Connie Herrera	Facilitation, Acquisitions
Peter Holm	Worker, Project preparation
Angela Horvath	Worker
Dave Keltner	Security
Andy Martin	Pupfish tank assistance
Jana Moe	Security
Christine Moscatiello	Facilitation
Ami Pate	Worker, Project preparation
Kenny Richardson	Equipment Operator, Worker
Sue Rutman	Worker, Project preparation, Compliance
Frank Sanora	Equipment Operator, Worker
Paula Sprenger	Worker
Ed Stowe	Worker
Karl Sommerhauser	Security
Dane Tantay	Security
Tim Tibbitts	Worker, Planning & preparation. Project lead
Joe Tuomey	Worker, Cultural compliance
Tommy Woodard	Equipment Operator, Worker

Petrified Forest National Park

Jimmy Baldwin	Equipment Operator, Worker
Richard Lynch	Equipment Operator, Worker

Other National Park Service Offices

Larry Martin	Facilitation, Support, Consultation
Colleen Filippone	Consultation
Michele Girard	Facilitation
Ron Beckwith	Cultural monitoring/compliance
Jim Bradford	Cultural compliance

Cabeza Prieta National Wildlife Refuge

Bullard Jones	Worker
Jon Erz	Worker
Curt McCasland	Facilitation, Pupfish holding
Sharon Vaughn	Facilitation, Pupfish holding

Arizona Game and Fish Department

Cristina Jones	Consultation, Turtle evacuations
Audrey Owens	Turtle evacuations
Ross Timmons	Consultation, Pupfish evacuation
Suzanne Ehret	Pupfish evacuation

US Fish and Wildlife Service

Marty Teugel	Consultation, Turtle evacuations
Doug Duncan	Consultation
Jim Rorabaugh	Consultation
Erin Fernandez	Consultation
J. Scott Foott	Consultation

Arizona-Sonora Desert Museum

Stephane Poulin	Pupfish and turtle holding
Craig Ivanyi	Pupfish and turtle holding

Phoenix Zoo

Paula Swanson	Turtle holding
Tara Sprankle	Turtle holding

TTibbitts
July 2008