Annual Monitoring Inspection Report
Earth Fissure Site Investigation
Siphon Draw Wash Drainage Improvements Project
Contract FCD 2006C020, Work Assignment No. 9
Maricopa and Pinal Counties, Arizona

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Submitted to:

Flood Control District of Maricopa County
Phoenix, Arizona

Submitted by:

AMEC Earth & Environmental, Inc.
Tempe, Arizona

August 23, 2011
AMEC Job No. 17-2011-4025

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Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

Attn: Bobbie Ohler, PE

Re: Annual Monitoring Inspection Report
Earth Fissure Site Investigation
Siphon Draw Wash Drainage Improvements Project
Contract FCD 2006C020, Work Assignment No. 9
Maricopa and Pinal Counties, Arizona

Submitted herewith is the Siphon Draw Drainage Improvements Project, Annual Monitoring Earth Fissure Site Investigation Report. The report documents observations and recommendations from AMEC Earth and Environmental, Inc. (AMEC) concerning the annual monitoring inspection conducted on July 7, 2011. Also included is a survey report for five monuments located along Meridian Channel.

Should you have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

D. Karen Anglin
Staff Professional

Reviewed by:

Kenneth C. Fergason, PG
Senior Geologist

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ARIZONA, U.S.A.
Expires 12/31/2012

c: Addressee (2)

G:\Geotechnical\2011 Projects\17-2011-4025 FCDMC_Siphon Draw Wash\Site Investigation July 7 2011\Final Report\Siphon Draw Earth Fissure Site Investigation_Aug 5 2011_Review Comments_Kcfdocx.Docx

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1.0 INTRODUCTION

Siphon Draw Wash Drainage Improvements Project (Siphon Draw) is located within western Pinal County and eastern Maricopa County, generally in the vicinity of Elliot Road and Meridian Road. Completed in 2010 the newly constructed Siphon Draw detention basin and Meridian channel were improvement projects in partnership between the Flood Control District of Maricopa County (DISTRICT) and the City of Mesa. Major project improvements included the construction of the Siphon Draw detention basin and an incised, concrete-lined channel from Meridian Road to West Guadalupe Road, known as the Meridian channel. Other improvements include a concrete-stepped inlet structure constructed to control flow into the detention basin, as well as cut-off walls and a geomembrane liner constructed to protect the detention basin against known and/or developing earth fissures. Previous geotechnical studies and investigations by AMEC Earth & Environmental, Inc. (AMEC [2006, 2008]) for the project have shown the project area is undergoing land subsidence and revealed the presence of existing earth fissures in the vicinity of the Meridian channel and the Siphon Draw detention basin.

As described in the Siphon Draw Operations and Maintenance Plan (FCDMC 2010), a portion of the annual inspection is dedicated to the monitoring of earth fissures located within the vicinity of the Siphon Draw detention basin and the Meridian channel. The inspection discussed herein is the first detailed geohazard inspection since completion of the project construction.

2.0 SITE INVESTIGATION

The Siphon Draw earth fissure site inspection was conducted by Kenneth Fergason, PG and Karen Anglin, both of AMEC, on July 7, 2011. The inspection included a careful driving inspection of the newly constructed detention basin facility and Meridian channel with stops at key locations to include a detailed walking inspection in areas of known earth fissures. This is the first inspection since construction was completed. A site map is included as Figure 1 and a photographic log and field notes documenting the site inspection are included in Appendix A. In general, the inspection did not identify any new ground disturbances or immediate earth fissure hazards that would pose an adverse impact to the safe operation of the basin or channel. Images presented in Appendix A show a general 'baseline' condition for visual comparison with future inspections.

2.1 Siphon Draw Detention Basin Facility

A driving inspection of the Siphon Draw detention basin was conducted along the perimeter of the crest of the basin. Visual observation revealed some minor erosional rills along the slope of the basin, but no significant signs of erosion or distress were observed. This area is represented as field notation area 1, in Figure 1.

2.2 Southwestern Fissure Alignment

A walking inspection was conducted along the known alignment of the Southwestern Fissure and along its projected alignment within the detention basin. Visual observation revealed widespread, typical longitudinal cracking throughout the detention basin, specifically along the base of the slopes within the detention basin. In general, these cracks were discontinuous and up to 3 to 4 feet in length with apertures up to ¼ inch at the surface. The depths are unknown

due to the small aperture of the cracks, though desiccation cracks of this nature typically have a depth of no more than 2 feet. These characteristics are typical of desiccation style cracking caused by differential wetting and/or drying and the local ponding of water, and are not related to earth fissuring.

Brush and vegetation, approximately 3 to 4 feet in height, were observed within the detention basin along the fissure alignment; however, this vegetation consists primarily of tall pot plants that were planted as part of the landscaping. The observed smaller sized vegetation and brush were from hydro seed, as seen in Photograph 1 within Appendix A.

A walking inspection was also conducted along the crest of the detention basin in the projected alignment of the Southwestern Fissure. The fissure extension, as seen in Figure 1, occurred during a single storm event in October of 2007 when the Southwestern Fissure grew by a length of about 250 feet overnight. Visual observation did reveal a crack on the ground surface roughly parallel to the alignment of the earth fissure, as seen in photograph 2a through 2c in Appendix A. This crack ranged from ¼ inch to ½ inch in aperture and 3 to 4 feet in length at the surface. Depth is unknown due to the narrowness of the crack, though the depth appears to be less than a foot or two. However, this crack appears to be a desiccation crack rather than cracking related to an earth fissure. Minor erosional rilling and some burrowing activity were observed east of the crest, along the backside slopes near the drainages, as seen in photograph 4 within Appendix A. There were no discernable cracks connecting the animal burrows at the ground surface. Overall, the subtle ground cracks observed appeared to be typical of desiccation style cracking and no significant signs of erosion or distress were observed. This area is represented as field notation area 2, in Figure 1.

2.3 Southwestern Fissure

A walking inspection of the Southwestern Fissure revealed areas of soil infilling within the earth fissure, but there have been no significant changes since construction completion. This area is represented as field notation area 3, in Figure 1.

2.4 North of Detention Basin

A walking inspection of the area located north of the detention basin revealed no obvious cracks or signs of distress at the ground surface.

2.5 SRP Fissures and Hawk Rock Southwest Fissures

A driving and walking inspection was conducted at the SRP and Hawk Rock Southwest Fissures and nearby drainages. In general, the investigation revealed no recent ground disturbances or immediate earth fissure hazards to the basin and channel. This area is represented as field notation area 4, in Figure 1.

2.6 Meridian Channel

A driving inspection along the east and west sides of the Meridian channel was conducted. Visual observation of the channel and surrounding area did not reveal any significant signs of cracking or distress within the structure. Five brass cap survey monuments, installed during construction, were also visited and photographed. The monuments are founded within the

reinforced concrete channel lining. Photographs of the survey monuments are presented in Appendix A. This area is represented as field notation area 5, in Figure 1.

3.0 MONUMENT SURVEY REPORT

AMEC conducted an initial survey of five monuments along the Meridian channel utilizing real time kinematic (RTK) GPS survey methods for a vertical accuracy of +/-0.066 feet. The survey was completed on June 27, 2011 and performed by Brian J. Benedict, RLS, of AMEC. It is AMEC's understanding an as-built survey of the five monuments was not completed. The survey report, consisting of coordinate positions for each monument, is included in Appendix B. The values for each coordinate position were determined from an average of five (minimum) 180 epoch RTK data solutions collected at each of the brass cap monuments. The monument survey report identifies each survey location in numerical order (Point No. 1 through Point No. 5). Figure 1 identifies the survey points as M-1 through M-5. AMEC selected the use of an additional alphabetic naming convention for more detailed reference to the monuments. The numerical values (1-5) remain consistent, such that Point No. 1 and M-1 is the southernmost survey monument, located nearest to the detention basin.

4.0 INSAR ANALYSIS

October 2004 to March 2010 InSAR imagery, previously published in a report by AMEC (2011), was analyzed for this investigation, as shown in Figure 2. This InSAR image indicates that relative subsidence of about 0.1 feet to 0.2 feet has occurred within this timeframe with the area around the detention basin subsiding the most and the north end of the existing Meridian channel subsiding the least. It is anticipated that this pattern of subsidence will continue into the future.

5.0 CONCLUSIONS AND RECOMMENDATIONS

AMEC's inspection, as described herein, did not document any surface features indicative of earth fissures, other than those previously known. Subtle ground cracking observed within and around the detention basin appears to be desiccation in origin. The Southwestern Earth Fissure and corresponding alignment should be visually inspected in the event of an impoundment and revisited as part of future monitoring efforts. The observed desiccation crack, in field notation area 2, located roughly parallel to the orientation of the Southwestern Fissure, should also be visited in future inspections. No further action is recommended at this time for the remaining areas inspected, though these sites should be revisited during future monitoring events.

Additional recommendations by AMEC include:

- Continue to monitor and remove any deep rooted vegetation in the locations where buried fissure mitigation has been constructed along the western and southwestern extents of the basin.

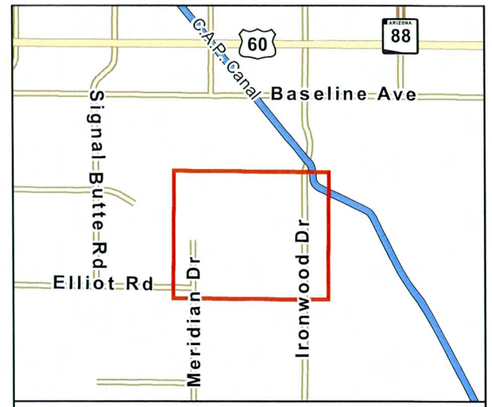
- InSAR imagery and photo lineament analyses for Siphon Draw should be performed in conjunction with the on-going annual monitoring of Powerline and Vineyard Road Flood Retarding Structures, each under separate work assignments. We recommend InSAR imagery be analyzed annually and photo lineament analyses be conducted at Siphon Draw every 5 years.

- The initial photo lineament analysis was performed in 2007 as part of the *Geologic Hazard Assessment and Geotechnical Characterization Investigation Report* published by AMEC in 2008. The results of this analysis are provided in Figure 1. The next lineament analysis should be conducted as part of the 2012 monitoring effort.

- Survey of the Meridian Channel brass cap monuments should be conducted on an annual basis to develop a baseline data set. This schedule should be reevaluated as part of the annual monitoring program and then adjusted should the measured rate of deformation merit either an increase or decrease in the frequency of data acquisition.

- The next regularly scheduled earth fissure monitoring inspection and brass cap survey should be completed in the fourth quarter of the District's 2012 fiscal year.

FIGURES



Legend

- (1) Field Notation Area
- Survey Monuments
- Known Earth Fissures**
- Lineaments***
- Fissure Extension 2007****
- CAP Canal
- Hawk Rock

Aerial Imagery: FCDMC, 2010

* Meridian Channel Construction Postdates Aerial Photograph.

** Earth fissure data: Earth Fissure Trace 03.11.11, Arizona Geological Survey, November, 30, 2009, Digital Information Series DI-39 v11.30.09, Tucson, Arizona.

*** AMEC Earth & Environmental Inc. (AMEC), 2008. Siphon Draw Drainage Improvement Project, Geologic Hazard Assessment and Geotechnical Characterization Report, Maricopa County, Contract FCD 2007C012, AMEC Job No. 7-117-001080, September 3.

**** The 2007 Fissure extension occurred during a single storm event in October, 2007 where the Southwestern Fissure grew by a length of about 250 feet overnight.

0 350 700 1,400 Feet

N

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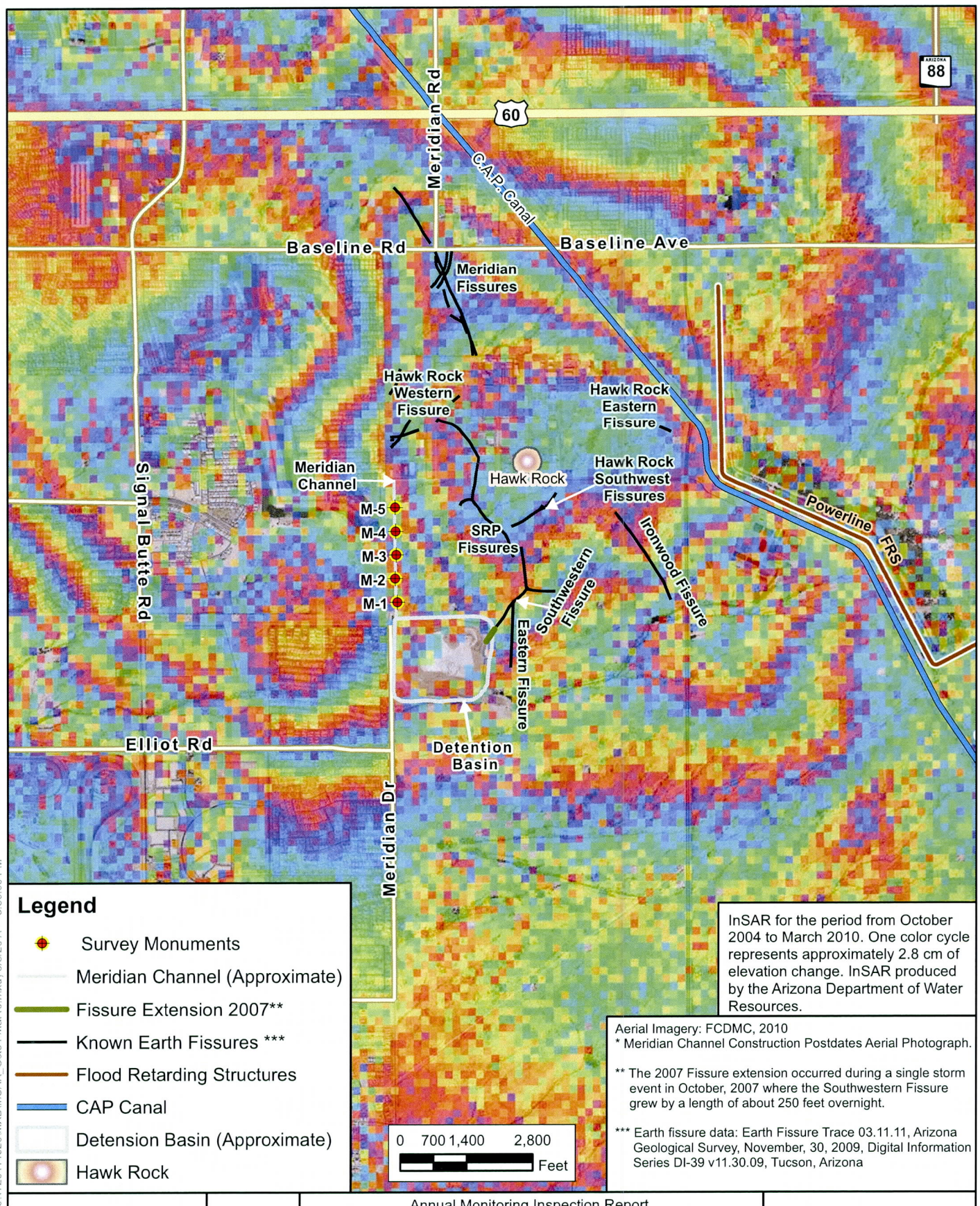
Maricopa and Pinal Counties, Arizona

Figure 1

Job No.	17-2011-4025
PM:	BAH
Date:	7/13/2011
Scale:	1" = 700'

amec

Path: X:\Projects\17\2011\4025\MXD\Siphon_Draw_Site_Map.mxd



Job No.	17-2011-4025
PM:	BAH
Date:	8/08/2011
Scale:	1" = 2800'

N

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Synthetic Aperture Radar Interferogram
October 2004 to March 2010

FIGURE
2

amec

APPENDIX A

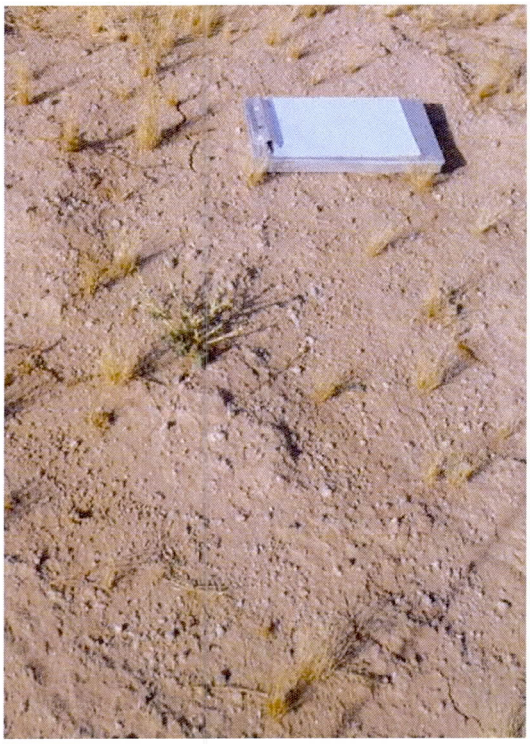
Photographic Log and Field Inspection Notes

Select Photographs

Photograph 1

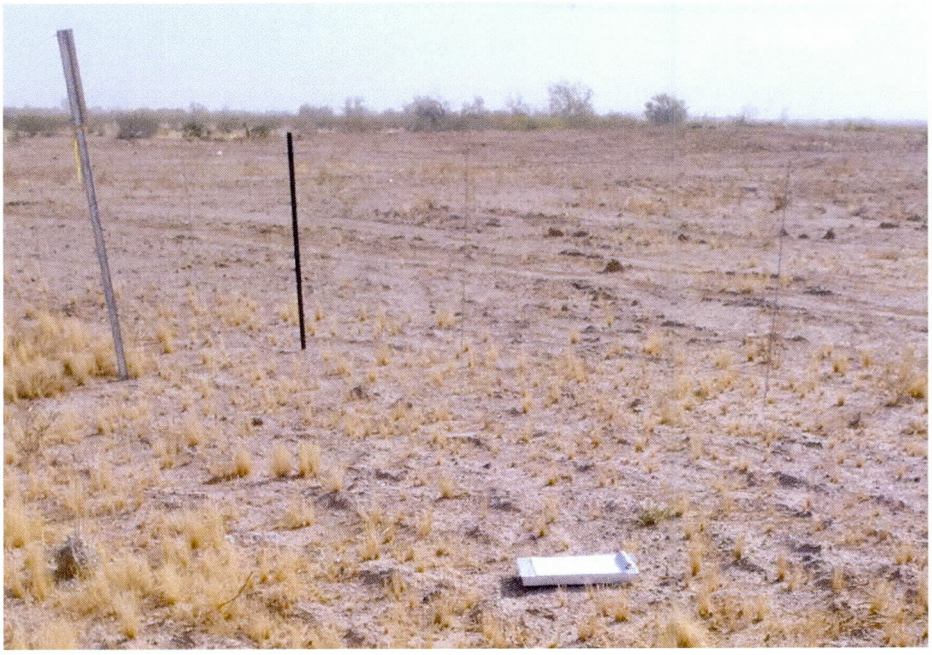
Viewing northeast within the Siphon Draw detention basin in the alignment of the Southwestern Fissure, with a tall pot plant and the basin embankment in background of photograph. See field notation area 2 on Figure 1 for approximate location.

Photograph 2a



Photograph 2b

Photograph 2a and 2b are of desiccation style cracking observed on the ground surface along the crest of the detention basin orientated roughly parallel to the Southwestern Fissure. See field notation area 2 on Figure 1 for approximate location.

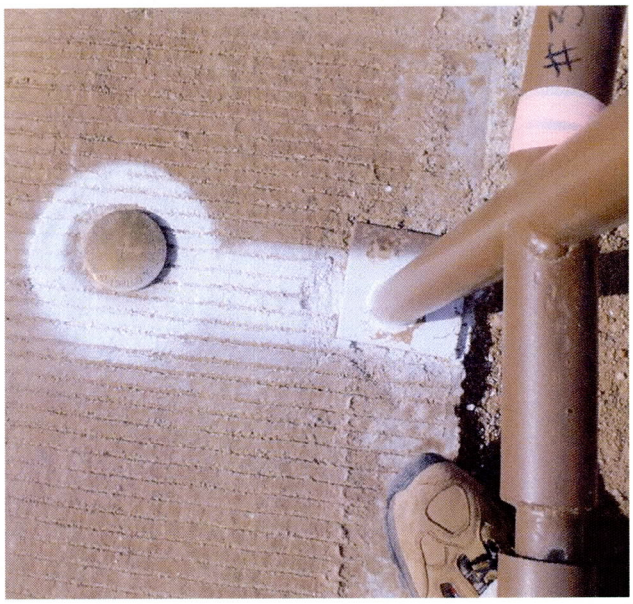


Photograph 2c

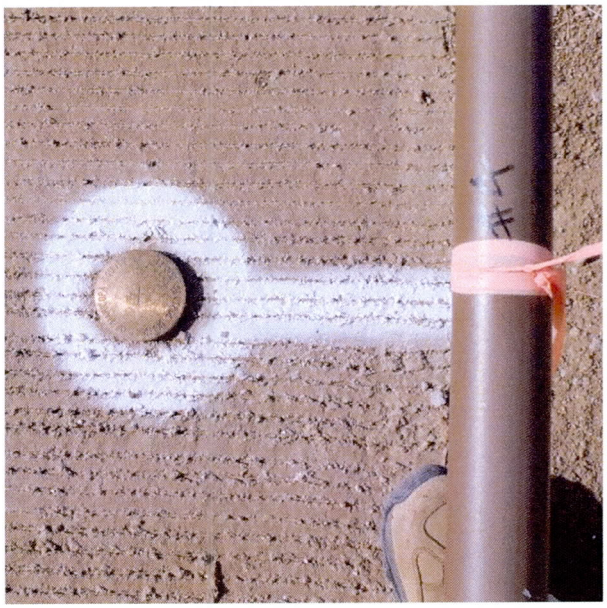
Photograph 2c depicts the same desiccation style crack observed on the ground surface in Photographs 2a and 2b. The sign in the background will be used as a reference point to relocate the crack during future inspections.

Photograph 3

Viewing southwest from the crest of the Siphon Draw detention basin in the alignment of the Southwestern Fissure. See field notation area 2 on Figure 1 for approximate location.

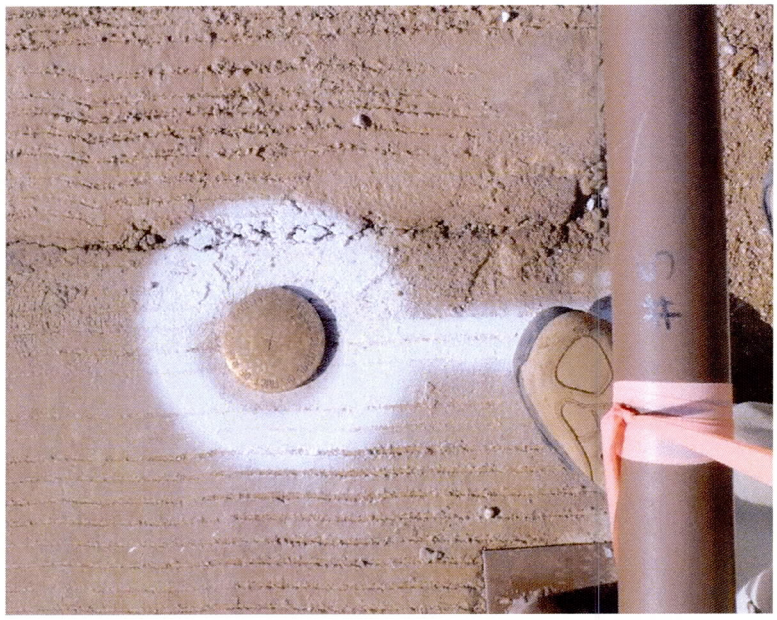


Photograph 6a



Photograph 6b

Photograph 6a is of the newly installed survey monument (M-3). Photograph 6b is of the newly installed survey monument (M-4). See field notation area 5 on Figure 1 for approximate location.

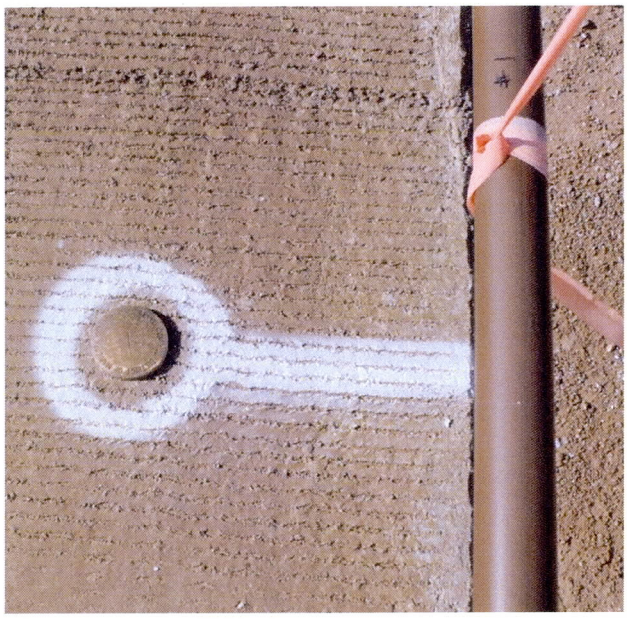


Photograph 7

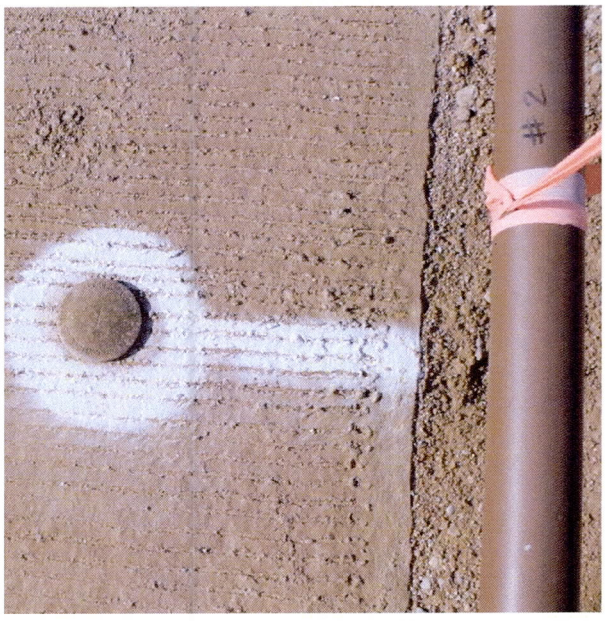
Newly installed survey monument (M-5). See field notation area 5 on Figure 1 for approximate location.

Photograph 4

Viewing north-northeast from the crest of the Siphon Draw detention basin in the approximate alignment of the Southwestern Fissure. Minor erosion rilling can be seen east of the crest, along the backside slope of the basin. See field notation area 2 on Figure 1 for approximate location.



Photograph 5a



Photograph 5b

Photograph 5a is of the newly installed survey monument (M-1). Photograph 5b is of the newly installed survey monument (M-2). See field notation area 5 on Figure 1 for approximate location.

FIELD INSPECTION NOTES

I. Crest of the Detention Basin
   a. Driving inspection
   b. Newly constructed basin with some minor erosional rilling along slopes; no significant signs of erosion or distress
   c. no obvious signs of earth fissuring

II. Alignment of the Southwestern Fissure
   A. Inside the Detention Basin
      a. Walking inspection, two photographs taken
      b. Observed typical longitudinal cracking at base of slope; appears insignificant with no obvious signs of earth fissuring
      c. Widespread cracking, 3-4 feet in length, approximately ¼" apertures
      d. Observed one green and lush tall pot plant; planted as part of landscaping and not a significant sign of earth fissuring
      e. Observed other larger vegetation, which are tall pot plants and part of landscaping
      f. Smaller brush, brown in color are part of hydro seed
   B. Crest of Detention Basin
      a. Walking inspection, ten photographs taken
      b. Observed crack on ground surface in alignment with earth fissure; 3-4 feet in length, approximately ¼" to ½" aperture
      c. Observed minor erosional rilling and burrowing activity along the slope (near the drainages); no cracks observed connecting burrows at surface

III. Southwestern Fissure
   a. Walking inspection, four photographs taken
   b. Observed infilling of soil within earth fissure
   c. No significant changes since construction was completed

IV. North of Detention Basin
   a. Walking inspection, no photographs taken
   b. No cracks observed at ground surface

V. Meridian Channel*
   a. Driving inspection, photographs taken at survey monument locations
   b. Observed minor areas of cracking running N-S in channel bottom, not viewed as significant

VI. Drainages near Meridian Channel, SRP and Hawk Rock Southwest Fissures*
   a. Driving inspection along drainage channels, SRP Fissures and southern segment of Hawk Rock Southwest Fissure
   b. Walking inspection along northern segment of Hawk Rock Southwest Fissure
   c. Total of sixteen photographs taken

*Field Notes do not correspond to text outline in report

APPENDIX B

Monitoring Survey Report

Siphon Draw Wash Monument Survey June 27, 2011

AMEC Job #1720114025
FCDMC Job #FCD 2006C020 (WA 9)

Point No.	Northing	Easting	Elevation	Description
1	858078.09	801740.99	1503.94	FD 3-1/2" FCDMC BRASS CAP SET IN TOP OF CONCRETE ON WEST SIDE OF CHANNEL
2	858575.43	801692.74	1507.05	FD 3-1/2" FCDMC BRASS CAP SET IN TOP OF CONCRETE ON WEST SIDE OF CHANNEL
3	859077.80	801719.96	1510.25	FD 3-1/2" FCDMC BRASS CAP SET IN TOP OF CONCRETE ON WEST SIDE OF CHANNEL
4	859570.00	801704.41	1512.56	FD 3-1/2" FCDMC BRASS CAP SET IN TOP OF CONCRETE ON WEST SIDE OF CHANNEL
5	860074.02	801693.93	1513.25	FD 3-1/2" FCDMC BRASS CAP SET IN TOP OF CONCRETE ON WEST SIDE OF CHANNEL

Datum:
Arizona State Plane Central Grid Coordinates (Zone 0202)
NAD 83(2007)
NAVD 88 Geoid 09

Methodology:
Values for each of the coordinate positions above were determined from an average of 5 (minimum) 180 epoch RTK data solutions collected at each of the brass cap monuments.

Base Point:
NGS PID DU1317, Designation G 474
Found brass cap in rock outcrop

Northing	Easting	Elevation
876748.280	816963.880	1748.03

EXPIRES 03-31-2013