West Speedway Wash Letter of Map Revision Technical Data Notebook

Prepared by:

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Approved by

Suzanne Shields, PE
Director

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DATE SIGNED 5/6/2010
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97 E Congress Street
Tucson Arizona, 85701

List of Tables

List of Figures

Exhibit

Section 1 Introduction

1.1 Propose

This Technical Data notebook (TDN) has been prepared for a Letter of Map Revision (LOMR) application for a portion of the West Speedway Wash (WSP) located in Pima County, Arizona. The objective of the TDN and LOMR submission is provide regulatory discharge rates and floodplain limits along the West Speedway Wash using better topographic, hydrologic, and hydraulic data.

This TDN was prepared in accordance with the "Instructions for Organizing and Submitting Technical Documentation for Flood Studies" prepared by the Arizona Department of Water Resources, Flood Mitigation Section (Arizona State Standard, SSA 1-97) and FEMA Guideline. FEMA LOMR forms are included in this TDN.

1.2 Project Authority

The State of Arizona has delegated the responsibility to each county flood control district to adopt floodplain regulations designed to promote the public health, safety and general welfare of its citizenry as provided under the Arizona Revised Statutes, Title 48, Chapter 21, Article 1, Sections 48-3601 through 3627. More specifically, A.R.S. 3609 directs county flood control districts to adopt floodplain regulations that:

> A. Regulate all development of land, construction of residential, commercial or industrial structures or uses of any kind which may divert, retard or obstruct flood water and threaten public health or safety or the general welfare; and
> B. Establish minimum flood protection elevations and flood damage prevention requirements for uses, structures and facilities which are vulnerable to flood damage; and
> C. Comply with state and local land use plans and ordinances, if any.
> In conformance with A.R.S. 3609, this ordinance provides for protection of the public health safety and welfare by regulation of flood and erosion hazard areas to control flood hazards and prevent repetitive loss from flood damage.
> D. The flood hazard areas of Pima County are subject to periodic inundation which may result in loss of life and property, create health and safety hazards, disrupt commerce and governmental services, require extraordinary public expenditures for flood protection and relief, and impair the tax base, all of which adversely affect the public health, safety, and general welfare.
> E. These flood losses are caused by the cumulative effect of obstructions in areas of special flood hazards which increase flood heights, flow velocities, and cause flood and erosion damage. Uses that are inadequately flood-proofed, elevated, or otherwise protected from flood damage, also contribute to the flood loss. (Ord. 2005 FC-2 § 2 (part), 2005).

Section 16 of the Pima County Ordinance describes the provisions for floodplain regulation in Pima County.

This study has been prepared by the Pima County Regional Flood Control District (RFCD):

Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701

The project was prepared by:

Evan Canfield, PE, Chief Hydrologist
Planning & Development Division
Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701

1.3 Project Location

The study reach of the West Speedway Wash (WSP) is located within a Federal Emergency Management Agency (FEMA)-designated "Zone A" flood-hazard area, as depicted on FIRM Map Panel Numbers 04019C1618K, and 1619K (February 8, 1999). No documented hydraulic analyses were found to determine the "Zone A", and the existing "Zone A" depiction is not consistent with current topography. The objective of the TDN and LOMR submission is provide regulatory discharge rates and floodplain limits along the West Speedway Wash using better topographic, hydrologic, and hydraulic data.

The study reach of the West Speedway Wash is located primarily west of Silverbell Rd. and extends to Sections 32 & 33, Township 13 South, Range 13 East, Pima County, Arizona (Fig. 1.1). The upstream study limit for the West Speedway Wash begins approximately 2500 feet downstream Ironwood Hills Dr. The West Speedway Wash enters study limit from the west and flows east until it converges with Silvercroft Wash just upstream of the Santa Cruz River.

1.3 Hydrologic and Hydraulic Methods

Hydrologic analysis was preformed to determine proposed regulatory discharge rate at Silberbell Rd using U.S. Army Corps of Engineers Computer Hydrologic Modeling System, HEC-HMS. Parameterization followed guidelines developed by Pima County Regional Flood Control District and described in technical Policy 018 (Tech 018, Appendix A). The proposed regulatory discharges are flow rates that have a 1-percent chance of being equaled or exceeded each year ("100-year" discharge rates). Hydraulic analysis was performed to delineate floodplain limit along the study reach of the West

Speedway Wash using U.S. Army Corps of Engineers Computer Backwater Model, HEC-RAS.

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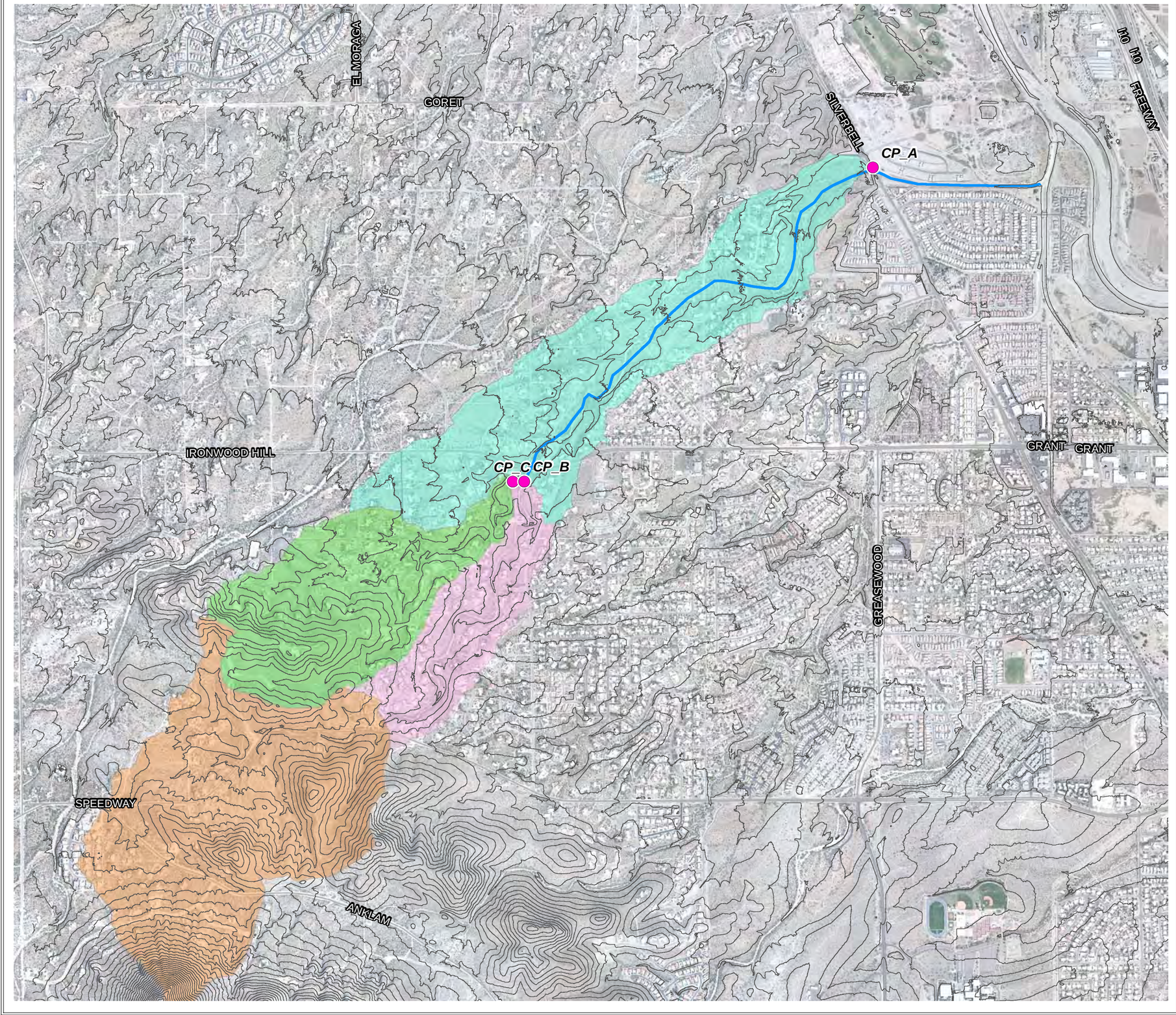
1.4 Acknowledgment

This study relied on assistance of RFCD GIS staff, who were integral to the development of the models and maps.

1.5 Study Results

The regulatory peak discharge rate was calculated at Silverbell Rd (CP A; Fig. 1.3). The estimated regulatory discharge rate is 1,458 cubic feet per second (cfs) with a drainage area of 1.42 square mile at CP A.

Figure 1.1
Watershed Map
West Speedway Wash

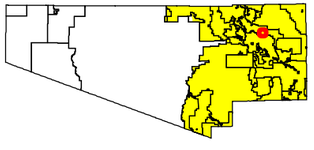


- Speedway CP
- River
- Speedway_contour20ft

Speedway Subbasins

- SPD_A
- SPD_B
- SPD_C
- SPD_D

Pima County Index Map



Index Map Scale 1:5,250,000

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

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Scale 1:300'

03/2010

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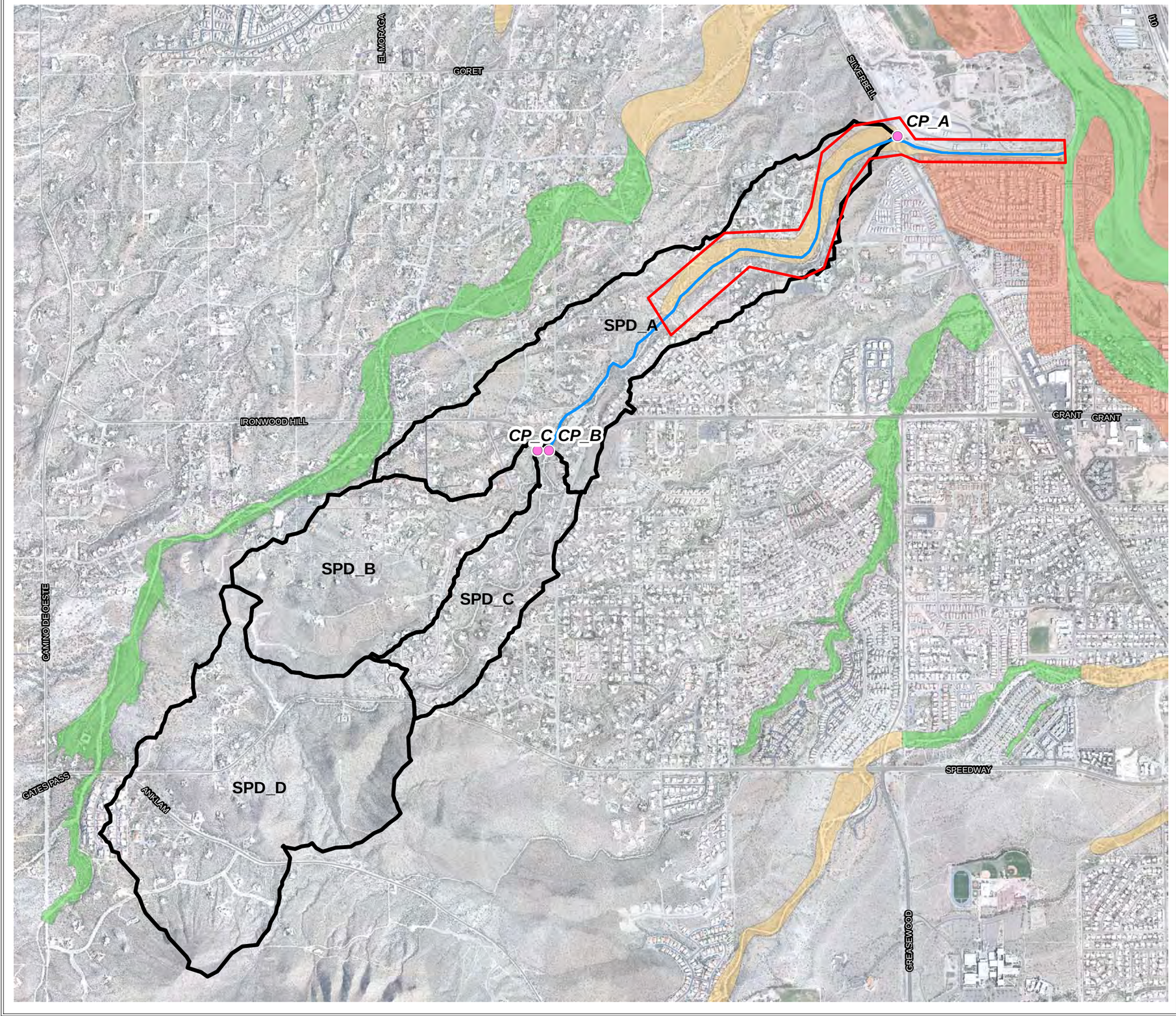
Figure 1.2
Study Limit Map
West Speedway Wash
with FEMA Floodplains



SpeedCP

River

Speedway Subbasins

Existing FEMA Floodplain

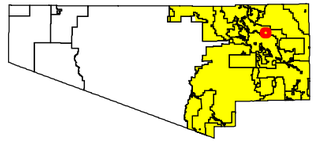
ZONE A

ZONE AE

ZONE X - SHADED

Study Limit Box

Pima County Index Map



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Pima County Regional Flood Control District

Scale 1:300'

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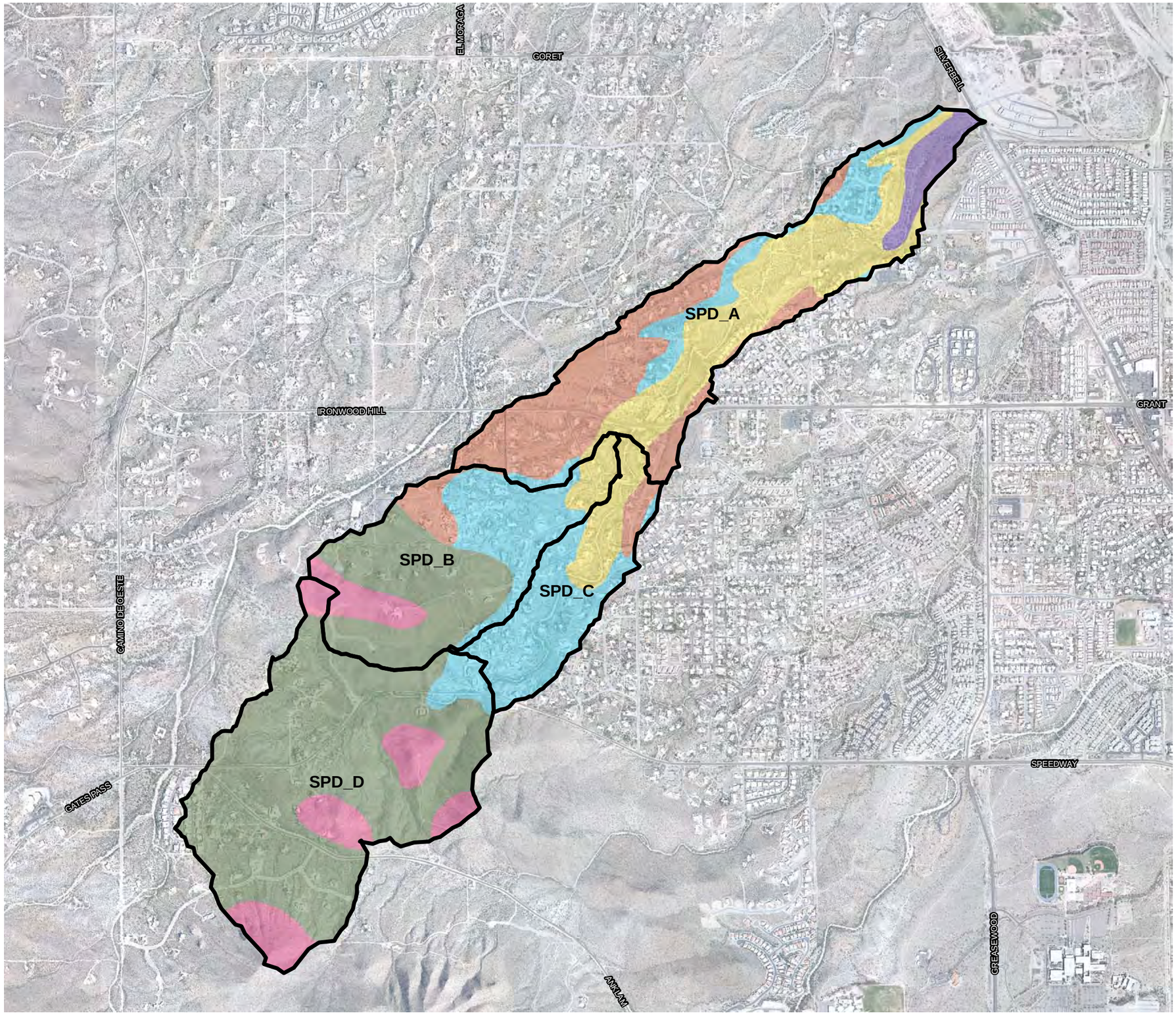
Figure 1.3
Soil Classification Map
West Speedway Wash



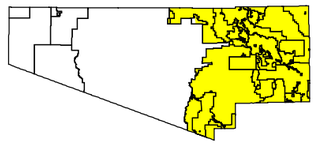
Subbasains

Soil Classification

- Soil Group: B (100%), GLENDALE SILT LOAM, 0 TO 3 PERCENT SLOPES
- Soil Group: B (100%), GRABE GRAVELLY LOAM, 1 TO 3 PERCENT SLOPES
- Soil Group: B (100%), PINALENO VERY COBBLY SANDY LOAM, 1 TO 8 PERCENT SLOPES
- Soil Group: B (100%), PINALENO-STAGECOACH COMPLEX, 5 TO 16 PERCENT SLOPES
- Soil Group: B (82%) C (18%), PINALENO-STAGECOACH-PALOS VERDES COMPLEX, 10 TO 35 PERCENT SLOPES
- Soil Group: C (47%) D (53%), PANTANO-GRANOLITE COMPLEX, 5 TO 25 PERCENT SLOPES
- Soil Group: D (100%), ANKLAM-CELLAR-ROCK OUTCROP COMPLEX, 15 TO 55 PERCENT SLOPES

2008PAGclr01ft.ecw

Pima County Index Map



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Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

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Scale 1:300'

05/2010

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Section 2 FEMA Forms

2.1 Study Documentation Abstract for FEMA submittals

2.1.1 Date Study Accepted: _____

2.1.2 Study Contractor:

Planning and Development Division,
Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701
(520) 243-1800

Prepared by Evan Canfield, PE, Chief Hydrologist

2.1.3 Local Technical Reviewer:

Terry Hendricks, C.F.M, Chief Hydrologist
Planning and Development Division,
Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701
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2.1.4 Reach Description

The study reach of the West Speedway Wash is located within a Federal Emergency Management Agency (FEMA)-designated “Zone A”, as depicted on FIRM Map Panel Numbers 04019C1618K, and 1619K (February 8, 1999). The study reach of the West Speedway Wash is located primarily west of Silverbell Rd., Pima County, Arizona (Fig. 1.1), though it originates at the confluence with Silvercroft Wash.. The study reach of the West Speedway Wash is primarily composed of sand channel and the bottom of the reach is relatively clean with vegetation cover. The overbank of the reach is covered with desert brush.

2.1.5 USGS Quad Sheets

Not available for this study

2.1.6 Unique Conditions and Problems

None.

2.1.7 Coordination of Peak Discharges

The 100-year regulatory discharge rate at the Silverbell Rd. was computed using HEC-HMS, assuming no base flow in the watersheds and no transmission loss within the reaches. The hydraulic data used to derive parameters for HEC-HMS was obtained using HEC-RAS. The discharge rate was acceptable per Suzanne Shields, Director of the Pima County Regional Flood Control District and Andy Dinauer of the City of Tucson

2.2 FEMA Forms

The FEMA MT-2 forms are included in Appendix B of this TDN.

Section 3 Survey and Mapping Information

3.1 Field Survey Information

None.

3.2 Mapping

The topographic data was obtained using HEC-GeoRas and ArcGIS. Digital Terrain Model (DTM) derived from 2008 Light Detection and Ranging (LiDAR) data was used to create 2-foot interval contour map.

The following data was used in this TDN;

The aerial photo: 2008 PAG aerial photo
Projection: UTM, Zone 12
Units: International feet
The contour interval of the topographic map is 2 feet.

The documentation showing that this Lidar data set is FEMA-compliant is included in Appendix C.

Section 4 Hydrology

4.1 Method Description

The 100-year peak discharges for the four subbasins of the West Speedway Wash (WSP A, B, C, and D; Fig. 1.3) were calculated using U.S. Army Corps of Engineers Computer Hydrologic Modeling System, (HEC-HMS) version 3.4. The HEC-HMS model requires the parameters regarding rainfall, topography, soil, vegetation, and channel characteristics to determine runoff volume and peak discharge. Those parameters were determined according to the Pima County Regional Flood Control District Technical Policy 018 (Tech-018). Tech-018 is included in Appendix A. The HEC-HMS model is included in Appendix D.

4.2 Parameter Estimation

4.2.1 Drainage Area

Subbasin boundaries were delineated using the hydrology function of ArcGIS with 2008 Lidar Data. A 2-ft contour map was used to make sure if the subbasin delineation was reasonable.

4.2.2 Watershed Work Map

A watershed work map is shown on Figure 1.3. Four subbasins were delineated for HEC-HMS hydrologic analysis. Three concentration points were included in the study watershed (CP A, B, C, and D). A 100-year peak discharge at Silverbell Rd. (CP A) was used for HEC-RAS hydraulic analysis.

4.2.3 Gage Data

No gage data were used in this TDN.

4.2.4 Spatial Parameters

No spatial parameters were used in this TDN.

4.2.5 Precipitation

According to the Tech-018, the 3-hour storm shall be used as rainfall data in the HEC-HMS model in the case that a time of concentration (Tc) is equal or less than three hours. A 3-hour storm was selected for a peak discharge calculation for the West Speedway Wash, since Tc was less than 3 hours in all the sub-basins.

A point 3-hour rainfall depth at the coordinates of the centroid of the watershed was obtained from NOAA Atlas 14, upper 90% confidence interval precipitation frequency estimate (NOAA 14 rainfall). Areal reduction factor was applied to watersheds larger than 1 square mile, as described in Tech-018. The 3-hour rainfall depth for the West Speedway Wash watershed is 3.14 inches. The areal reduction factor of 0.96 was applied to CP A.

4.2.6 Physical Parameters

The physical parameters for the subbasins and reaches of the HEC-HMS model were summarized in Tables 1 and 2. As mentioned in 4.1, all the methods and parameters were determined following Tech-018. Table 1 summarizes the method used for a HEC-HMS analysis.

Table 1 Methods used for a HEC-HMS analysis

	Selected Method
Rainfall Depth	NOAA 14, upper 90% Confidence Interval
Rainfall Distribution	3-hr SCS Type II Storm
Rainfall Loss	SCS Curve number
Time of Concentration	SCS Segmental Method
Transform	SCS Unit Hydrograph
Routing	Modified-Puls

The SCS Curve Number (CN) method was utilized as a rainfall loss method in the HEC-HMS model. The CN was determined using the Curve Number table associated with the PC Hydro User Guide (Arroyo Engineering, 2007) and a Hydrologic Soils Group map. The CN was not adjusted for rainfall intensity or antecedent moisture conditions. The SCS Unit Hydrograph method was used as a transform method. Impervious cover was determined using the 2008 PAG aerial photograph and Table 3 in the PC Hydro User Guide (Arroyo Engineering, 2007). The combination of the kinematic wave method and the U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (Tc) calculation method (USDA-NRCS, 1986) was used to determine Tc, following the recommendation on Tech-018. The Tc was calculated by summing the travel time for sheet flow, shallow concentrated flow and channel flow. The Tc for sheet flow was estimated using the kinematic wave equation. Manning's roughness coefficient for sheet flow was obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986). HEC-GeoRAS and HEC RAS were used to

estimate average velocity of channels. The detail of the Tc calculation is included in Appendix D.

Table 2 Physical Parameters for the Sub-Basins

Sub-Basin	Area (sq mi)	CN	Impervious Area (%)	Vegetation Cover (%)	Lag Time (min)
SPD_A	0.44	84.8	15.0	30	26.1
SPD_B	0.3	87.3	10.0	30	15.4
SPD_C	0.154	85.6	20.0	30	11.8
SPD_D	0.53	89.1	5.0	30	13.5

Runoff from subbasins was routed using the Modified-Puls method.Storage discharge tables for the channel routing were developed using HEC-GeoRAS and HEC-RAS. Six different discharges were used for storage-discharge relations. The number of subreaches was calculated using the following method:

$$V_w = 1.5 * V_{ave} \text{.....} eq.1$$

$$K = \frac{L}{V_w} \text{.....} eq.2$$

Therefore,

$$N = \frac{K}{\Delta t} \text{.....} eq.3$$

where V_{ave} is average flow velocity, L is reach length, V_w is velocity of flood wave (a conversion factor of 1.5 is used for natural channels), K is hydrograph travel time, Δt is the time interval for computations in the model, and N is the number of steps in the reach routing. Eq.4 was obtained from eq.1, 2, and 3. The detail of the calculation of the number of subreach is included in Appendix D.

4.3 Problems Encountered During the Study

4.3.1 Special Problems and Solutions

There were no problems with the hydrologic modeling.

4.3.2 Modeling Warning and Error Messages

The time interval of the rainfall data used in this study is 5 minutes, while the simulation time interval is 1 minute. The HEC-HMS model interpolated the 5-minute time interval of the rainfall data to 1-minute time interval.

4.4 Calibration

No calibration was conducted in this study.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

The 100-year peak discharges for the West Speedway Wash subbasins and at CP A were determined using the HEC-HMS. The results are summarized Tables 3 and 4.

Table 3 Summary of the Hydrologic Analysis Results for Sub-Basins

Sub-Basin	Area (sq mi)	Rainfall Depth (in)	Runoff Volume (in)	Peak Discharge (cfs)
SPD_A	0.44	3.14	1.58	496
SPD_B	0.3	3.14	1.77	541
SPD_C	0.154	3.14	1.64	298
SPD_D	0.53	3.14	1.92	1107

Table 4 Summary of the Hydrologic Analysis Results at the Concentration Points

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q100 HMS (cfs)	Time to Peak
CP A	**at Sliverbell Rd**	1.42	3.14	1.69	1,458	2:24
CP B	**at Ironwood Hills**	0.98	3.14	1.89	1,637	1:45
CP C	**at Speedway Blvd**	0.53	3.14	1.75	1,107	1:37

4.5.2 Verification results

An existing 100-year regulatory discharge near the CP A was shown in Table 5. The comparison shows that the 100-year peak discharges estimated in this study is very close to the existing value. The peak discharge was also compared with the peak discharge obtained from USGS Regression Equation 13 (Thomas et al., 1997) (Table 5). The

comparison showed that the HMS-derived peak discharge was approximately the same as the ones derived from the Regression Equation.

Table 5 Comparison of a peak discharge

Concentration Point	Location	Area (sq mile)	Q100 HMS (cfs)	Q100 RRE (cfs)
CP A	**at Sliverbell Rd**	1.42	1,458	1,584
CP B	**at Ironwood Hills**	0.98	1,637	1,242
CP C	**at Speedway Blvd**	0.53	1,107	810

Section 5 Hydraulics

5.1 Method Description

The hydraulic modeling for the Sweetwater was performed using Hec-Ras, Version 4.0 (HEC-RAS), HEC-GeoRAS, Version 4.1.1 (HEC-GeoRAS), and ArcGIS, Version 9.3.

As previously mentioned, DTM derived from 2008 LiDAR data was used to create a 2-foot contour map. The locations of the stream centerline, cross-sections, and bank of the West Speedway Wash were determined using the contour map and 2008 PAG aerial photos. The physical attributes of the wash were digitized in ArcGIS using the HEC-GeoRAS extension and then exported to HEC-RAS to create geospatially referenced geometric data (cross section, reach profile). Other parameters for the steady-state analysis, such as Manning's n-values, expansion and contraction coefficients, boundary condition, and ineffective flow areas were manually input into HEC-RAS. The hydraulic data obtained from HEC-RAS were then imported into HEC-GeoRAS to delineate a floodplain boundary in the study area.

Hydraulic analysis was performed in the area currently mapped as FEMA Zone A. Steady flow analysis was performed to determine 100-year water surface elevations in the study area by using HEC-RAS. As described above, geometric data for HEC-RAS including stream centerline, flow paths and cross-sections were obtained using HEC-GeoRAS. Normal-depth with a slope of 0.01 was assumed for the upstream boundary condition for the western reach.

5.2 Work Study Maps

The work study map for the West Speedway Wash is included in Exhibit 1.

5.3 Parameter Estimation

5.3.1 Roughness Coefficients

Manning's n values were determined by a combination of a site visit and 2008 PAG aerial photo. Manning's n value of 0.06 was assigned for the overbank with desert brush along the West Speedway Wash. The value of 0.06 was assigned to a channel upstream of Silverbell Rd, and 0.035 in the constructed reach downstream of Silverbell Rd.

5.3.2 Expansion and Contraction Coefficients

The channel of the West Speedway Wash is assumed to have generally gradual transitions with minimum curvature. The expansion coefficient of 0.30 and contraction coefficient of 0.10 were used for the entire study reach.

5.4 Cross-Section Description

A 5-foot interval contour map was used to select the location of cross sections. Cross-section locations were determined primarily based on the channel topography. The cross-section lines were drawn to be perpendicular to flow paths in Hec-GeoRAS.

5.5 Modeling Consideration

5.5.1 Hydraulic Jump and Drop Analysis

No hydraulic, drop analyses or adjustment of the floodplain was conducted in this study.

5.5.2. Bridges and Culverts

A box culvert was on Speedway Wash at Silverbell Rd in 1986. It consists of six 10' x 6' boxes that are about 0.5' filled with sediment. It is aligned with the wash, which means the boxes are oriented about 45 degrees to the road (i.e. about 45 degrees off perpendicular). The plans for this culvert are presented in Appendix E.

5.5.3 Levees and Dikes

There are no levees or dikes located within the study limit.

5.5.4 Island and Flow Splits

There were no islands or flow splits modeled.

5.5.5 Ineffective Flow Areas

Ineffective flow option was modeled in the following situations. In general these ineffective flow areas were disconnected overbank areas that would not convey flow to the next downstream cross-section.

5.6 Floodway Modeling

No floodway modeling was performed in this study.

5.7 Problems Encountered

5.7.1 Special Problems and Solutions

There are no special problems in the study limit.

5.7.2 Model Warnings and Errors

No errors occurred. The following warning messages occurred:

Divided flow
Energy loss greater than 1.0
Energy equation could not be balanced and defaulted to critical.
Cross-section extended vertically.
Multiple critical depths calculated.
Conveyance ratio is less than 0.7 or greater than 1.4.

Inspection indicated that the modeling is accurate given the channel conditions. In most cases, a subcritical solution was found. However, in some cases the errors require a critical solution which is reasonable for in steeper portions of this watercourse. A summary of errors is available in the error summary in the HEC-RAS model in Appendix E.

5.8 Calibration

The model was not calibrated in this study.

5.9 Final Results

5.9.1 Hydraulic Analysis Results

The HEC-RAS modeling results are summarized in Appendix E.

5.9.2 Verification of Results

The floodplain limit produced in this West Speedway Wash LOMR study was compared to the existing FEMA floodplain limit. The proposed floodplain limit tends to follow the existing floodplain limit. The results suggest that the proposed floodplain limit is reasonable based on the topography.

Section 6 Erosion and Sediment Transport

No erosion or sediment transport analysis was conducted in this study.

Section 7 Draft FIS Report Data

7.1 Summary of Discharges

Peak discharges at CP A was used for the hydraulic analysis in this study. The estimated regulatory discharge rates are 1458 cubic feet per second (cfs) with a drainage area of 1.42 square mile.

7.2 Floodway Data

Not applicable.

7.3 Annotated Flood Insurance Rate Map

An annotated Flood Insurance Rate Map (FIRM) is included in Exhibit 2.

7.4 Flood Profiles

Flood profiles are included in the HEC-RAS model in Appendix E.

A.1 Data Collection Summary

Aldridge, B. and J. Garrett. 1973. Roughness Coefficients for Stream Channels in Arizona. US Department of the Interior Geological Survey. Tucson, AZ.

Arizona Department of Water Resources, Flood Mitigation Section
"Instruction for Organization and Submitting Technical Document for Flood Studies" SSA1-97, November 1997

Arizona Department of Water Resources, Flood Mitigation Section
"Requirements for Flood Study Technical Documentation" SS1-97, November 1997

Arroyo Engineering. 2007. PC-Hydro User Guide. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona. Revised in 1998.

National Weather Service. 1984. Depth-Area Ratios in the Semi-Arid Southwest United States, NOAA Technical Memorandum NWS Hydro-40

Phillips, J., and S. Tadayon. 2006. Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

Phillips, J., and T. Ingersoll. 1998. Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona. U.S. Geological Survey Professional Paper 1584.

Pima County Regional Flood Control District
"Pima County Mapguide Map", 2008

U.S. Army Corps of Engineers (COE). 1998. HEC-1 Flood Hydrograph Package, Users Manual, CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. HEC-RAS, River Analysis System, Hydraulic
Reference Manual, CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. Geospatial Hydrologic Modeling Extension HEC-GeoHMS, (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2006. HEC-HMS, Hydrologic Modeling System User's Manual, (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.

A 2. Referenced Documents

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

Eychaner, J.H., 1984. Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. Design Hydrology and Sedimentology for Small Catchments, Academic Press.

Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States. USGS Water Supply Paper 2433. 195 p.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY
(DRAFT)

POLICY NAME: Acceptable Model Parameterization for Determining Peak Discharge

POLICY NUMBER: Technical Policy, TECH-018

EFFECTIVE DATE: To be Determined
(comment period from October 1, 2008 to March 1, 2009)

PURPOSE

To standardize the parameterization of hydrologic models.

BACKGROUND

When peak discharges need to be established or revised, a computer-based hydrologic model or previously-accepted discharge value may be used. Technical Policy 015 describes which models are acceptable for determining peak discharges. Once a model is selected, this policy describes which parameterization shall be used for submittals to the Pima County Regional Flood Control District (District).

POLICY

A. **Watershed Delineation:** The accuracy of watershed delineation and flow path identification is critical in hydrologic modeling. The District requires the use of 2-foot contour interval (or finer where available) contour maps, such as the Pima Association of Governments (PAG) contour maps for delineation of basin boundaries and flow paths in all areas other than steep terrain. In areas of steep terrain, or where 2-foot or finer contour interval maps are not available, U.S. Geologic Survey (USGS) contour maps (7.5 minute series) may be used. At the discretion of the District, it may be necessary to acquire topographic data that has been sealed by a Professional Civil Engineer (PE), or Registered Land Surveyor (RLS) registered in the State of Arizona. In regulatory sheetflood areas, both 2-foot or finer contour interval maps and aerial photos with a resolution sufficient to determine flow paths and watershed boundaries shall be used. If Geo-HMS (COE, 2003) is used, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs derived from lidar data from PAG or other reputable vendors, may be used. With the approval of the District, alternative topographic data, such as stereo photography may be used.

B. **Pima County Hydrology Procedures:** Peak discharges calculations performed using the Pima County Hydrology Procedures shall follow the guidance for

parameterization provided in the PC- Hydro User Guide (Arroyo Engineering, 2007).

C. **HEC-1 and HEC-HMS:** Peak discharges calculated using HEC-HMS (COE, 2006) or HEC-1 (COE, 1998) shall employ the following parameterization:

a. ***Rainfall Loss Method:*** Models shall employ the U.S Soil Conservation Service (SCS) Curve Number method using the Curve Number tables and Hydrologic Soils Group maps associated with the PC Hydro User Guide (Arroyo Engineering, 2007). The Curve Number shall not be adjusted for rainfall intensity or antecedent moisture conditions.

b. ***Time of Concentration Calculation:*** The U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (T_c) calculation shall be employed (USDA-NRCS, 1986). The Tc shall be calculated by summing the travel time for overland flow, shallow concentrated flow and channel flow, along the primary flow path. Manning's roughness coefficient for sheet flow shall be obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986). Maximum slope length for sheet flow shall be 100 feet. Manning's roughness coefficient for concentrated flow shall be determined using the method described in the District's Technical Policy 019.

c. ***Transform:*** The SCS Unit Hydrograph method shall be used.

d. ***Channel Routing:***

i. ***Routing in Natural Channels:*** Runoff can be routed using the Modified-Puls method for natural channels with the slope less than 1%. If HEC-1 is used, an 8-point cross-section may be used. A storage discharge table must be developed if HEC-HMS is used. Such a table can be developed using cross-sections and slopes derived from a Manning normal depth analysis or HEC-RAS (COE, 2001). The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manuals. Selection of Manning's n values shall conform to the guidance in Technical Policy 019.

ii. ***Routing in Constructed Channels and Steep Channel:*** Shall use the kinematic wave for constructed channels and channels with the slope greater than 1%. Reach length, slope, bottom of width and side slope may be obtained using the data utilized for watershed delineation (e.g. 2-foot contour interval contour maps, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs). Selection of Manning's n values shall conform to the

guidance in Technical Policy 019. The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manuals.

e. ***Rainfall:*** The NOAA 14 Upper 90% rainfall shall be used as described in the District's Technical Policy 010. Point rainfall depth shall be evaluated for each basin or subbasin, based on the latitude and longitude of the centroid of the basin or subbasin.

f. ***Rainfall Distribution:*** Pima County is evaluating rainfall data to determine if the following rainfall distributions are reasonable. In the interim, the higher peak discharge calculated using the following two distributions shall be used:

   i. **SCS Type II 3-hr Storm:** The 3-hr distribution shall be used as the local storm. In general, this includes watersheds with a time of concentration (T_c) equal to or less than three hours (see Haan et al 1994).

   ii. **SCS Type I (24 hr):** The SCS Type I rainfall (NRCS, 1986) may apply for general storms on watersheds with times of concentration (T_c) greater than three hours.

g. ***Rainfall Aerial Reduction:*** Aerial reduction shall be estimated using Hydro-40 (National Weather Service, 1984) for the watershed and event of interest (i.e. same tables as Arizona State Standard). Aerial reduction shall be applied to watersheds larger than 1 square mile.

D. **Comparison of peak discharge**: Recommend to compare the peak discharge calculated using the Pima County Hydrology Procedures and the peak discharge obtained from USGS Regression Equation 13 (Thomas et al., 1997) and/or the equation developed by Eychaner (1984) (See Appendix).

REFERENCES

Aldridge, B. and J. Garrett. 1973. *Roughness Coefficients for Stream Channels in Arizona.* US Department of the Interior Geological Survey. Tucson, AZ.

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona.* Revised in 1998.

Eychaner, J.H., 1984. *Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods*: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. *Design Hydrology and Sedimentology for Small Catchments*, Academic Press.

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Phillips, J., and S. Tadayon. 2006. *Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona*: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

Phillips, J., and T. Ingersoll. 1998. *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona.* U.S. Geological Survey Professional Paper 1584.

Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. *Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States*. USGS Water Supply Paper 2433. 195 p.

U.S. Army Corps of Engineers (COE). 1998. *HEC-1 Flood Hydrograph Package, Users Manual,* CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. *HEC-RAS, River Analysis System, Hydraulic*
Reference Manual, CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. *Geospatial Hydrologic Modeling Extension HEC-GeoHMS,* (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2006. *HEC-HMS, Hydrologic Modeling System User's Manual,* (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. *Urban Hydrology for Small Watersheds,* Technical Release 55. Washington, DC.

APPROVED BY:

_____

_____

Suzanne Shields, P.E. **Date**
Director and Chief Engineer

Appendix for Tech-018

1.) USGS Regression Equation 13: The current regional regression relationship for southern Arizona is regression equation 13 from Thomas et al (1994). This method predicts peak discharge in cfs (Qp) as a function of watershed Area (square miles) only. It has the form:

$$Qp100 = 10^{(5.52 - 2.42 * A^{-0.12})}$$

2.) Eychaner 1984 (rural): This is a USGS publication that was prepared in cooperation with the City and County. It presents a series of regression equations that rely on watershed area (sq. miles), main channel slope (%), channel length (miles) and a shape factor to account for the differences in runoff noted between long watersheds and more traditionally-shaped watersheds. The equation for the 100 year peak discharge is:

$$Qp100 = 10^{(3.044 + 0.646(\log A) - 0.49(\log A)^2 + 0.706(\log S) - 0.367(\log S)^2 - 0.614(\log S)(LogSh))}$$

The shape factor (Sh) is calculated as (channel length)2/(Area)

3.) Eychaner 1984 (urban): This equation adjusts Eychaner's rural equation to account for the amount of impervious area, channel lining and channel modification. It is:

$$Qp100 = 7.7A^{0.15}(13 - BDF)^{-0.32} Qp100^{0.82}$$

The Basin Development Factor (BDF) is a scoring factor to account for the degree of urbanization. The specific scoring is based on four factors described in pages 10-13 of the manual.The lower, middle and upper portions of a watershed are scored separately and the results are summed. The maximum BDF score is 12, and a score of 0 indicates that the rural equation should be used. (The Qp100 in the equation is the Qp100 calculated using Eychaner's rural method described in section 2 above.)

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY

POLICY NAME: Acceptable Model Parameterization for Determining Peak Discharges

POLICY NUMBER: Technical Policy, TECH-018

EFFECTIVE DATE: May 1, 2010

PURPOSE

To standardize the parameterization of hydrologic models.

BACKGROUND

When determining peak discharges, a computer-based hydrologic model or previously-accepted discharge value may be used. Technical Policy *TECH-015, Hydrologic Model Selection for Peak Discharge Determination*, describes which models are acceptable for determining peak discharges. The Pima County Hydrology Procedures shall be used for riverine watersheds with an area less than 1 square mile. Peak discharges calculations performed using the Pima County Hydrology Procedures shall follow the guidance for parameterization provided in the PC- Hydro User Guide (Arroyo Engineering, 2007). Technical Policy *TECH-018* shall be applied to riverine watersheds with an area larger than 1 square mile but smaller than 20 square mile. This policy describes which parameterization shall be used for submittals to the Pima County Regional Flood Control District (District).

POLICY

A. **Watershed Delineation:** The accuracy of watershed delineation and flow path identification is critical in hydrologic modeling. The District requires the use of 2-foot contour interval (or finer where available) maps, such as the Pima Association of Governments (PAG) contour maps for delineation of basin boundaries and flow paths in all areas other than steep terrain. In areas of steep terrain, or where 2-foot or finer contour interval maps are not available, U.S. Geologic Survey (USGS) contour maps (7.5 minute series) may be accepted. At the discretion of the District, topographic data that has been sealed by an Arizona registered civil engineer (PE), or land surveyor (RLS) may be required. In regulatory sheetflood areas, both 2-foot or finer contour interval maps and aerial photos with a resolution sufficient to determine flow paths and watershed boundaries shall be used. If Geo-HMS (COE, 2003) is used, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs derived from lidar data from PAG or other reputable vendors, may be used. With the approval of the District, alternative topographic data, such as stereo photography may be used.

B. **Pima County Hydrology Procedures:** Peak discharges calculations performed using the Pima County Hydrology Procedures shall follow the guidance for parameterization provided in the PC- Hydro User Guide (Arroyo Engineering, 2007).

C. **HEC-1 and HEC-HMS:** Peak discharges calculated using HEC-HMS (COE, 2006) or HEC-1 (COE, 1998) shall employ the following parameterization:

a. ***Rainfall Loss Method:*** Models shall employ the U.S Soil Conservation Service (SCS) Curve Number method using the Curve Number tables, Vegetation map and Hydrologic Soils Group map associated with the PC Hydro User Guide (Arroyo Engineering, 2007) shall be used. The default vegetation cover percent provided in the PC- Hydro User Guide (Arroyo Engineering, 2007) shall be used. unless additional justification is provided. The Curve Number shall not be adjusted for rainfall intensity or antecedent moisture conditions.

b. ***Time of Concentration Calculation:*** The modified U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (T_c) calculation shall be employed (USDA-NRCS, 1986). The Tc shall be calculated by summing the travel time for sheet flow, shallow concentrated flow and channel flow, along the primary flow path.

i. For sheet flow segment:

1. Manning's roughness coefficient for sheet flow shall be obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986).
2. Maximum slope length for sheet flow shall be 100 feet.
3. The Kinematic wave method shall be used to estimate the travel time for sheet flow.

ii. For shallow concentrated flow segment:

1. The travel time for shallow concentrated flow using the velocity determined from Figure 3-1 of Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986).

iii. *For channel flow*

1. Manning's roughness coefficient for channel flow shall be determined using the method described in the District's Technical Policy *TECH-019, Standards for Floodplain Hydraulic Modeling*.
2. HEC-RAS velocity or the Manning's equation may be used to estimate the travel time for channel flow.
3. The discharge used to calculate velocity shall be estimated by integrating the Regional Regression Equation 13 (Thomas et al., 1997) with respect to area (which is 0.667 x the discharge value calculated with Regional Regression Equation 13).

c. ***Transform:*** The SCS Unit Hydrograph method shall be used.

d. ***Channel Routing:***

1.) ***Routing in Natural Channels:*** Runoff shall be routed using the Modified-Puls method for natural channels with the slope less than 1.5%. A storage discharge table is required if HEC-HMS is used. Such a table can be developed using cross-sections and slopes derived from a Manning normal depth analysis or HEC-RAS (COE, 2001). The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manual. Initial discharge to estimate HEC-RAS velocity for channel flow should be determined using discharge calculated with USGS Regression Equation 13 (Thomas et al., 1997).

2.) ***Routing in Constructed Channels and Steep Channel:*** Kinematic wave may be used for constructed channels and natural channels with slopes greater than 1%. Reach length, slope, bottom width and side slope may be obtained using the data utilized for watershed delineation (e.g. 2-foot contour interval contour maps, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs). Selection of Manning's n values shall conform to the guidance in Technical Policy *TECH-019, Standards for Floodplain Hydraulic Modeling*.. The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manuals.

e. ***Rainfall:*** The NOAA 14 Upper 90% rainfall shall be used as described in the District's Technical Policy *TECH-010, Rainfall Input for Hydrologic Modeling.* Point rainfall depth shall be evaluated for a watershed, based on the latitude and longitude of the centroid of the watershed. If appreciable elevation change occurs on a watershed, users should use different values for higher and lower elevations.

f. ***Rainfall Aerial Reduction:*** Aerial reduction shall be applied to watersheds larger than 1 square mile. Aerial reduction shall be estimated using Hydro-40 (National Weather Service, 1984) for the watershed and event of interest (i.e. same tables as Arizona State Standard).

g. ***Rainfall Distribution:*** The following rainfall distributions shall be used, with the highest peak discharge selected in order to determine the critical (i.e. storm that produces the highest discharge) :

1. **SCS Type II 3-hr Storm:** The 3-hr distribution shall be used as the local storm. In general, this includes watersheds with a time of concentration (T_c) equal to or less than three hours (Haan et al 1994).

3. **SCS Type I (24 hr):** The SCS Type I rainfall (NRCS, 1986) may apply for general storms on watersheds with times of concentration (T_c) greater than three hours.

D. **Comparison of peak discharge**: The peak discharge shall be compared with the peak discharge obtained from USGS Regression Equation 13 (Thomas et al., 1997) and/or the equation developed by Eychaner (1984) (See Appendix), and existing regulatory discharge estimate.

REFERENCES

Aldridge, B. and J. Garrett. 1973. *Roughness Coefficients for Stream Channels in Arizona.* US Department of the Interior Geological Survey. Tucson, AZ.

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona.* Revised in 1998.

Eychaner, J.H., 1984. *Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods*: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. *Design Hydrology and Sedimentology for Small Catchments*, Academic Press.

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Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. *Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States*. USGS Water Supply Paper 2433. 195 p.

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U.S. Army Corps of Engineers (COE). 2001. *HEC-RAS, River Analysis System, Hydraulic Reference Manual*, CPD-69, Hydraulic Engineering Center, Davis, CA.

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U.S. Army Corps of Engineers (COE). 2006. *HEC-HMS, Hydrologic Modeling System User's Manual*, (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. *Urban Hydrology for Small Watersheds*, Technical Release 55. Washington, DC.

APPROVED BY:

_____ _____

Suzanne Shields, P.E. **Date**
Director and Chief Engineer

Appendix

1.) USGS Regression Equation 13: The current regional regression relationship for southern Arizona is regression equation 13 from Thomas et al (1994). This method predicts peak discharge in cfs (Qp) as a function of watershed Area (square miles) only. It has the form:

$$Qp100 = 10^{(5.52-2.42*A^{-0.12})}$$

2.) Eychaner 1984 (rural): This is a USGS publication that was prepared in cooperation with the City and County. It presents a series of regression equations that rely on watershed area (sq. miles), main channel slope (%), channel length (miles) and a shape factor to account for the differences in runoff noted between long watersheds and more traditionally-shaped watersheds. The equation for the 100 year peak discharge is:

$$Qp100 = 10^{(3.044+0.646(\log A)-0.49(\log A)^2+0.706(\log S)-0.367(\log S)^2-0.614(\log S)(LogSh))}$$

The shape factor (Sh) is calculated as (channel length)2/(Area)

3.) Eychaner 1984 (urban): This equation adjusts Eychaner's rural equation to account for the amount of impervious area, channel lining and channel modification. It is:

$$Qp100 = 7.7A^{0.15}(13 - BDF)^{-0.32}Qp100^{0.82}$$

The Basin Development Factor (BDF) is a scoring factor to account for the degree of urbanization. The specific scoring is based on four factors described in pages 10-13 of the manual.The lower, middle and upper portions of a watershed are scored separately and the results are summed. The maximum BDF score is 12, and a score of 0 indicates that the rural equation should be used. (The Qp100 in the equation is the Qp100 calculated using Eychaner's rural method described in section 2 above.)

Appendix B FEMA MT-2 Form, General Documentation and Correspondence

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☒ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301 480287	City of Katy Harris County	TX TX	480301 48201C	0005D 0220G	02/08/83 09/28/90
040073	Pima County	AZ	04019C	1618K 1619K	02/08/99
040078	City oif Tucson	AZ	04019C	1619K	02/08/99

2. a. Flooding Source: West Speedway Wash

b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: WSpeedway

4. FEMA zone designations affected: A (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

a. The basis for this revision request is (check all that apply)

☐ Physical Change ☒ Improved Methodology/Data ☐ Regulatory Floodway Revision ☐ Base Map Changes

☐ Coastal Analysis ☒ Hydraulic Analysis ☒ Hydrologic Analysis ☐ Corrections

☐ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes

☒ New Topographic Data ☐ Other (Attach Description)

Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following structures (check all that apply)

Structures: ☐ Channelization ☐ Levee/Floodwall ☒ Bridge/Culvert

☐ Dam ☐ Fill ☐ Other (Attach Description)

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☒ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Evan Canfield, Ph.D., PE, C.F.M.	Company: Pima County Regional Flood Control	
Mailing Address: 97 E. Congress, Tucson AZ, 85701	Daytime Telephone No.: 520 243 1800	Fax No.: 520 243-1821
	E-Mail Address: evan.canfield@rfcd.pima.gov	
Signature of Requester (required): H. Evan Canfield	Date: 5/5/10	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Andrew Dinauer, Engineering Administrator	Community Name: City of Tucson	
Mailing Address: P.O. Box 27210 Tucson, AZ 85726-7210	Daytime Telephone No.: 520 791- 4251	Fax No.:
	E-Mail Address: adinaue1@ci.tucson.az.us	
Community Official's Signature (required):	Date: 5/4/10	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Howard Evan Canfield	License No.: 41917	Expiration Date: 3/31/2011
Company Name: Pima County Regional Flood Control	Telephone No.: 520 403-6378	Fax No.:
Signature: H. Evan Canfield		Date: 5/5/10

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☒ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

Registered Professional Engineer (Civil) CERTIFICATE NO. 41917 HOWARD EVAN CANFIELD Date Signed 5/5/10 ARIZONA, U.S.A. Seal (Optional)

Expires 3/31/2011

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☒ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Evan Canfield, Ph.D., PE, C.F.M.	Company: Pima County Regional Flood Control	
Mailing Address: 97 E. Congress, Tucson AZ, 85701	Daytime Telephone No.: 520 243 1800	Fax No.: 520 243-1821
	E-Mail Address: evan.canfield@rfcd.pima.gov	
Signature of Requester (required): H/ Evan Canfield	Date: 5/5/10	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Suzanne Shields, PE Chief Engineer	Community Name: :Pima County Flood Contro	
Mailing Address: 97 E Congress St Tucson, AZ 85701	Daytime Telephone No.: 520 243-1880	Fax No.: 520 243-1821
	E-Mail Address: suzanne.shields@rfcd.pima.gov	
Community Official's Signature (required): Suzanne Shields	Date: 5/5/10	

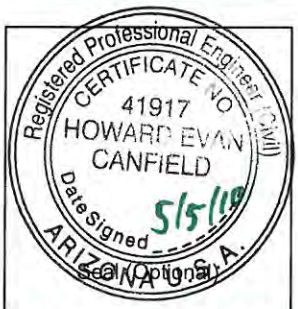
CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Howard Evan Canfield	License No.: 41917	Expiration Date: 3/31/2011
Company Name: Pima County Regional Flood Control	Telephone No.: 520 243-1836	Fax No.:
Signature: H/ Evan Canfield		Date: 5/5/10

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☒ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans



Expires 3/3/2011

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3.25 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: West Speedway Wash
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section B) ☐ No existing analysis ☒ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)
at Silverbell Rdi	1.42	N/A	1458

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model HEC-HMS
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit	Atthe confluence with Silvercroft Wash	St# 33		
Upstream Limit	5060 ft above Silverbell	St# 7701		

2. Hydraulic Method/Model Used

HEC-RAS

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs may help verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. **These tools do not replace engineering judgment.** CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. Review of your submittal and resolution of valid modeling discrepancies may result in reduced review time.

4. Models Submitted

Models Submitted	Natural Run	Floodway Run	Datum
Duplicate Effective Model*	File Name: N/A Plan Name: N/A	File Name: N/A Plan Name: NA	NA
Corrected Effective Model*	File Name: WSpeedway Plan Name: Plan01	File Name: Plan Name:	NAVD88
Existing or Pre-Project Conditions Model	File Name: N/A Plan Name:	File Name: Plan Name:	
Revised or Post-Project Conditions Model	File Name: N/A Plan Name:	File Name: Plan Name:	
Other - (attach description)	File Name: N/A Plan Name:	File Name: Plan Name:	

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☒ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:
   - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
   - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot.

   b. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☒ No
   If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR/CLOMR requests, does this request have the potential to impact an endangered species? ☐ Yes ☒ No

   If Yes, please submit documentation to the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA). Section 9 of the ESA prohibits anyone from "taking" or harming an endangered species. If an action might harm an endangered species, a permit is required from U.S. Fish and Wildlife Service or National Marine Fisheries Service under Section 10 of the ESA.

   For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: West Speedway Wash
Note: Fill out one form for each flooding source studied

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization ..... complete Section B
Bridge/Culvert ..... complete Section C
Dam/Basin ..... complete Section D
Levee/Floodwall ..... complete Section E
Sediment Transport..... complete Section F (if required)

Description Of Structure

1. Name of Structure: Culvert #1

Type (check one): ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure: Silverbell Rd

Downstream Limit/Cross Section: West of Silverbell Rdl

Upstream Limit/Cross Section: East ofSilverbell Rd

2. Name of Structure:

Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

3. Name of Structure:

Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure: .

Downstream Limit/Cross Section: .

Upstream Limit/Cross Section: .

NOTE: For more structures, attach additional pages as needed.

B. CHANNELIZATION

Flooding Source:

Name of Structure:

1. Accessory Structures

The channelization includes (check one):

- ☐ Levees [Attach Section E (Levee/Floodwall)]
- ☐ Superelevated sections
- ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)]
- ☐ Other (Describe):
- ☐ Drop structures
- ☐ Transitions in cross sectional geometry
- ☐ Energy dissipator

2. Drawing Checklist

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Hydraulic Considerations

The channel was designed to carry (cfs) and/or the -year flood.

The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions
☐ Other locations (specify):

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: West Speedway Wash

Name of Structure: Culverts #1 (Existing)

1. This revision reflects (check one):

☒ Bridge/culvert not modeled in the FIS
☐ Modified bridge/culvert previously modeled in the FIS
☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): HEC-RAS
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

- ☒ Dimensions (height, width, span, radius, length)
- ☒ Shape (culverts only)
- ☒ Material
- ☐ Beveling or Rounding
- ☒ Wing Wall Angle
- ☐ Skew Angle
- ☐ Distances Between Cross Sections
- ☐ Erosion Protection
- ☐ Low Chord Elevations – Upstream and Downstream
- ☐ Top of Road Elevations – Upstream and Downstream
- ☒ Structure Invert Elevations – Upstream and Downstream
- ☐ Stream Invert Elevations – Upstream and Downstream
- ☐ Cross-Section Locations

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

D. DAM/BASIN

Flooding Source:

Name of Structure:

1. This request is for (check one): ☐ Existing dam ☐ New dam ☐ Modification of existing dam

2. The dam was designed by (check one): ☐ Federal agency ☐ State agency ☐ Local government agency ☐ Private organization

   Name of the agency or organization:

3. The Dam was permitted as (check one):

   a. ☐ Federal Dam ☐ State Dam

      Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

      Permit or ID number Permitting Agency or Organization

   b. ☐ Local Government Dam ☐ Private Dam

      Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm?

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport).
   If No, then attach your explanation for why debris/sediment analysis was not considered.

6. Does the Base Flood Elevation behind the dam or downstream of the dam change?

   ☐ Yes ☐ No If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

   Stillwater Elevation Behind the Dam

FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)		
50-year (2%)		
100-year (1%)		
500-year (0.2%)		
Normal Pool Elevation		

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

☐ upgrading of an existing levee/floodwall system
☐ a newly constructed levee/floodwall system
☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc.	Station	to
☐ structural floodwall	Station	to
☐ Other (describe):	Station	to

c. Structural Type (check one):

☐ monolithic cast-in place reinforced concrete
☐ reinforced concrete masonry block
☐ sheet piling
☐ Other (describe):

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency?

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers:
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers:
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers:
4. A layout detail for the embankment protection measures. Sheet Numbers:
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers:

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater).	☐ Yes	☐ No
2.0 feet above the 1%-annual-chance stillwater surge elevation	☐ Yes	☐ No

E. LEVEE/FLOODWALL (CONTINUED)

2. Freeboard (continued)

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope landside is:

b. The maximum levee slope floodside is:

c. The range of velocities along the levee during the base flood is: (min.) to (max.)

d. Embankment material is protected by (describe what kind):

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

E. LEVEE/FLOODWALL (CONTINUED)

4. Embankment Protection (continued)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:

☐ Overall height: Sta. ; height ft.

☐ Limiting foundation soil strength:

Sta. , depth to

strength ϕ = degrees, c = psf

slope: SS = (h) to (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

c. Summary of stability analysis results:

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is hours.

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one):

☐ UBC (1988) or ☐ Other (specify):

b. Stability analysis submitted provides for:

☐ Overturning ☐ Sliding If not, explain:

c. Loading included in the analyses were:

☐ Lateral earth @ P_A = psf; P_p = psf

☐ Surcharge-Slope @ , ☐ surface psf

☐ Wind @ P_w = psf

☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = %g

☐ 1%-annual-chance significant wave height: ft.

☐ 1%-annual-chance significant wave period: sec.

d. Summary of Stability Analysis Results: Factors of Safety.

Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)

(Note: Extend table on an added sheet as needed and reference)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is ft. to ft.

c. Settlement of the levee crest is determined to be primarily from :

☐ Foundation consolidation
☐ Embankment compression
☐ Other (Describe):

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: acres
Draining to ponding area: acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

f. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No

If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is cfs

h. The length of levee system used to drive this seepage rate in item g: ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants:
For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No

Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

E. LEVEE/FLOODWALL (CONTINUED)

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No

If the answer is No to any of the above, please attach supporting documentation.

11. Maintenance Plan

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No
If No, please attach supporting documentation.

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

F. SEDIMENT TRANSPORT

Flooding Source:

Name of Structure:

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume acre-feet

Debris load associated with the base flood discharge: Volume acre-feet

Sediment transport rate (percent concentration by volume)

Method used to estimate sediment transport:

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition:

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport:
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

Explanation of Fee Payment

This LOMR is based on better data. The previous A-Zone did not follow the topography in the area. The new mapping uses FEMA-compliant Lidar data which greatly improves the topographic data used for the mapping. The hydrology was also updated using this better data.

An existing box culvert is included in the model. Since the culvert has been in place since 1986, it was included in the previous mapping.

Because this LOMR is based on better data, it is eligible to be reviewed without fee as described in the December 14, 2009 review fee schedule.

Appendix C: Survey Field Notes

Pima County Regional
FLOOD CONTROL
DISTRICT

PIMA COUNTY
REGIONAL FLOOD CONTROL DISTRICT
97 EAST CONGRESS STREET, THIRD FLOOR
TUCSON, ARIZONA 85701-1797

SUZANNE SHIELDS, P.E.
DIRECTOR

(520) 243-1800
FAX (520) 243-1821

January 2, 2009

Craig S. Kennedy, CFM, Program Specialist
Engineering Management Branch
Mitigation Directorate
FEMA
500C Street SW
Washington, DC 20472

Re: Re: Acceptability of LiDAR

Dear Mr. Kennedy:

The Pima Association of Governments (PAG) has contracted with Sanborn to generate ortho rectified aerial photography and LiDAR. Figure 1 shows the extent of the LiDAR coverage for Pima County and the FIRM Special Flood Hazard Areas. The next version of Flood Insurance Rate Maps for Pima County will be converted to the North American Vertical Datum of 1988 (NAVD88). Attached to this letter you will find a draft letter from Sanborn indicating the vertical accuracy of the LiDAR meets FEMA's Map Modernization requirements.

The Pima County Regional Flood Control District (District) requests that the documentation in the draft letter be examined by FEMA to verify the LiDAR and topography created from this data would meet FEMA's vertical requirements for mapping to the NAVD88 Datum. If acceptable, the District will request PAG to have Sanborn seal the documentation so that it may be used in FEMA re-mapping processes. The District understands the digital maps generated from the LiDAR would need to be re-projected to FEMA's UTM coordinate system for LOMR applications.

Please call me at 520-243-1800, should you have any questions with this request.

Sincerely,

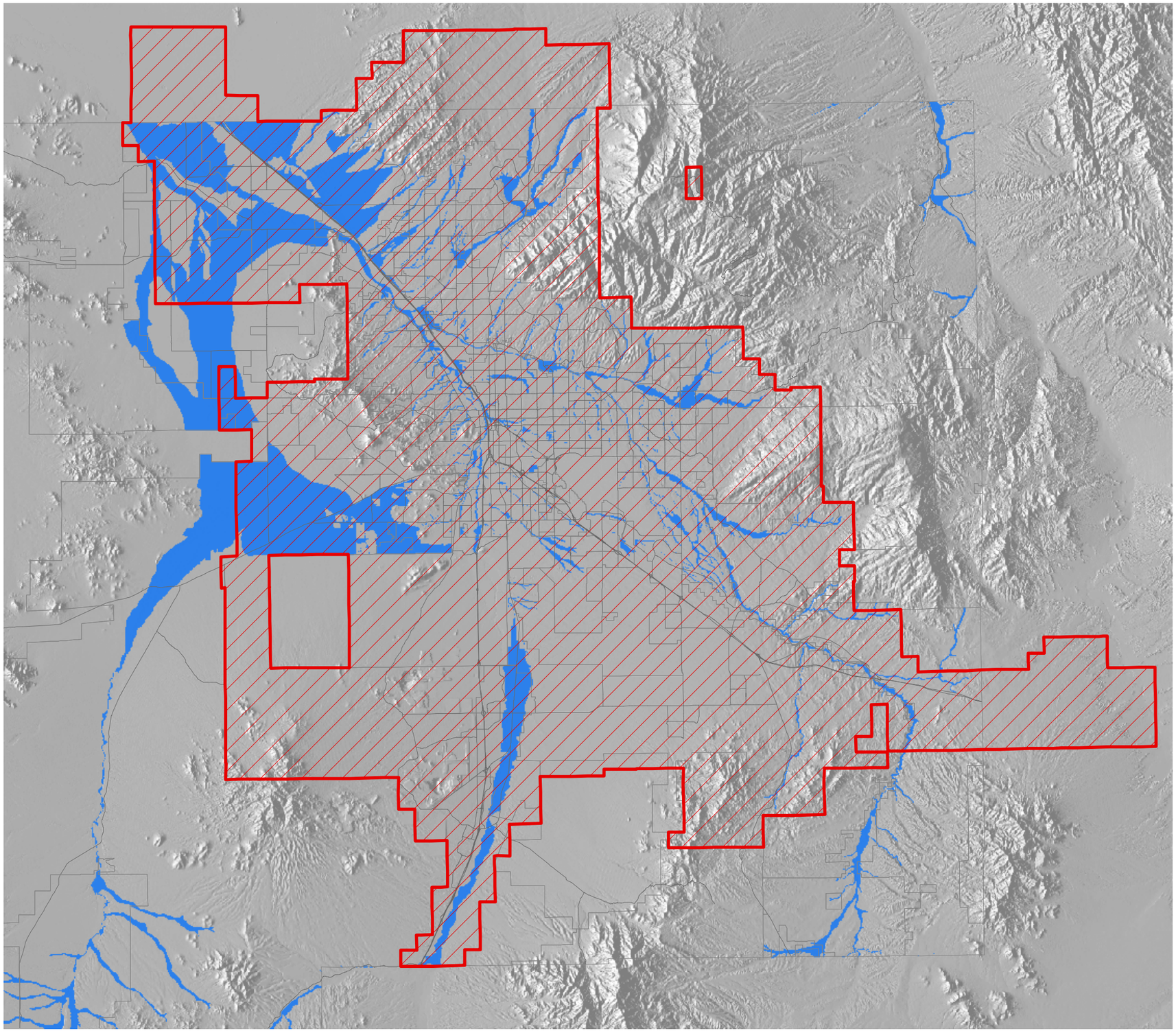
R. "Terry" Hendricks, CFM, Chief Hydrologist
Planning and Development Division

RTH/cd

Cc: Steve Whitney, GIS Manager, Pima County Department of Transportation
Kenneth Maits, Senior GIS Analyst, PC Regional Flood Control District
Manny M. Rosas, GIS Administrator, Pima Association of Governments.

Enclosures

Exhibit 1:
2008 LiDAR Coverage and FEMA Special Flood Hazard Areas



2008 LiDAR Coverage

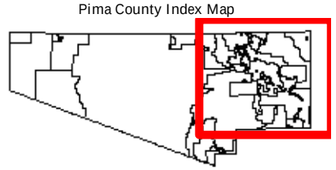
FEMA Floodplains

Major Streets

Jurisdiction Lines

Not Shown: Western Pima County, including Ajo and LiDAR coverage on Tohono O'dham Nation.

Pima County Index Map



Index Map Scale 1:5,250,000

Pima County Regional Flood Control District

Scale 1:415,000

\\gislib\rfcd\projects\imd\ken\lidar08\fema_08cov.mxd km

Corporate Headquarters:
Colorado Springs
Colorado

Ann Arbor
Michigan

Charlotte
North Carolina

Ft. Collins
Colorado

Pelham
New York

Portland
Oregon

Sacramento
California

St. Louis
Missouri

Sanborn
Middle East

Mumbai
India

30 December 2008

Manny Rosas, GIS Administrator
Pima Association of Governments
177 N. Church Ave.
Suite 405
Tucson, AZ 85701

Re: FEMA Results for the PAG 2008 Ortho Project (Contract – 08-5951-01)

Dear Mr. Rosas,

Attached you will find the results of the FEMA checkpoints for PAG 2008 LiDAR data. Sanborn's contracted Arizona State Registered Land-Surveyor, Greg Thompson, performed a review of the report and is in agreement with the results.

Background

To ensure the accuracy of the PAG 2008 LiDAR data, Sanborn was contracted to implement a project plan that included the integration of FEMA checkpoints as part of the QA/QC process. To support this initiative, Sanborn collected 69 checkpoints as part of the control survey effort. This meets the minimum standards for vertical accuracy testing and reporting as defined in FEMA's map modernization requirements. FEMA recommends 20 checkpoints in each of the major land cover categories representative of floodplains being mapped; this normally requires a minimum of 60 checkpoints for at least three land cover categories. The three categories surveyed were:

1. Bare Earth and Low Grass
2. High Grass, Weeds, and Crops
3. Brush lands/low trees

Field data was acquired using GPS equipment and static surveying methods. Sanborn team surveyed all checkpoint following the procedures in NOAA Technical Memorandum NOS NGS-58, "Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm and 5 cm)" and use NGS' latest Geoid Model to compute NAVD88 orthometric heights accurate to 5-cm at the 95% confidence level. (The x and y coordinates of checkpoints will be accurate to 2-cm at the 95% confidence level.)

Final adjusted results were adjusted to Arizona State Plane Coordinates, Central Zone NAD83-92 (HARN), NAVD88, in units of International Foot.

Testing Methodology

As stated in the Guidelines and Specifications for Flood Hazard Mapping Partners (April 2003), Section A.87.6.1, "The Root Mean Square Error (RMSE) is the square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent source of higher accuracy for identical points…TINs (and DEMs derived therefrom) should normally have a maximum RMSE of 18.5 centimeters, equivalent to

2-foot contours, in flat terrain. The following are the results from the PAG 2008 Ortho Program.

Bare Earth:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1001837.162	410093.611	2587.031	2587.530	+0.499
7	999345.782	449442.944	2441.401	2441.640	+0.239
20	933721.166	412981.849	2439.091	2439.310	+0.219
17	933650.558	412993.658	2438.451	2438.660	+0.209
15	897369.501	552863.803	1937.257	1937.430	+0.173
3	1159921.689	349431.234	4294.062	4294.210	+0.148
8	1005806.086	434836.185	2509.196	2509.340	+0.144
9	1000927.946	448200.185	2446.309	2446.400	+0.091
13	994444.372	503631.914	2655.984	2656.070	+0.086
11	994513.846	503595.055	2658.012	2658.090	+0.078
18	955798.751	425094.504	2540.814	2540.880	+0.066
2	906521.919	540616.247	1946.585	1946.640	+0.055
12	987338.200	503575.338	2542.972	2542.930	-0.042
14	965580.705	519074.819	2667.182	2667.120	-0.062
21	955893.647	425085.496	2541.302	2541.240	-0.062
5	1021871.892	457772.536	2472.149	2472.080	-0.069
6	1033139.499	445741.877	2610.656	2610.580	-0.076
16	939704.593	416728.203	2432.726	2432.640	-0.086
10	985754.835	454784.703	2313.130	2312.980	-0.150
19	939508.793	416651.451	2432.802	2432.630	-0.172
22	1027485.930	416573.872	2740.833	2740.650	-0.183
4	1156429.917	365109.827	4055.003	outside	*

Average dz	+0.053
Minimum dz	-0.183
Maximum dz	+0.499
Average magnitude	0.139
Root mean square	**0.171 (foot)**
Std deviation	0.166

Medium Vegetation:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1187028.525	351518.925	4080.561	4080.540	-0.021
2	1117108.620	363592.785	3587.077	3586.940	-0.137
3	1073972.909	383419.761	3240.515	3240.590	+0.075
4	1010832.502	410849.441	2643.786	2643.990	+0.204
5	1005445.314	419156.617	2579.495	2579.880	+0.385
6	1045092.088	435136.157	2724.009	2724.050	+0.041

7	1069748.640	446273.392	2760.125	2760.050	-0.075
8	1033371.126	464364.855	2518.606	2518.310	-0.296
9	1054207.161	418935.174	2886.854	2886.950	+0.096
10	955203.805	487660.945	2178.734	2179.130	+0.396
11	997532.713	434803.804	2460.164	2460.250	+0.086
12	979509.921	492673.940	2417.792	2418.190	+0.398
13	995655.491	465569.990	2344.777	2344.690	-0.087
14	997550.935	482620.376	2598.648	2598.550	-0.098
15	1001334.429	474026.061	2493.153	2493.240	+0.087
16	990196.690	487542.780	2546.083	outside	*
17	990519.334	490352.801	2559.039	2559.110	+0.071
18	998219.739	493708.248	2936.804	2937.080	+0.276
19	996795.607	504234.682	2727.497	2727.370	-0.127
20	988245.902	501104.027	2560.988	2560.870	-0.118
21	985960.009	501595.086	2553.169	2553.130	-0.039
22	997446.853	506178.000	2694.613	2695.140	+0.527
23	987398.768	503506.302	2546.335	2546.410	+0.075
24	985971.797	501493.493	2552.516	2552.570	+0.054
25	997540.656	506124.929	2707.864	2708.230	+0.366
26	991206.370	506306.455	2518.406	2518.250	-0.156
27	978945.698	519233.465	2782.405	2782.330	-0.075
28	978935.642	519272.398	2784.006	2784.080	+0.074
29	965555.375	519044.382	2666.260	2666.260	+0.000
30	897298.425	552978.606	1937.352	1937.730	+0.378
31	910066.011	514280.384	2003.658	2003.840	+0.182

Average dz	+0.085
Minimum dz	-0.296
Maximum dz	+0.527
Average magnitude	0.167
Root mean square	**0.217 (foot)**
Std deviation	0.203

High Vegetation:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1041505.790	408998.331	2868.881	2869.410	+0.529
4	1007421.616	441240.211	2501.880	2502.270	+0.390
9	988302.547	500937.045	2557.959	2558.170	+0.211
10	993323.041	504876.742	2616.818	2616.900	+0.082
3	944799.536	483176.205	2406.404	2406.480	+0.076
6	993338.640	505132.410	2616.096	2616.130	+0.034
13	995168.385	519848.931	2773.051	2773.040	-0.011
8	996811.199	504124.980	2733.504	2733.470	-0.034
14	995094.857	519807.072	2771.624	2771.590	-0.034
5	995053.089	492295.493	2741.552	2741.500	-0.052
7	986911.443	504348.439	2463.848	2463.780	-0.068

11	986965.447	504425.310	2458.159	2458.090	-0.069
12	993296.411	506167.522	2598.730	2598.640	-0.090
16	919968.908	521623.590	2003.520	2003.130	-0.390
15	909979.986	514314.158	2004.186	2003.740	-0.446
2	988498.629	488163.006	2506.243	outside	*

Average dz	+0.009
Minimum dz	-0.446
Maximum dz	+0.529
Average magnitude	0.168
Root mean square	**0.240 (foot)**
Std deviation	0.248

Sanborn concludes that the overall RMSE of the LiDAR data is within PAG 2008 Ortho project requirements, as it meets the +/- 15.0 cm (0.492 foot) RMSE at 95% confidence for all three categories. RMSE is an indicator of overall accuracy of the product and is not used for individual point accuracy.

Please contact me at (719) 593-0093 extension 5645 or Jamie Young (General Manager – ext. 5602) if you have any question regarding the report.

Sincerely,

Andrew Lucero
Sanborn
Senior Project Manager

Evan Canfield

From: Kenneth Maits
Sent: Monday, May 03, 2010 12:20 PM
To: Evan Canfield
Subject: FW: PAG 2008 Orthos/Lidar

From: Curtis, Edward [mailto:Edward.Curtis@dhs.gov]
Sent: Tuesday, November 10, 2009 2:44 PM
To: Manny M. Rosas
Cc: Terry Hendricks; Lucero, Andrew; Caldwell, Jason; Akl, Pascal
Subject: RE: PAG 2008 Orthos/Lidar

Mr. Rosas –

I apologize for the delay in responding to you regarding the Sanborn LiDAR report. Pascal Akl of Michael Baker, Jr. reviewed the updated July 2009 report on behalf of FEMA and advised me that all of the concerns raised in his May 18, 2009 memorandum titled "Pima County, CA [sic] Sanborn LiDAR Report Items" were addressed in the updated report except the comment that the original report lacked a sufficient number of checkpoints in urban areas and dense vegetation areas. No additional checkpoints were surveyed in such arease to permit analysis of data accuracy in these land cover categories. However, in the data voids analysis section of the updated report (p. 16), Sanborn states the following: "*Specific areas, dense vegetation or undergrowth near small streams, for example, prevents the LiDAR pulses to fully penetrate to the true ground surface. Thus, for mapping products such as floodplain or contour mapping, LiDAR data must often be manually supplemented with breaklines and mass-points to accurately model the terrain surface.*" As long as the data is used with caution and supplemented with additional ground survey data where necessary in accordance with this statement, I am satisfied that the terrain data meets FEMA standards for use in detailed flood studies.

Please contact me if you have any questions regarding our review and comments.

Ed Curtis, P.E., CFM
Risk Analysis Branch
FEMA Region IX
(510) 627-7207 - office
(510) 295-5249 - mobile

From: Manny M. Rosas [mailto:MRosas@pagnet.org]
Sent: Tuesday, November 10, 2009 7:29 AM
To: 'Lucero, Andrew'; 'Caldwell, Jason'
Cc: 'Terry Hendricks'; Curtis, Edward
Subject: PAG 2008 Orthos/Lidar

Hi Andy,
I resent Sanborn's Version 3 document produced in July 2009 and yet to receive any comments from FEMA, Pima County and Michael Baker Inc. therefore
please proceed with direct communications with Michael Baker Inc (Pascal Akl) to resolve all issues regarding the FEMA guidelines

Thank You
Manny

Manny M. Rosas Jr.
GIS Administrator

Pima Association of Governments

177 N Church Ave. Suite 405
Tucson, Arizona 85701

520-792-1093 (tel)
520-620-6981 (fax)

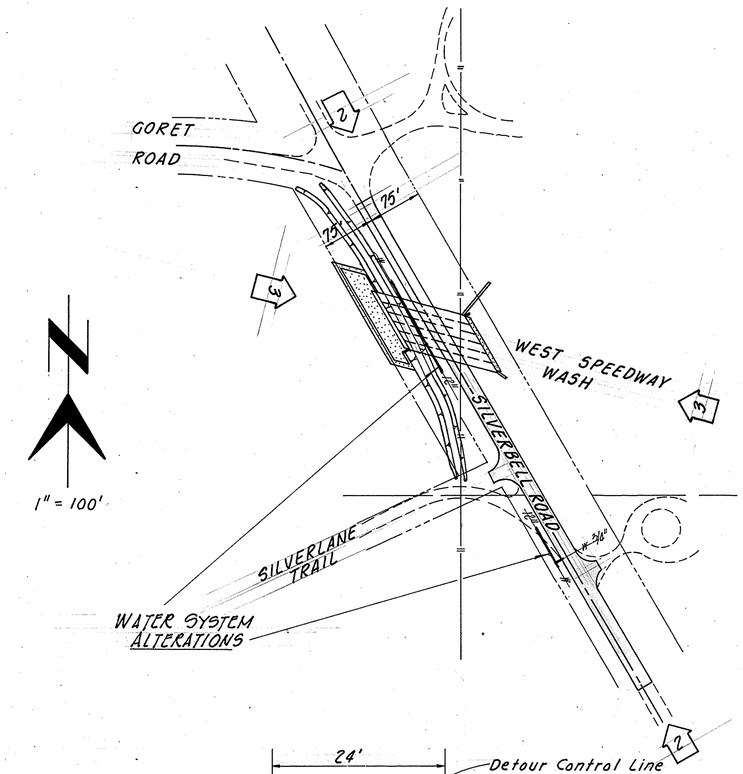
Appendix D: Hydrologic Analysis Supporting Documentation

(models, spreadsheets and supporting information is provided digitally in the TDN disk)

Appendix E: Hydraulic Analysis and As-Built Drawings for Hydraulic Structures

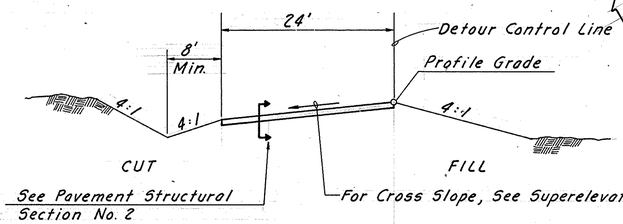
(models, spreadsheets and supporting information is provided digitally in the TDN disk)

WEST SPEEDWAY WASH
BOX CULVERT
AT SILVERBELL ROAD
JOB NO. 652

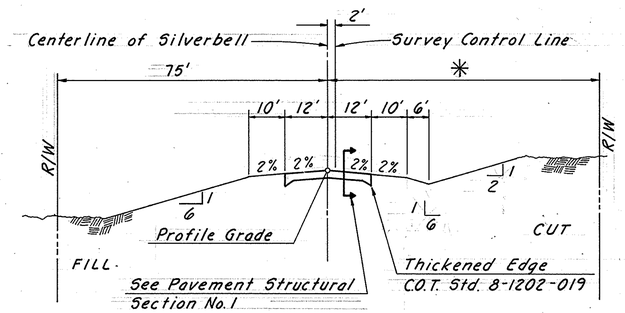


WATER ALTERATION NOTES:

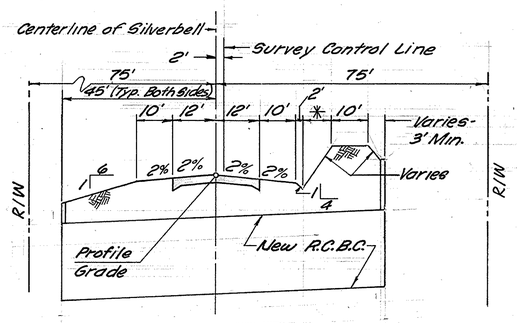
1. ALL WATER SYSTEM ALTERATION CONSTRUCTION WORK TO CONFORM TO TUCSON WATER STANDARD SPECIFICATIONS AND DETAILS EXCEPT WHEN SUPERSEDED BY SPECIAL SPECIFICATIONS.
2. WATER SYSTEM ALTERATION PRE-CONSTRUCTION PROCEDURE: THE CONTRACTOR SHALL CONTACT MR. HANK LEON, FIELD ENGINEER, TUCSON WATER (791-2665) PRIOR TO ANY WATER WORK. NO ALTERATION WORK IS TO BEGIN UNTIL WRITTEN AUTHORIZATION HAS BEEN ISSUED.
3. THE CONTRACTOR IS TO MAKE EVERY EFFORT TO INSURE THE SAFE INTEGRITY OF THE WATER SYSTEM. THE USE OF HEAVY EQUIPMENT OVER AND AROUND WATER FACILITIES WILL BE WITH THE FULL AWARENESS OF THEIR WHEREABOUTS AND VULNERABILITY. REPAIR TO DAMAGED WATER FACILITIES DETERMINED BY THE FIELD INSPECTOR AS AVOIDABLE WILL BE THE RESPONSIBILITY OF THE CONTRACTOR.
4. RECONNECTIONS TO EXISTING WATER SYSTEM SHALL BEGIN BEFORE 10:00 A.M. IN THE WORK DAY TO ALLOW FOR COMPLETED CONNECTION PRIOR TO END OF WORK DAY.
5. SHUT-DOWN OF WATER SYSTEM REQUIRING THE OPERATION OF WATER VALVES WILL BE COORDINATED THROUGH TUCSON WATER FIELD INSPECTOR.
6. COSTS INVOLVED IN MAKING REPAIRS TO WATER FACILITIES DAMAGED BY OTHER UTILITIES OR THEIR REPRESENTATIVES IN THE INSTALLATION OF THEIR FACILITIES ARE THE SOLE RESPONSIBILITY OF THAT UTILITY.
7. TESTING AND DISINFECTION TO BE AS PER SD-900 AND SD-950.
8. ALL EXCAVATION, BEDDING AND BACKFILL TO BE AS PER SD-100.



DETOUR - TYPICAL SECTION
STA. 7+36.00 TO STA. 17+37.34



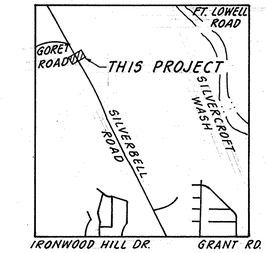
SILVERBELL ROAD - TYPICAL SECTION
STA. 10+50.00 TO STA. 18+40.00



SILVERBELL ROAD - MOD. SECTION
STA. 11+93 TO STA. 12+61

✳ Varies: 75' from Sta. 7+36.00 to 13+80.00, 30' from 13+80.00 to 20+00.00

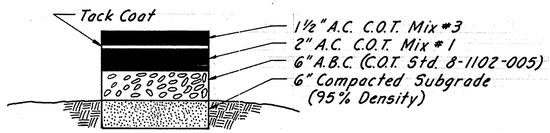
✳ Varies: From 7' at Sta. 11+93.00 to 10' at Sta. 12+61.00



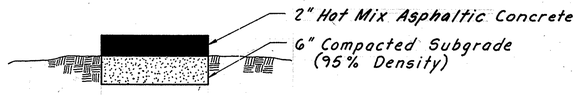
LOCATION PLAN
SCALE: 3" = 1 MILE

CITY OF TUCSON
STANDARD DETAILS

8-1202-012	No. 1 Bituminous Conc. Mixture Diagram
8-1202-013	Mineral Aggregate Mix No. 2
8-1202-019	Thickened Pavement Edge
8-1207-002	Detail for Adjustment of Water Valve Boxes & Cover



PAVEMENT STRUCTURAL SECTION NO. 1



PAVEMENT STRUCTURAL SECTION NO. 2

LEGEND

	Exst. Swale
	New Ditch
	Concrete
W.V.	Water Valve
P.P.	Power Pole
MB Ped.	Mt. Bell Pedestal
FH	Fire Hydrant
San. MH	Sanitary Manhole
GM	Gas Meter
S	Sanitary Sewer
W	Water
G	Gas
III	1/16 Section Line
II	1/4 Section Line
x	Existing Fence
Existing R/W	Existing Right-Of-Way
	Center line
	Easement
	Existing Pavement
	New Pavement
	Pavement Removal

INDEX OF SHEETS

AS BUILT

INSP. FIELD BOOK NO. 1542
☐ INSPECTORS COPY ☐ SURVEYORS COPY
INSPECTED BY Frank Mlaren
REC'D, MAPS & RECORDS, DATE
"AS BUILT" BY R.J.L. DATE May 8, 1986
CONTRACTOR MAYA Construction
CONST. COMPLETED, DATE April 2, 1986
FINAL COST $358,004.78
REMARKS

APPROVALS:

DIRECTOR, TUCSON WATER — DATE 8 Aug 85

PIMA COUNTY DEPARTMENT OF WASTEWATER MANAGEMENT — DATE 22 Aug 85

Two working days before you dig, CALL FOR THE BLUE STAKES 792-2211 Blue Stake Center CALL COLLECT

Johnson · Brittain & Associates, Inc.
ENGINEERS · PLANNERS · SURVEYORS
630 East 9th Street · Tucson, Arizona 85705
Phone (602) 623-4314

NO.	DATE	REVISION	BY	CH.	APPR.

CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD
1 OF 7

DRWN. BY DCB 1985
DSGN. BY RDB 1985
CHKD. BY RDB 1985
APPD. [signature] CITY ENGINEER 8/6/85 1985
APPD BY [signature] 8/6/85 1985
REF ——— SCALE: AS SHOWN
PLAN NO. D-85-01


BM #1, Sta. 10+25.00, 75' Lt.
1/2" Rebar, Elev. 2296.18
BM #2, Sta. 14+77.06, 86' Rt.
Brass Disc, Elev. 2299.79
BM #3 (C.O.T. F.B. #1252 & #1416)
Aluminum Capped Rebar Stamped K-129
18' East of Silverbell Road
20' North of Police Academy Entrance
Elev. = 2296.06
Sta. 12+61.00 Silverbell Rd. = Sta. 10+00.00 West Speedway Wash
Sta. 12+61.00
New 6-10' x 6' x 128' R.C.B.C.
A.D.O.T. Std. Det. CB-6, 45° Skew
See Sheet 3
New Drainage Easement
Sta. 10+50.00
Begin New Pvmt.
Meet Exst. Pvmt.
Sawcut, Tack & Join
Exist. 36" C.M.P. to Remain. It Was Abandon and Plug w/ Conc. @ Both End.
Sta. 11+50± to Sta. 13+25±
Exst. 12" C.A. Pipe to be abandoned
Sta. 12+95± 21' Rt.
1-22 1/2° Bend
Inv. = 2284.46
New Drng. Esmt.
Sta. 15+26.27
Intersection of 1/16th Section Line & Silverbell Cst. Centerline
Fnd. Brass Disc.
Remove 162 S.Y. Exst. Conc.
See Spillway Detail, Sheet 6
Exst. R/W
Sta. 15+46± to Sta. 16+40±
Exst. 12" C.A. Pipe to be abandoned
Sta. 15+83.7
New 79 L.F. 48" R.C.P., 34°17'19" Skew Lt.
W/1-Headwall, ADOT Std. C-14.20
For Driveway See Sheet 4
Survey Control Line
Sta. 18+40.00
End New Pvmt., Meet Exst. Pvmt.
Sawcut, Tack & Join
P.C. 8+70.60
P.T. 11+02.27
Fnd. 60d Nail
SILVERBELL ROAD
S 30°58'50" E
2" STL.
San. M.H.
25' R (TYP)
Abandoned
Sta. 22+80.38
Fnd. 1/2" I.P. - P.C.
Adjust Water Valves
C.O.T. Std. 8-1207-002
Brace Power Pole During Construction
P.M.B.
Sta. 14+54 to Sta. 15+03, 20' Rt.
New 49 L.F. 18" R.C.P.
Temp. Cst. Esmt. For Side Street
See Sheet 4
Sta. 16+10± to Sta. 16+40±
30 L.F. new 12" C.A. Pipe, N. & S.
Connect to new 12" C.A. to D.I. Adaptor, N. and Connect to exst. 12" C.A. Pipe with C900 PVC Flex Coupling, South
GORET ROAD
Sta. 11+50± to Sta. 11+80±
30 L.F. new 12" C.A. Pipe, N. & S. Connect to exst. 12" C.A. Pipe, N. with C900 PVC Flex Coupling and Connect to New 12" C.A. to D.I. Adaptor, South.
New Drng. Esmt.
S 75°58'50" E
Sta. 12+95± to Sta. 13+25±
30 L.F. new 12" C.A. Pipe, N & S.
Connect to new 12" C.A. to D.I. Adaptor, N. and Connect to exst. 12" C.A. Pipe with C900 PVC Flex Coupling, South
Sta. 15+76± to Sta. 16+10±
34 L.F. new Class 51 Ductile Iron Pipe
Sta. 15+76± 22' Rt.
1-22 1/2° Bend
Inv. = 2282.82
Sta. 16+10± 22' Rt.
1-22 1/2° Bend
Inv. = 2282.82
Sta. 14+77.06, 86.00' Rt.
1/16th Section Corner
Fnd. Brass Disc.
40 L.F. of wood post & rail fence to be relocated
SILVERLANE TRAIL
N 88°39'50" E
Sta. 11+80± to Sta. 12+95±
115 L.F. new 12" Class 51 Ductile Iron Pipe.
Sta. 11+80± 21' Rt.
1-22 1/2° Bend
Inv. = 2284.46±
New locations of 40 L.F. of fence
Sta. 15+46± to Sta. 15+76±
30 L.F. new 12" C.A. Pipe, N. & S.
Connect to exst. 12" C.A. Pipe with C900 PVC Flex Cpl., N. and Connect to new 12" C.A. to D.I. Adaptor, South
Service Tie Over
Sta. 16+28±
3/4" Cu., +5'
CURVE DATA
Δ = 02°20'52"
R = 5653.66'
T = 115.85'
L = 231.67'
Silverbell Centerline Reestablished Based on C.O.T. F.B. #1252
Johnson · Brittain & Associates, Inc.
ENGINEERS · PLANNERS · SURVEYORS
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Phone (602) 623-4314
Two working days before you dig, CALL FOR THE BLUE STAKES
792-2211
Blue Stake Center
CALL COLLECT
9 10 11 12 13 14 15 16 17 18 19
2300 2295 2290 2285
200' V.C.
Finish Grade @ Cst. ℄
-0.1485%
Begin New Pvmt.
10+50.00 2297.89
6-6' x 10' Conc. Box Culvert 12+61
BVC 12+80 2297.55
13+00 97.51
13+25 97.41
13+50 97.26
13+75 97.07
14+00 96.84
14+25 96.56
14+50 96.23
14+75 95.85
EVC 14+80 2295.77
PVI 13+80
Elev. 2297.40
Corr. = -0.37
-1.6296%
93.20
92.80
BVC 15+50 2294.63
48" R.C.P.
15+80
INLET INV. 87.80
OUTLET INV. 86.90
15+75 94.25
16+00 93.94
16+25 93.68
PVI 16+50
Elev. 2293.00
Corr. = +0.48
16+75 93.34
17+00 93.27
17+25 93.25
EVC 17+50 2293.29
+0.2947%
18+40.00 2293.56
End New Pvmt.
Exst. Ground @ Cst. ℄
Exst. 12" C.A. Pipe
C900 PVC Flex Cpl.
66 L.F. New C.A. Pipe
Roll Short Sections
D.I./C.A. Adaptor
65 L.F. New C.A. Pipe
Roll Short Sections
30'± New C.A. Pipe
Roll Short Sections
D.I./C.A. Adaptor
104 L.F. Class 51 Ductile Iron Pipe
Exst. 8" Sewer
Inv. = 2282.82
Connect to exst. 12" C.A. Pipe @ Sta. 11+50±
Sta. 11+80±
1-22 1/2° Bend
Inv. = 2284.46
Sta. 12+95±
1-22 1/2° Bend
Inv. = 2284.46
Connect to exst. 12" C.A. Pipe @ Sta. 13+25±
Connect to exst. 12" C.A. Pipe @ Sta. 15+46±
Sta. 15+76±
1-22 1/2° Bend
Sta. 16+10±
1-22 1/2° Bend
Connect to exst. 12" C.A. Pipe @ Sta. 16+40±
Class 51 Ductile Iron Pipe
49 L.F.
AS BUILT
MAY 8, 1986
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION
ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD
2 OF 7
DRWN BY D.M., D.D. 1985
DSGN BY D.W. 1985
CHKD BY R.D.B. 1985
APPD BY
CITY ENGINEER
SCALE: HORIZ 1" = 40'
VERT 1" = 4'
PLAN NO. D-85-01
NO. DATE REVISION BY CH. APPR.


GORET ROAD
SILVERBELL ROAD
Sta. 12+61.00
New 6 - 10' x 6' x 128' R.C.B.C.
ADOT Std. Det. CB-6, 45° Skew
Exst. 36" CMP
To Remain
Sta. 12+25.00, 40' Lt.
Anchor Assembly
Exst. Conc. Pad
64 Sy. To Be Removed
Sta. 12+25.00, 40' Lt.
New Cutoff Wall
See Detail D
Exst. Cutoff Wall
To Be Removed
Sta 10+48.11, 67.15' Lt.
Beg. New Bank Protection
New Downstream Apron
ADOT Std. CWA-1
New Wingwalls
Downstream: ADOT Std. CWG-7
Upstream: ADOT Std. CWL-2, Type A
H=8', L=10'
New Drng. Esmt.
Sta. 12+50, 14' Lt., End New Bank Protection
For End Condition See Detail F
S 75° 58' 50" E
Sta. 13+62.50, 40' Lt.
Begin Flared Cable Terminal
Sta. 13+99.71, 44' Lt.
End Flared Cable Terminal
Sta. 12+61.00 Silverbell Road = Sta. 10+00.00 West Speedway Wash
Reconstruct exst. M.H. per P.C.W.W.M. Std. Det. 205
Elev. = 2295.43
New Drng. Esmt.
New Spillway, See Sheet 6
New 75.00 L.F. Guard Rail Type A
ADOT Std. C-10.01
1-Flared Breakaway Cable Terminal Assembly ADOT Std. C-10.15
1-Guard Rail Anchor Assembly ADOT Std. C-10.21
Sta. 15+81.50, 13' Rt.
End Flared Breakaway Cable Terminal
Sta. 16+19.00, 13' Rt.
Anchor Assembly
Add 12' Wing Wall,
Move Guard Rail ± 2'
Sta. 15+44.25, 17' Rt.
Begin Flared Breakaway Cable Terminal
Sta. 10+75.29, 38' Rt.
Begin Flared Breakaway Cable Terminal
Sta. 11+12.50, 34' Rt.
End Flared Breakaway Cable Terminal. Begin Guardrail
New Concrete Apron
See Detail E
Channel ℄
Sta. 11+75.00, 34' Rt.
New Bridge Guard Rail Type A
ADOT Std. C-10.01
2-Flared Breakaway Cable Terminals Assembly ADOT Std. C-10.15
2-Guard Rail Anchor Assembly ADOT Std. C-10.21
Buried & Bolt Anchor (Timber Post) ADOT Std. C-10.23
175 L.F. Upstream Side
125 L.F. Downstream Side
Sta. 12+99.80, 41' Rt.
Anchor Assembly
Exst. Saguaro
Protect in place
New Drainage Esmt.
Exst. R/W
Curve Data
Δ = 29° 30' 00"
R = 410.00'
T = 107.94'
L = 211.10'
SECTION B-B
10'
2300.0
2' Thick
Dumped Rip Rap
Compact Berm to 95% Density
Permeable Filter Blanket
SECTION A-A
3'
21'
Toe of Bank Protection
Fill As Required Behind New Bank Protection
Compact To 90% Density
6" Class "A" Concrete w/ 6 x 6 - W2.1 x W2.1 WWF
Top Of New Bank Protection
Sta. 12+50.00
Top Of Exist. North Bank
Finish Grade @ ℄
Exst. Tel.
Exst. 12" Water
Exst. 2" Gas
2300.00
2298.52
2296.0
2296.38
2289.64
2289.00
2288.95
0.5000%
Toe Of Bank Protection
86.00
87.00
Exst. Ground @ Channel ℄
New 12" Water
Sta. 10+48.11
Sta. 11+22.00
2286.70
Grade to meet exst. channel
5' Toedown
2295
2290
2285
2280
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Blue Stake Center
CALL COLLECT

AS BUILT
MAY 8, 1986

CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION

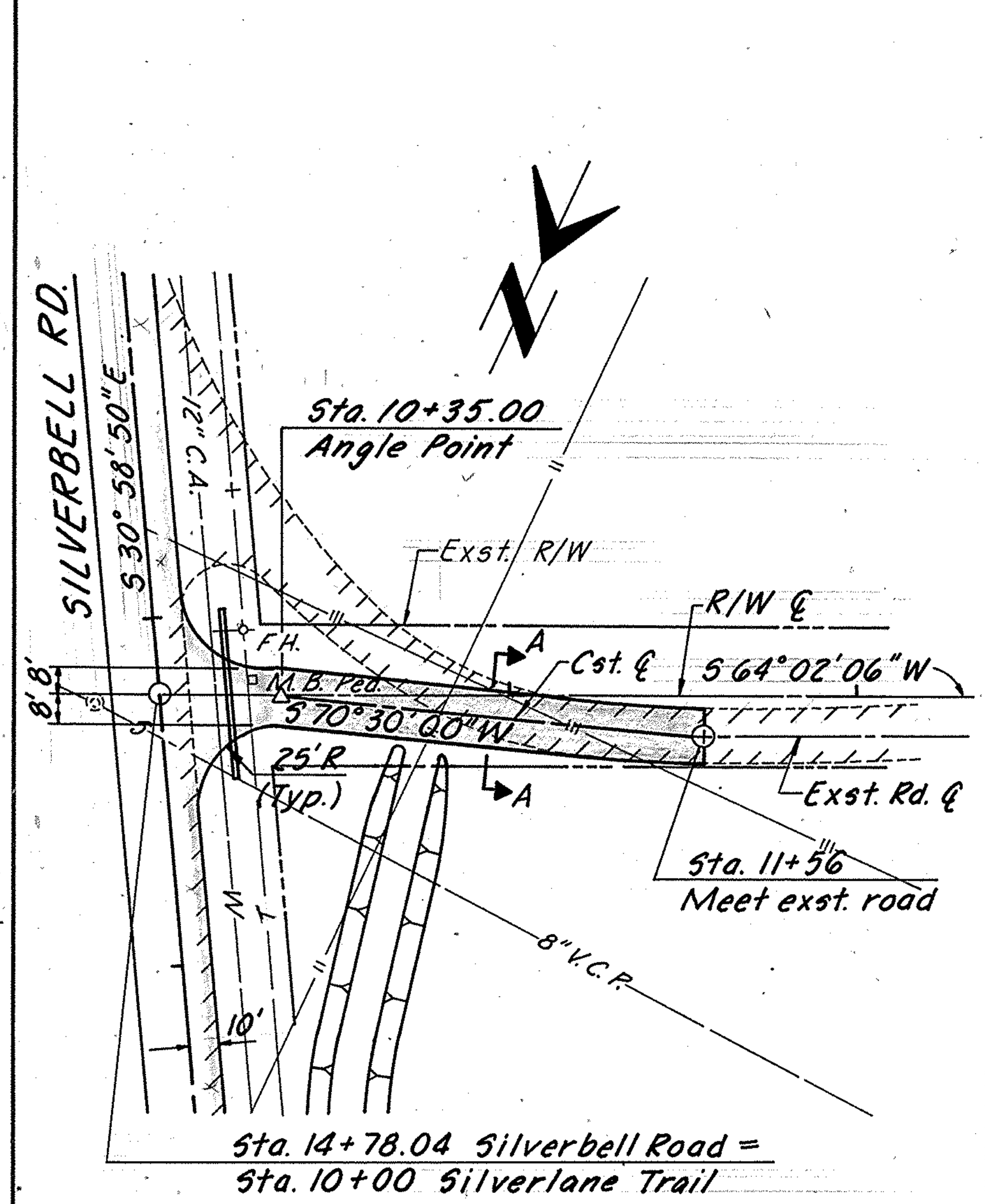
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD

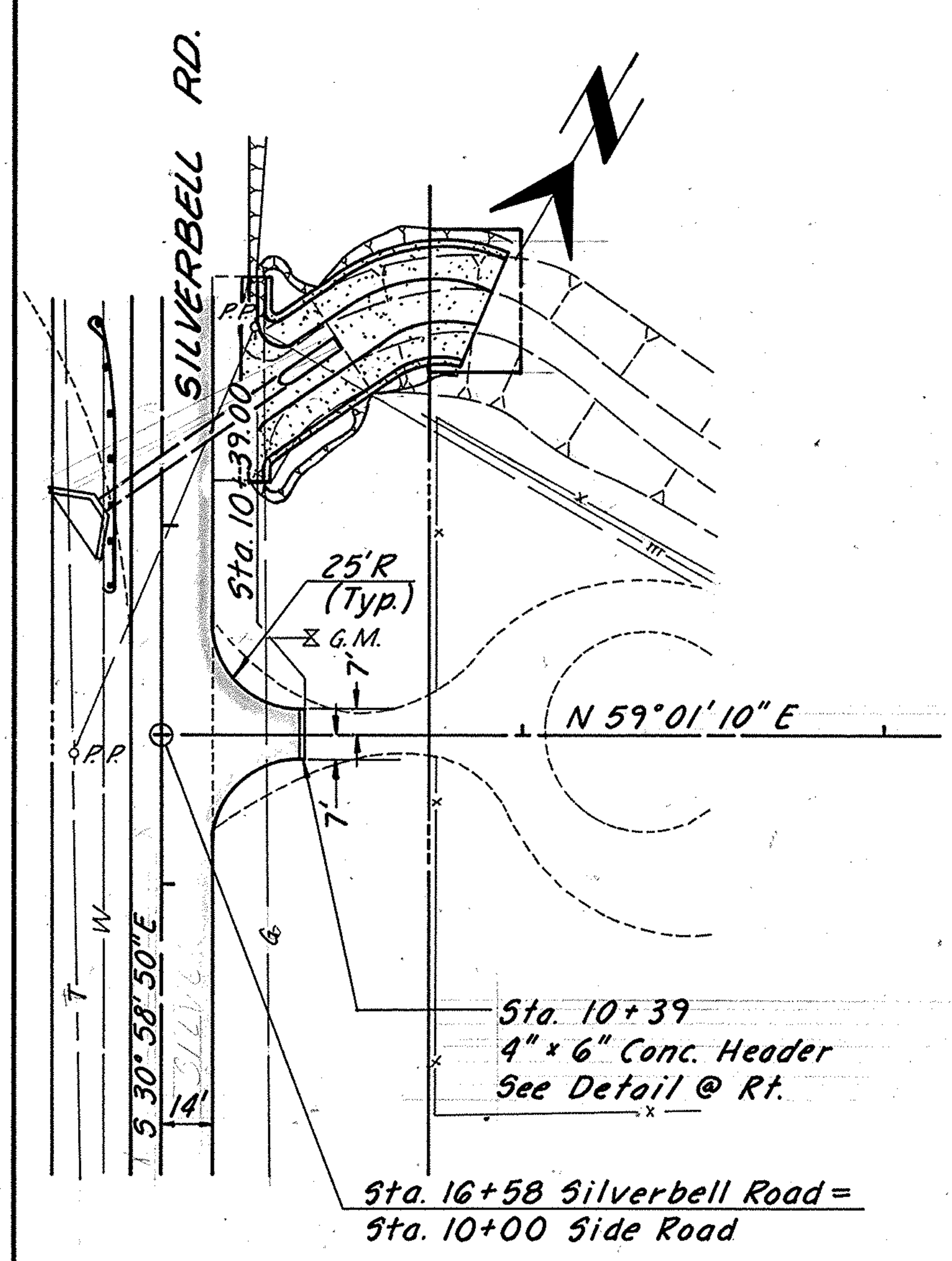
3 OF 7

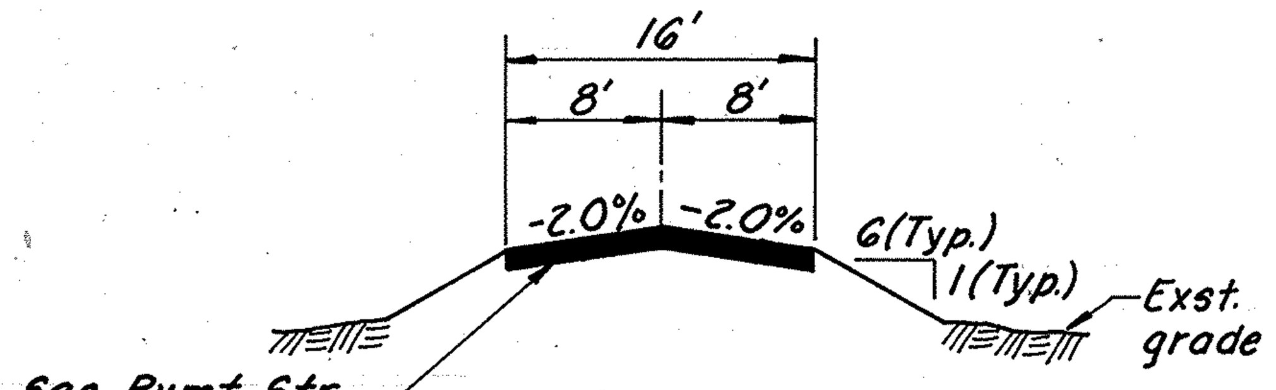
DRWN. BY DCB, DAD 1985	APPD. BY [signature] CITY ENGINEER		SCALE: H: 1" = 40' V: 1" = 4'
DSGN. BY DCB 1985		REF.	
CHKD. BY RDB 1985	APPD. BY [signature]		PLAN NO. D-85-01

NO.	DATE	REVISION	BY	CH.	APPR.

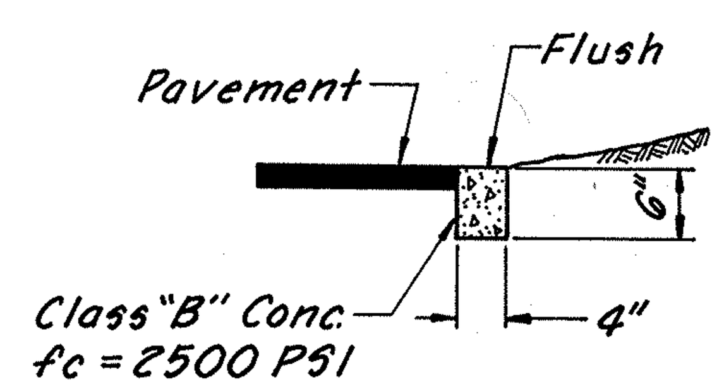
W. SPEEDWAY







CROSS-SECTION A-A



CONC. HEADER

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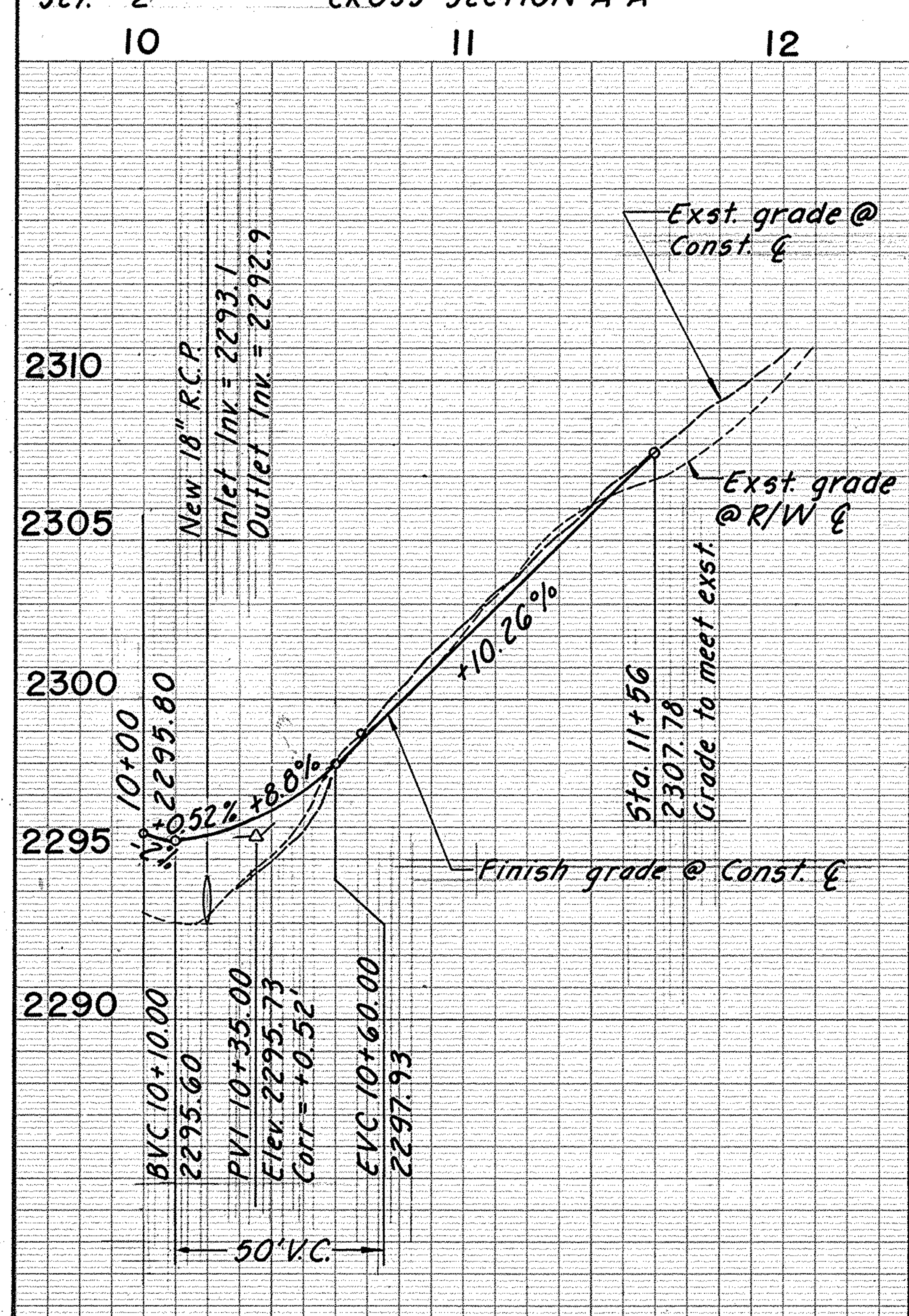
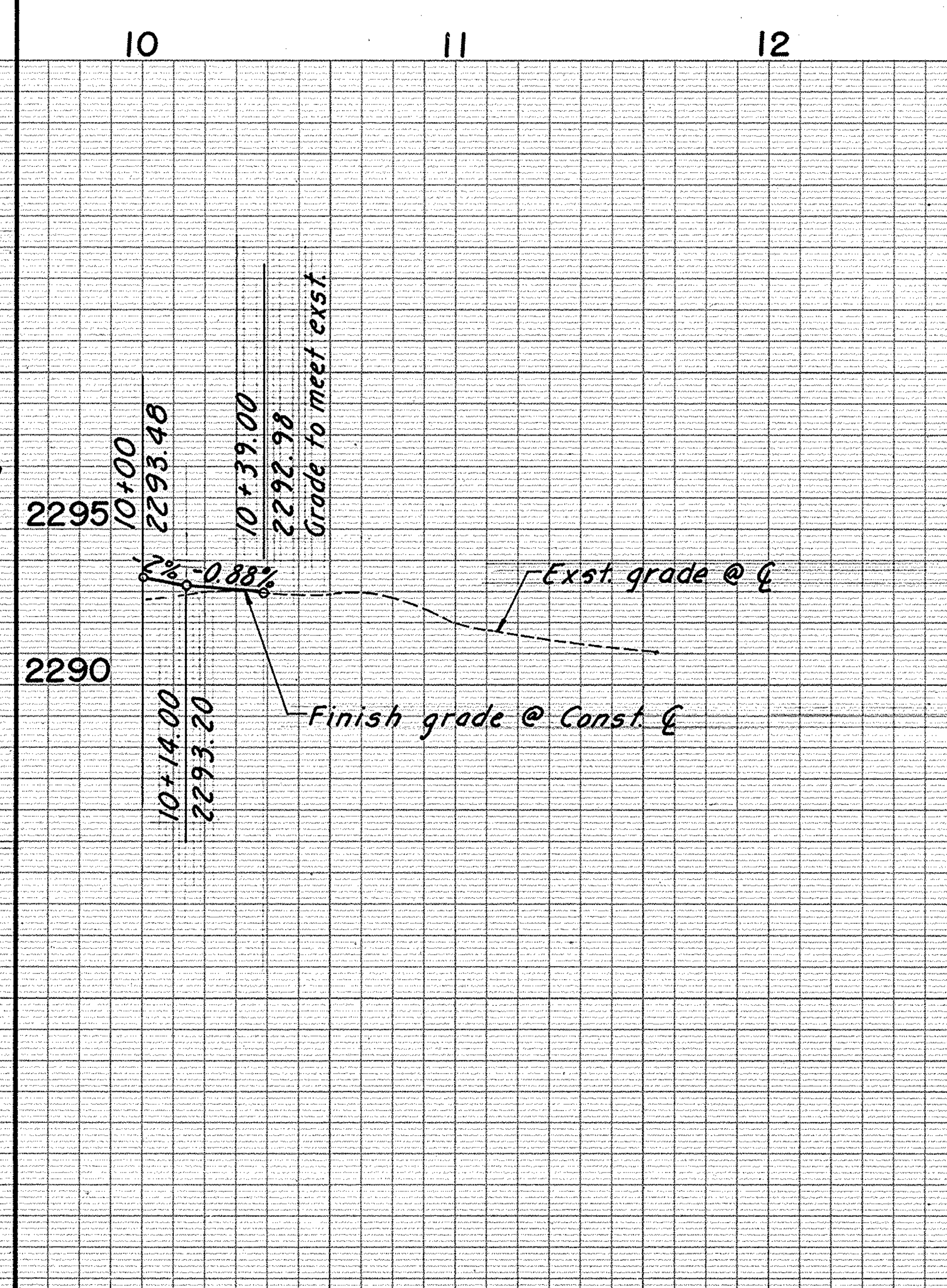




AS-BUILT
MAY 8, 1986

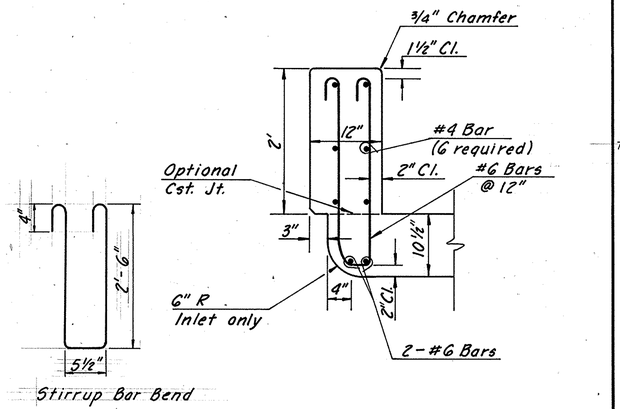
NO.	DATE	REVISION	BY	CH.	APPR.

CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT
AT SILVERBELL ROAD

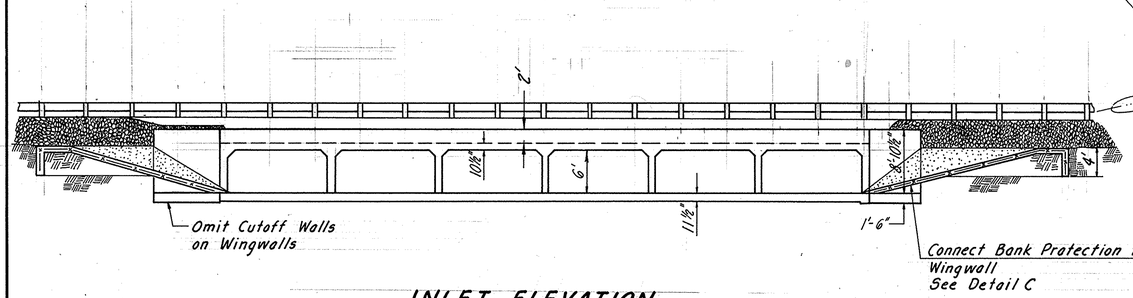
4 OF 7

DRWN BY DM 1985	APPD BY		REF
DSGN BY DM 1985	CITY ENGINEER		SCALE H: 1" = 40' V: 1" = 4'
CHKD BY RDB 1985	APPD BY	19	PLAN NO. D-85-01

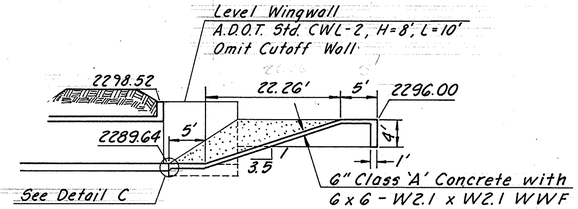
WEST SPEEDWAY



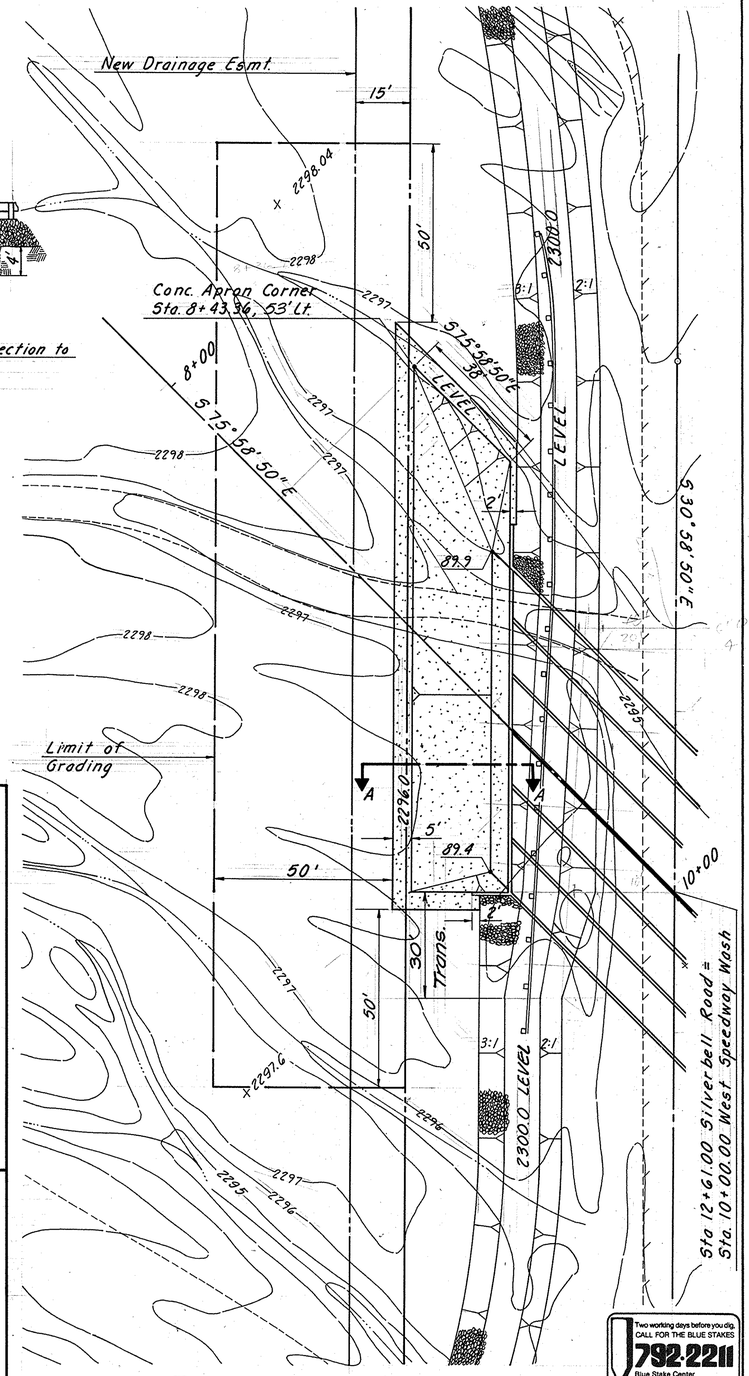
A SPECIAL HEADWALL SECTION
(UPSTREAM ONLY)
1" = 1'-0"



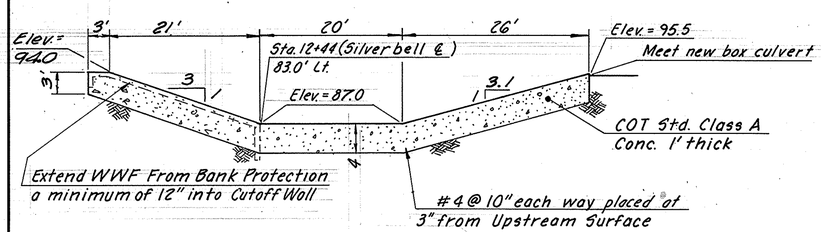
INLET ELEVATION
1" = 10'



SECTION A-A
1" = 10'

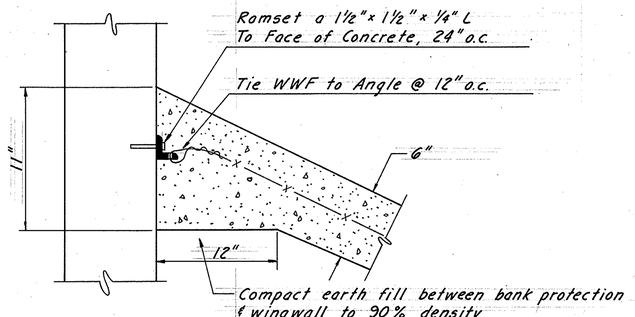


E BOX CULVERT INLET
1" = 20'

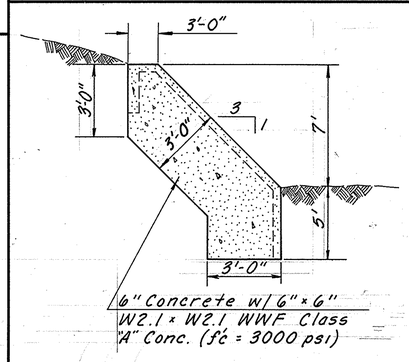


D 1'x 4'x 70' CUT OFF WALL (C.O.W)
(LOOKING DOWNSTREAM)
1" = 10'

DETAIL B - Not Used



C BANK PROTECTION CONNECTION
TO WINGWALL OR BOX CULVERT
N.T.S.



F BANK PROTECTION
END CONDITION

AS BUILT
MAY 8, 1986

NO.	DATE	REVISION	BY	CH.	APPR.

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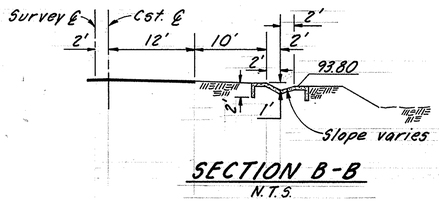
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION

WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD

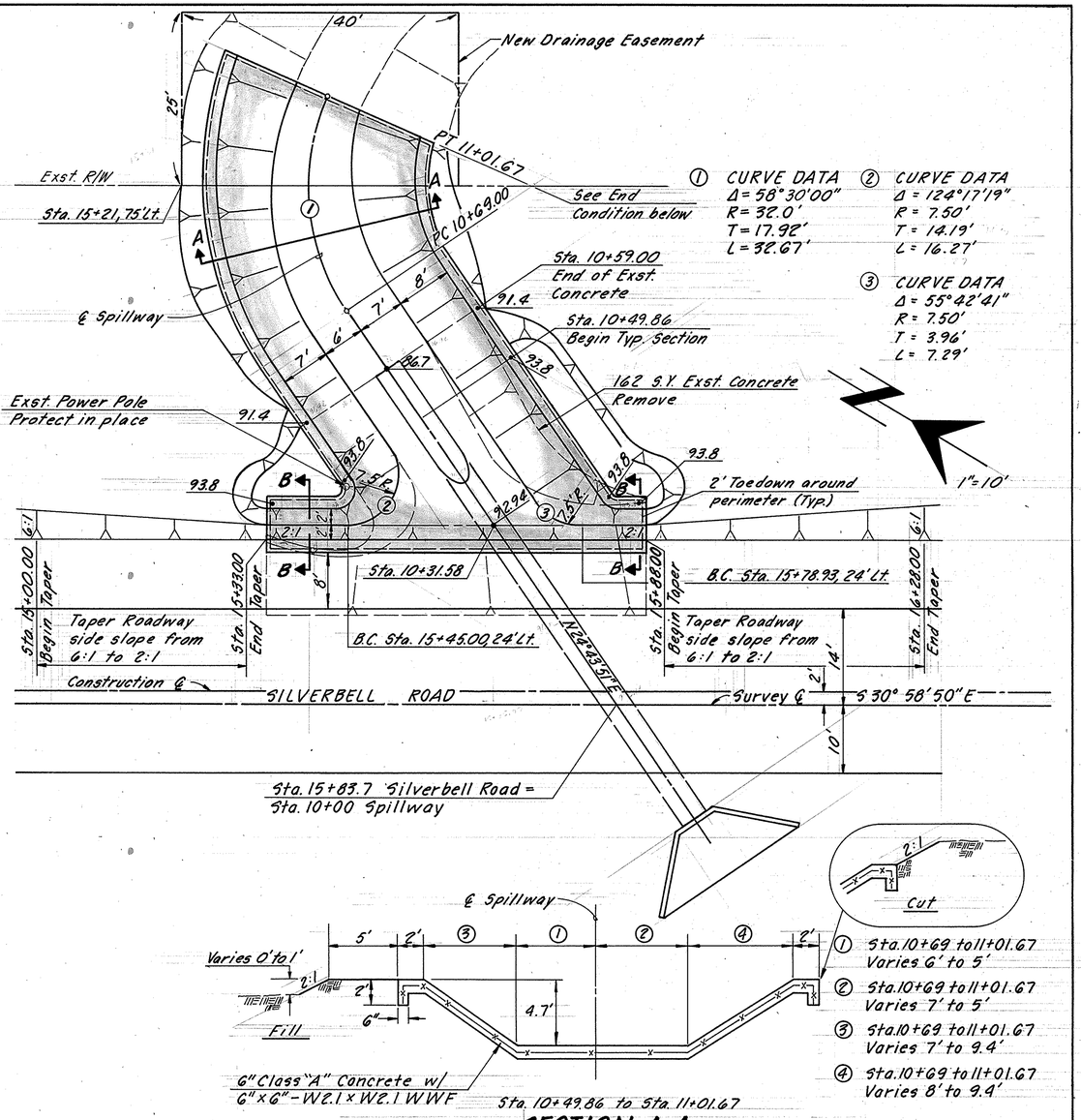
5 OF 7

DRWN BY DAD, DCB 19 85
DSGN BY DCB 19 85
CHKD BY RDB 19 85
APPD BY _____ CITY ENGINEER 19 85
APPD BY _____ 19 85
REF _____ SCALE AS SHOWN
PLAN NO. D-85-01

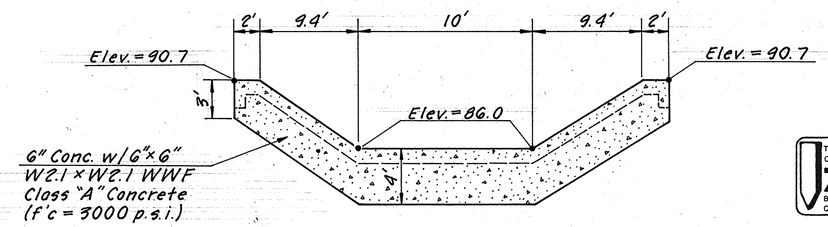
(E) SPEEDWAY



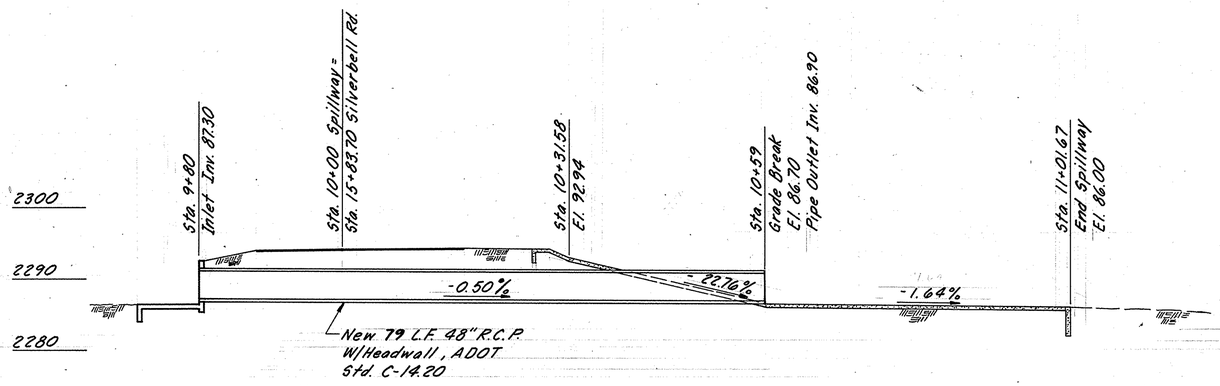
SECTION B-B
N.T.S.



SECTION A-A
N.T.S.



STA. 11+01.67 END CONDITION
N.T.S.



SPILLWAY ℄ SECTION
1"=10'

AS-BUILT
MAY 8, 1986

SPILLWAY DETAIL

Two working days before you dig, CALL FOR THE BLUE STAKES
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Blue Stake Center
CALL COLLECT

NO.	DATE	REVISION	BY	CH.	APPR.

CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION

WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD

6 OF 7

DRWN BY DAD 19 85
DSGN BY K M 19 85
CHKD BY RDB 19 85
APPD [signature] CITY ENGINEER 8/5 1985
APPD BY [signature] 19
REF ____ SCALE AS SHOWN
PLAN NO. D-85-01


BEGIN DETOUR ROAD
Sta. 8+93.74, 9.0'Rt. Silverbell Road =
Sta. 51+50.30 Detour Road
Detour Control Line
0.02 ft./ft.
0.02 ft./ft.
0.02 ft./ft.
52+20
57+80
50+00.00
53+50
56+50
60+28.93
10" VCP
Inside Edge of Detour
Exst. Saguaro
Protect in place
New Drng. Esmts
Exst. 36" C.M.P. to
Remain Until Box Culvert
is Constructed
SUPERELEVATION
DIAGRAM
Exst. R/W
P.C. 51+79.93
P.C. 8+70.60
P.T. 11+02.27
Fnd. 60d Nail
P.C. 57+87.58
2" STL.
S 28° 37' 58" E
S 30° 58' 50" E
S08°37'58"E
12" CA
S 40° 58' 50" E
P.T. 58+87.06
Exst. R/W
Grade & Pave (Pvmt. Sect. 2)
Goret to meet new Detour
After demolition of Detour,
Regrade & Repave to Original Condition
(Pvmt. Sect. 1)
25'R
30'
40'
14'
24 TYP
S 30° 58' 50" E
P.C. 55+98.49
S 50° 58' 50" E
Temp. Cst. Esmt.
Temporary Detour Use
By Contractor During
Construction
Exst. Power Pole
Protect in Place
P.R.C. 52+40.93
P.T. 54+29.00
P.T. 57+03.21
25'R
Grade & Pave (Pvmt. Sect. 2)
Silverlane Trail to meet
new Detour
GORET RD.
8" CA
SILVERLANE TRAIL
See Sheet 1 for
Typical Section
Sta. 52+74 - New
60 L.F. x 24" ⌀ C.M.P. -
12 Gauge, 0° Skew
Detour Control Line
Sta. 56+50 - New 60 L.F.
x 24" ⌀ C.M.P. - 12 Gauge
0° Skew (Radial)
END DETOUR ROAD
Sta. 17+22.96, 9' Rt. Silverbell Road =
Sta. 60+14.99, Detour Road
① CURVE DATA
Δ = 02°20'52"
R = 5653.66'
T = 115.85'
L = 231.67'
② CURVE DATA
Δ = 10°00'00"
R = 570.00'
T = 49.87'
L = 99.48'
③ CURVE DATA
Δ = 13°58'48"
R = 250.00'
T = 30.65'
L = 61.00'
④ CURVE DATA
Δ = 20°00'00"
R = 300.00'
T = 52.90'
L = 104.19'
⑤ CURVE DATA
Δ = 36°19'40"
R = 296.62'
T = 97.32'
L = 188.07'
TEMPORARY DETOUR
Johnson · Brittain & Associates, Inc.
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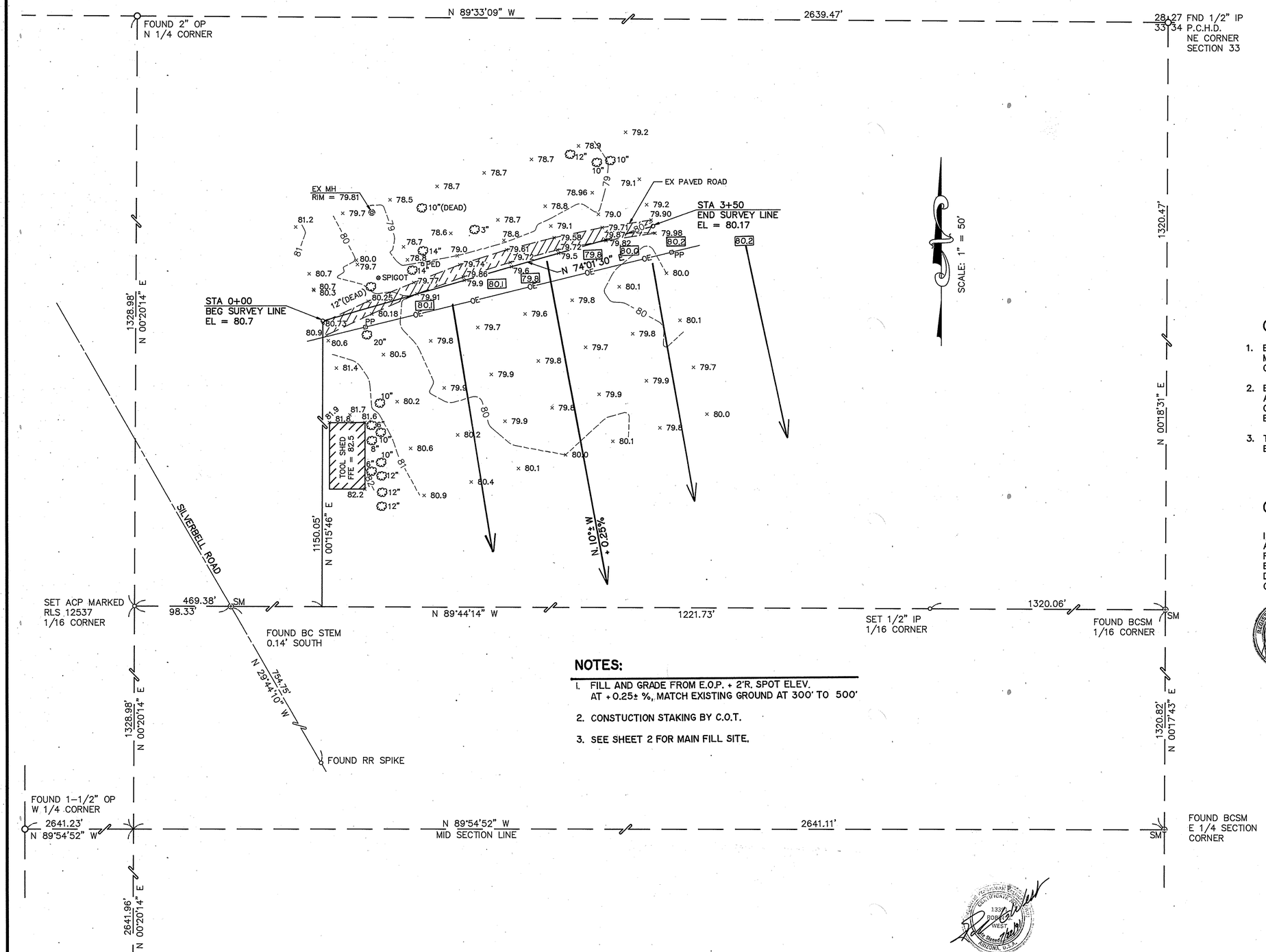
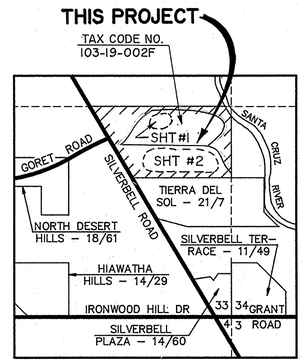
792-2211
Blue Stake Center CALL COLLECT
100' V.C.
100' V.C.
100' V.C.
51
54
55
56
57
58
59
60
2300
2295
+2.00%
+3.00%
-1.20%
-0.40%
-3.00%
+1.69%
B.V.C. 51+50.30
2296.60
P.V.I. 52+00.30
Elev = 2297.60
Corr = +0.13
P.R.V.C. 52+50.30
2299.10
P.V.I. 53+00.30
Elev = 2300.60
Corr = -0.52
P.R.V.C. 53+50.30
2300.00
E.V.C. 54+50.30
2299.20
P.V.I. 54+00.30
Elev = 2299.40
Corr = +0.10
Sta. 52+70
60 L.F. x 24" ⌀ C.M.P. - 12 Gauge
Inlet Inv = 2296.47
Outlet Inv = 2296.0
B.V.C. 57+00
2298.20
P.V.I. 57+50
Elev = 2298.00
Corr = -0.32
E.V.C. 58+00
2296.50
B.V.C. 59+00
2293.50
P.V.I. 59+50
Elev = 2292.00
Corr = +0.59
E.V.C. 60+00
2292.85
End Detour Road
60+14.99, 9.0' Rt.
2293.10 Meet Exst Grade
100' V.C.
100' V.C.
Finish Grade @ Detour Control Line
Exst Grade @ Detour Control Line
Sta. 56+50
60 L.F. x 24" ⌀ C.M.P. - 12 Gauge
Inlet Invert = 2295.07
Outlet Invert = 2294.5
Begin Detour Road
Meet Existing Grade
AS BUILT
MAY 8, 1986
50
52
53
NO. DATE REVISION BY CH. APPR.
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT
AT SILVERBELL ROAD
7 of 7
DRWN. BY DCB 1985
DSGN. BY RDB 1985
CHKD. BY RDB 1985
APPD. BY CITY ENGINEER
APPD. BY
REF.
SCALE: HORIZ 1"= 40'
VERT 1"= 4'
PLAN NO. D-85-01





LOCATION PLAN

SECTION 33, T 13 S, R 13 E, GSRBM
PIMA COUNTY, ARIZONA
SCALE: 3" = 1 MILE

GENERAL NOTES:

1. BASIS OF BEARING: THE NORTH LINE OF LOT 1 AS SHOWN ON THE PLAT MAP OF TIERRA DEL SOL, MAPS AND PLATS BOOK 21 AT PAGE 7, RECORDS OF PIMA COUNTY, ARIZONA, BEARING BEING N 89° 44' 14" W.
2. BASIS OF ELEVATION: RAILROAD SPIKE IN EAST FACE OF POWER POLE AT THE NORTHWEST CORNER OF SILVERBELL ROAD AND GORET ROAD PER CITY OF TUCSON AS SHOWN IN CITY FIELD BOOK 1529 AT PAGE 36, ELEVATION = 2299.05.
3. THE LEGAL DESCRIPTION FOR THE SUBJECT PROPERTY IS AS SHOWN BY PIMA COUNTY TAX CODE NUMBER 103-19-001F.

CERTIFICATION:

I, FREDERICK J. STURNIOLO, R.L.S., HEREBY CERTIFY THAT THE BOUNDARY AND EXISTING TOPOGRAPHY INFORMATION REPRESENTED HEREIN IS THE RESULT OF SURVEYS PERFORMED UNDER MY DIRECTION, AND THAT THE BOUNDARY AND EXISTING TOPOGRAPHY INFORMATION IS ACCURATELY DEPICTED ON THESE PLANS. THIS CERTIFICATION IS MADE WITH RESPECT ONLY TO THE BOUNDARY AND EXISTING TOPOGRAPHY INFORMATION SHOWN.

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
12537
FREDERICK J. STURNIOLO
Frederick J. Sturniolo
Expires 6-30-93
ARIZONA, U.S.A.

Frederick J. Sturniolo
FREDERICK J. STURNIOLO, REGISTERED LAND SURVEYOR
ARIZONA REGISTRATION NO. 12537

NOTES:

1. FILL AND GRADE FROM E.O.P. + 2'R. SPOT ELEV. AT +0.25± %, MATCH EXISTING GROUND AT 300' TO 500'
2. CONSTUCTION STAKING BY C.O.T.
3. SEE SHEET 2 FOR MAIN FILL SITE.

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
13378
ROBERT L.
WEST
Robert L. West
Expires 6-30-93
ARIZONA, U.S.A.

AS BUILT
11-15-93

SHEET 1 OF 2

DATE: JUNE 18, 1991
JOB NO: 91038
REVISIONS:
⚠ ADDED FILL GRADES & NOTES
MBB 7-91

ROUGH GRADING PLAN

PRECISION LAND SURVEYING
7301 EAST 22ND STREET, SUITE 11E
TUCSON, ARIZONA 85710
(602) 298-3200

91114-1 JUNE 18, 1991

NOTES:

1. GRADE 20'W×2'D "V" GRADER DITCH, STA 8+50 230'L± TO STA 15+20 20'R±, 99.9 = SPOT ELEV.
2. INSTALL 18' CMP 30'± LONG UNDER ROADWAY, STA 15+20 20'R± TO STA 15+41 41'R±, MATCH EXISTING CHANNEL INVERT APPROX. 80.5', PIPE SUPPLIED BY C.O.T.
3. TOTAL FILL VOLUME AT BOTH SITES = 54,000C.Y.±. EXCESS IMPORT IS TO BE USED IN THIS AREA BORDERED BY THE ROAD AND THE LANDFILL EMBANKMENT OR DISPOSED OF BY THE CONTRACTOR AT THE DIRECTION OF THE ENGINEER.
4. SEE SPECIAL PROVISIONS OF E-84-16 SILVERCROFT WASH DRAINAGE IMPROVEMENT FOR HAULAGE, CLEARING, COMPACTION, ETC. OWNER WILL INSTALL TEMPORARY IRRIGATION AND RESEED THESE AREAS.

AS BUILT
11-15-93

SHEET 2 OF 2

ROUGH GRADING PLAN

PRECISION LAND SURVEYING
7301 EAST 22ND STREET, SUITE 11E
TUCSON, ARIZONA 85710
(602) 298-3200

DATE: JUNE 18, 1991
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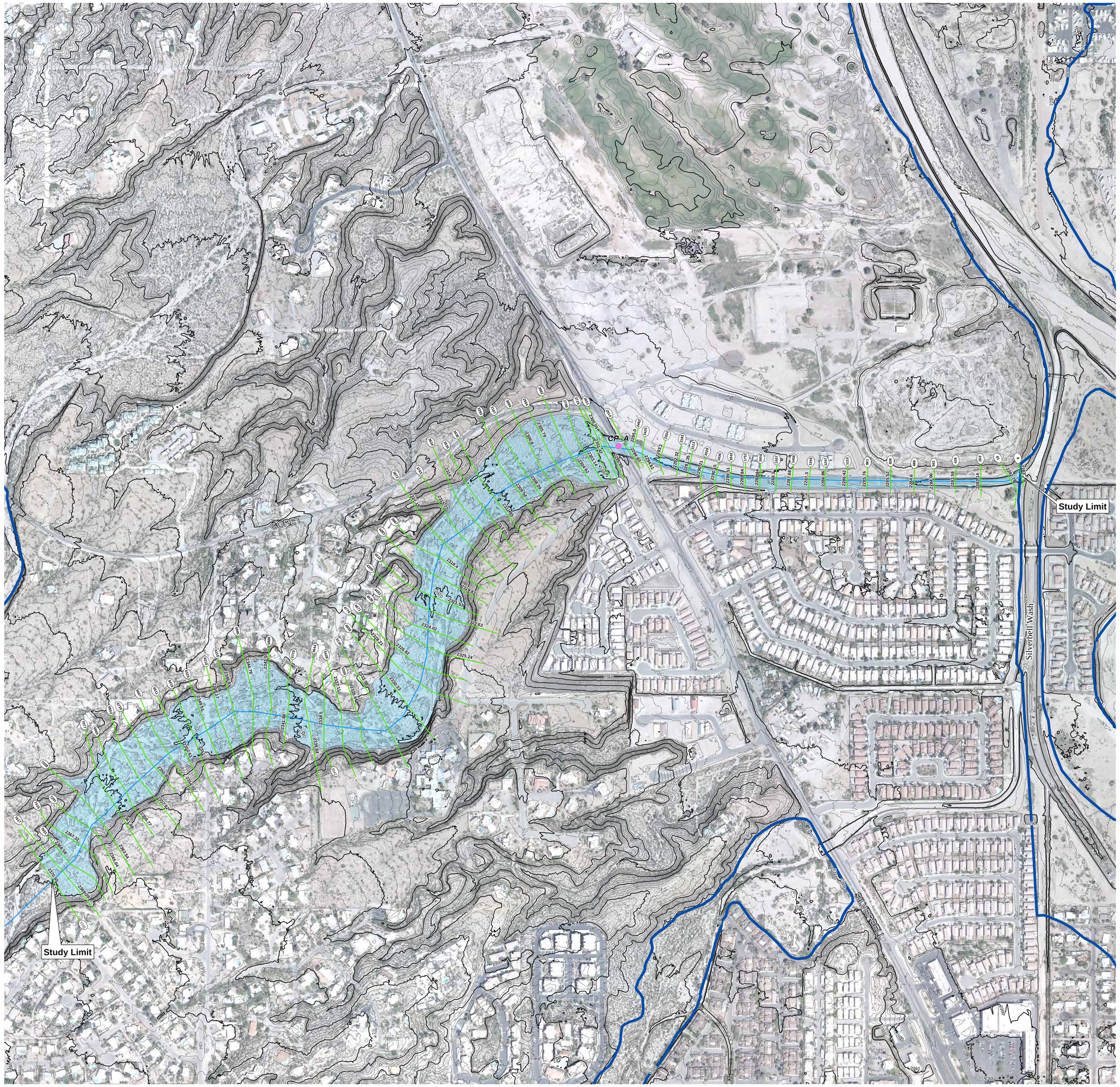
91114-2 JUNE 18, 1991

D-85-01 7B

Appendix F: Erosion and Sediment Transport Analysis Supporting Documentation

None

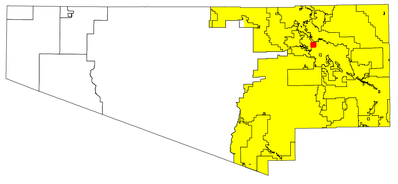
Exhibit 1
100-year Floodplain Workmap with cross sections
West Speedway Wash



- Discharge point
- XSection & Elevations
- River
- Speedway_contour2ft (2008)
- Speedway_contour10ft (2008)
- Existing Zone AE
- Proposed Zone A

Aerial Photo:2008 by Pima Association of Governments
Topo created: 04/2010
Datum: NAVD 1988

Pima County Index Map



Index Map Scale 1:1,500,000

N

0 200 400 Feet

Pima County Regional FLOOD CONTROL DISTRICT

THE SEAL OF PIMA COUNTY ARIZONA

Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson. Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

05/2010

gislib\rfcd\projects\imd\xavi\mdx\AKITSU\west_speedway\Speedway_watershed_100yrFINALexh1.mxd

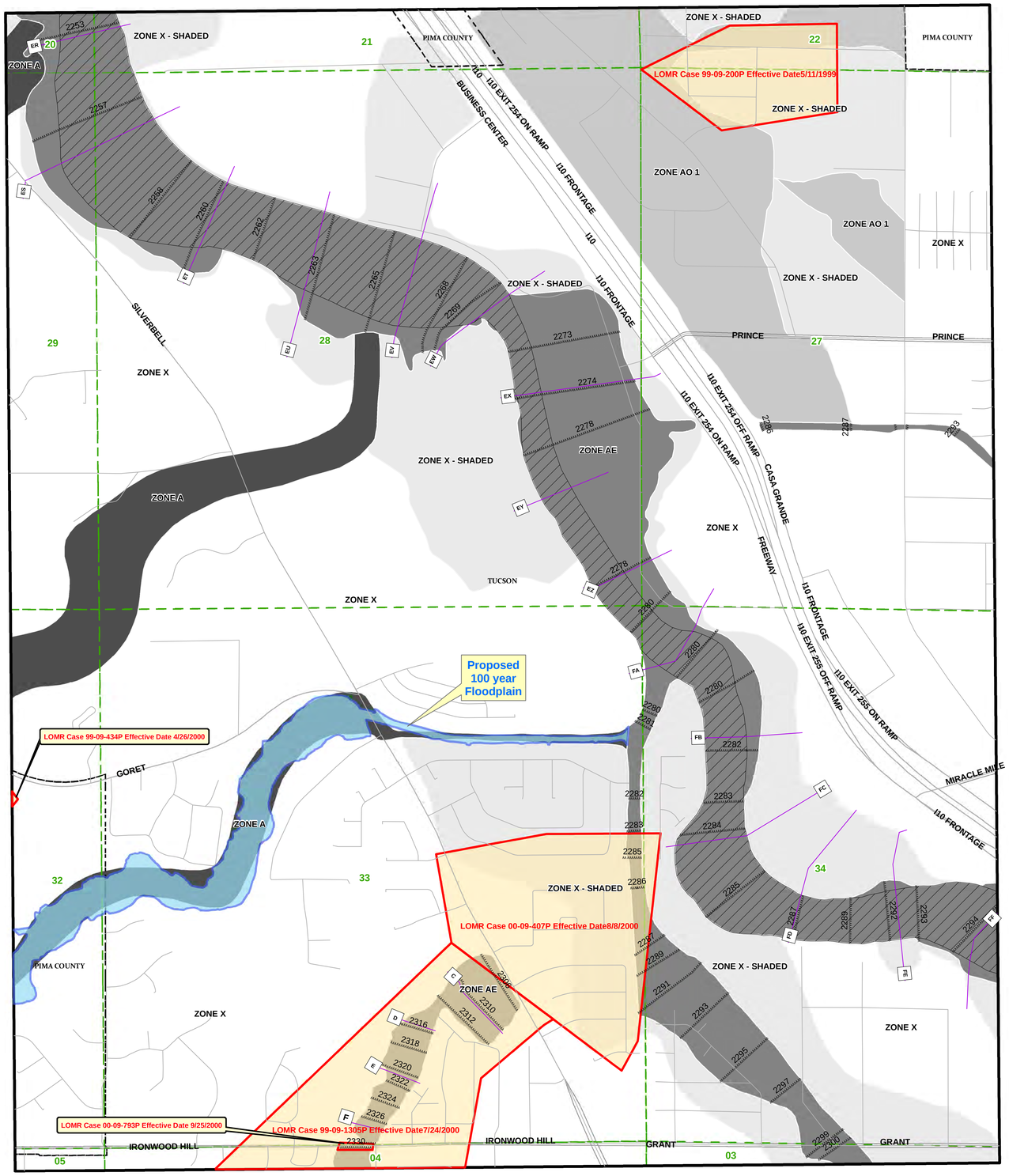


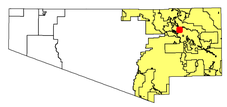
Exhibit 2
Annotated Flood Insurance Rate Map
04019C1619 K
West Speedway Wash

- Streets
- FIRM X-Sections
- Base Flood Elevations
- Proposed Floodplain
- LOMRs
- FIRM - Flood Insurance Rate Map
- Floodways
- Sections
- Jurisdictions

Existing Floodplain Zone

- A
- AE
- AO
- X
- X - (SHADED)

Pima County Index Map



The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Department of Transportation Technical Services Division makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Disclaimer and Use Restrictions.

0 250 500 1,000 Feet

Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
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(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

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A.1 Data Collection Summary

Aldridge, B. and J. Garrett. 1973. Roughness Coefficients for Stream Channels in Arizona. US Department of the Interior Geological Survey. Tucson, AZ.

Arizona Department of Water Resources, Flood Mitigation Section
"Instruction for Organization and Submitting Technical Document for Flood Studies" SSA1-97, November 1997

Arizona Department of Water Resources, Flood Mitigation Section
"Requirements for Flood Study Technical Documentation" SS1-97, November 1997

Arroyo Engineering. 2007. PC-Hydro User Guide. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona. Revised in 1998.

National Weather Service. 1984. Depth-Area Ratios in the Semi-Arid Southwest United States, NOAA Technical Memorandum NWS Hydro-40

Phillips, J., and S. Tadayon. 2006. Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

Phillips, J., and T. Ingersoll. 1998. Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona. U.S. Geological Survey Professional Paper 1584.

Pima County Regional Flood Control District
"Pima County Mapguide Map", 2008

U.S. Army Corps of Engineers (COE). 1998. HEC-1 Flood Hydrograph Package, Users Manual, CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. HEC-RAS, River Analysis System, Hydraulic
Reference Manual, CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. Geospatial Hydrologic Modeling Extension HEC-GeoHMS, (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2006. HEC-HMS, Hydrologic Modeling System User's Manual, (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.

A 2. Referenced Documents

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

Eychaner, J.H., 1984. Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. Design Hydrology and Sedimentology for Small Catchments, Academic Press.

Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States. USGS Water Supply Paper 2433. 195 p.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY
(DRAFT)

POLICY NAME: Acceptable Model Parameterization for Determining Peak Discharge

POLICY NUMBER: Technical Policy, TECH-018

EFFECTIVE DATE: To be Determined
(comment period from October 1, 2008 to March 1, 2009)

PURPOSE

To standardize the parameterization of hydrologic models.

BACKGROUND

When peak discharges need to be established or revised, a computer-based hydrologic model or previously-accepted discharge value may be used. Technical Policy 015 describes which models are acceptable for determining peak discharges. Once a model is selected, this policy describes which parameterization shall be used for submittals to the Pima County Regional Flood Control District (District).

POLICY

A. **Watershed Delineation:** The accuracy of watershed delineation and flow path identification is critical in hydrologic modeling. The District requires the use of 2-foot contour interval (or finer where available) contour maps, such as the Pima Association of Governments (PAG) contour maps for delineation of basin boundaries and flow paths in all areas other than steep terrain. In areas of steep terrain, or where 2-foot or finer contour interval maps are not available, U.S. Geologic Survey (USGS) contour maps (7.5 minute series) may be used. At the discretion of the District, it may be necessary to acquire topographic data that has been sealed by a Professional Civil Engineer (PE), or Registered Land Surveyor (RLS) registered in the State of Arizona. In regulatory sheetflood areas, both 2-foot or finer contour interval maps and aerial photos with a resolution sufficient to determine flow paths and watershed boundaries shall be used. If Geo-HMS (COE, 2003) is used, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs derived from lidar data from PAG or other reputable vendors, may be used. With the approval of the District, alternative topographic data, such as stereo photography may be used.

B. **Pima County Hydrology Procedures:** Peak discharges calculations performed using the Pima County Hydrology Procedures shall follow the guidance for

parameterization provided in the PC- Hydro User Guide (Arroyo Engineering, 2007).

C. **HEC-1 and HEC-HMS:** Peak discharges calculated using HEC-HMS (COE, 2006) or HEC-1 (COE, 1998) shall employ the following parameterization:

a. ***Rainfall Loss Method:*** Models shall employ the U.S Soil Conservation Service (SCS) Curve Number method using the Curve Number tables and Hydrologic Soils Group maps associated with the PC Hydro User Guide (Arroyo Engineering, 2007). The Curve Number shall not be adjusted for rainfall intensity or antecedent moisture conditions.

b. ***Time of Concentration Calculation:*** The U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (T_c) calculation shall be employed (USDA-NRCS, 1986). The Tc shall be calculated by summing the travel time for overland flow, shallow concentrated flow and channel flow, along the primary flow path. Manning's roughness coefficient for sheet flow shall be obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986). Maximum slope length for sheet flow shall be 100 feet. Manning's roughness coefficient for concentrated flow shall be determined using the method described in the District's Technical Policy 019.

c. ***Transform:*** The SCS Unit Hydrograph method shall be used.

d. ***Channel Routing:***

i. ***Routing in Natural Channels:*** Runoff can be routed using the Modified-Puls method for natural channels with the slope less than 1%. If HEC-1 is used, an 8-point cross-section may be used. A storage discharge table must be developed if HEC-HMS is used. Such a table can be developed using cross-sections and slopes derived from a Manning normal depth analysis or HEC-RAS (COE, 2001). The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manuals. Selection of Manning's n values shall conform to the guidance in Technical Policy 019.

ii. ***Routing in Constructed Channels and Steep Channel:*** Shall use the kinematic wave for constructed channels and channels with the slope greater than 1%. Reach length, slope, bottom of width and side slope may be obtained using the data utilized for watershed delineation (e.g. 2-foot contour interval contour maps, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs). Selection of Manning's n values shall conform to the

guidance in Technical Policy 019. The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manuals.

e. ***Rainfall:*** The NOAA 14 Upper 90% rainfall shall be used as described in the District's Technical Policy 010. Point rainfall depth shall be evaluated for each basin or subbasin, based on the latitude and longitude of the centroid of the basin or subbasin.

f. ***Rainfall Distribution:*** Pima County is evaluating rainfall data to determine if the following rainfall distributions are reasonable. In the interim, the higher peak discharge calculated using the following two distributions shall be used:

   i. **SCS Type II 3-hr Storm:** The 3-hr distribution shall be used as the local storm. In general, this includes watersheds with a time of concentration (T_c) equal to or less than three hours (see Haan et al 1994).

   ii. **SCS Type I (24 hr):** The SCS Type I rainfall (NRCS, 1986) may apply for general storms on watersheds with times of concentration (T_c) greater than three hours.

g. ***Rainfall Aerial Reduction:*** Aerial reduction shall be estimated using Hydro-40 (National Weather Service, 1984) for the watershed and event of interest (i.e. same tables as Arizona State Standard). Aerial reduction shall be applied to watersheds larger than 1 square mile.

D. **Comparison of peak discharge**: Recommend to compare the peak discharge calculated using the Pima County Hydrology Procedures and the peak discharge obtained from USGS Regression Equation 13 (Thomas et al., 1997) and/or the equation developed by Eychaner (1984) (See Appendix).

REFERENCES

Aldridge, B. and J. Garrett. 1973. *Roughness Coefficients for Stream Channels in Arizona.* US Department of the Interior Geological Survey. Tucson, AZ.

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona.* Revised in 1998.

Eychaner, J.H., 1984. *Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods*: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. *Design Hydrology and Sedimentology for Small Catchments*, Academic Press.

National Weather Service. 1984. *Depth-Area Ratios in the Semi-Arid Southwest United States*, NOAA Technical Memorandum NWS Hydro-40

Phillips, J., and S. Tadayon. 2006. *Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona*: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

Phillips, J., and T. Ingersoll. 1998. *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona.* U.S. Geological Survey Professional Paper 1584.

Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. *Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States*. USGS Water Supply Paper 2433. 195 p.

U.S. Army Corps of Engineers (COE). 1998. *HEC-1 Flood Hydrograph Package, Users Manual,* CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. *HEC-RAS, River Analysis System, Hydraulic*
Reference Manual, CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. *Geospatial Hydrologic Modeling Extension HEC-GeoHMS,* (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2006. *HEC-HMS, Hydrologic Modeling System User's Manual,* (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. *Urban Hydrology for Small Watersheds,* Technical Release 55. Washington, DC.

APPROVED BY:

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Suzanne Shields, P.E. **Date**
Director and Chief Engineer

Appendix for Tech-018

1.) USGS Regression Equation 13: The current regional regression relationship for southern Arizona is regression equation 13 from Thomas et al (1994). This method predicts peak discharge in cfs (Qp) as a function of watershed Area (square miles) only. It has the form:

$$Qp100 = 10^{(5.52 - 2.42 * A^{-0.12})}$$

2.) Eychaner 1984 (rural): This is a USGS publication that was prepared in cooperation with the City and County. It presents a series of regression equations that rely on watershed area (sq. miles), main channel slope (%), channel length (miles) and a shape factor to account for the differences in runoff noted between long watersheds and more traditionally-shaped watersheds. The equation for the 100 year peak discharge is:

$$Qp100 = 10^{(3.044 + 0.646(\log A) - 0.49(\log A)^2 + 0.706(\log S) - 0.367(\log S)^2 - 0.614(\log S)(LogSh))}$$

The shape factor (Sh) is calculated as (channel length)2/(Area)

3.) Eychaner 1984 (urban): This equation adjusts Eychaner's rural equation to account for the amount of impervious area, channel lining and channel modification. It is:

$$Qp100 = 7.7A^{0.15}(13 - BDF)^{-0.32} Qp100^{0.82}$$

The Basin Development Factor (BDF) is a scoring factor to account for the degree of urbanization. The specific scoring is based on four factors described in pages 10-13 of the manual.The lower, middle and upper portions of a watershed are scored separately and the results are summed. The maximum BDF score is 12, and a score of 0 indicates that the rural equation should be used. (The Qp100 in the equation is the Qp100 calculated using Eychaner's rural method described in section 2 above.)

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY

POLICY NAME: Acceptable Model Parameterization for Determining Peak Discharges

POLICY NUMBER: Technical Policy, TECH-018

EFFECTIVE DATE: May 1, 2010

PURPOSE

To standardize the parameterization of hydrologic models.

BACKGROUND

When determining peak discharges, a computer-based hydrologic model or previously-accepted discharge value may be used. Technical Policy *TECH-015, Hydrologic Model Selection for Peak Discharge Determination*, describes which models are acceptable for determining peak discharges. The Pima County Hydrology Procedures shall be used for riverine watersheds with an area less than 1 square mile. Peak discharges calculations performed using the Pima County Hydrology Procedures shall follow the guidance for parameterization provided in the PC- Hydro User Guide (Arroyo Engineering, 2007). Technical Policy *TECH-018* shall be applied to riverine watersheds with an area larger than 1 square mile but smaller than 20 square mile. This policy describes which parameterization shall be used for submittals to the Pima County Regional Flood Control District (District).

POLICY

A. **Watershed Delineation:** The accuracy of watershed delineation and flow path identification is critical in hydrologic modeling. The District requires the use of 2-foot contour interval (or finer where available) maps, such as the Pima Association of Governments (PAG) contour maps for delineation of basin boundaries and flow paths in all areas other than steep terrain. In areas of steep terrain, or where 2-foot or finer contour interval maps are not available, U.S. Geologic Survey (USGS) contour maps (7.5 minute series) may be accepted. At the discretion of the District, topographic data that has been sealed by an Arizona registered civil engineer (PE), or land surveyor (RLS) may be required. In regulatory sheetflood areas, both 2-foot or finer contour interval maps and aerial photos with a resolution sufficient to determine flow paths and watershed boundaries shall be used. If Geo-HMS (COE, 2003) is used, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs derived from lidar data from PAG or other reputable vendors, may be used. With the approval of the District, alternative topographic data, such as stereo photography may be used.

B. **Pima County Hydrology Procedures:** Peak discharges calculations performed using the Pima County Hydrology Procedures shall follow the guidance for parameterization provided in the PC- Hydro User Guide (Arroyo Engineering, 2007).

C. **HEC-1 and HEC-HMS:** Peak discharges calculated using HEC-HMS (COE, 2006) or HEC-1 (COE, 1998) shall employ the following parameterization:

a. ***Rainfall Loss Method:*** Models shall employ the U.S Soil Conservation Service (SCS) Curve Number method using the Curve Number tables, Vegetation map and Hydrologic Soils Group map associated with the PC Hydro User Guide (Arroyo Engineering, 2007) shall be used. The default vegetation cover percent provided in the PC- Hydro User Guide (Arroyo Engineering, 2007) shall be used. unless additional justification is provided. The Curve Number shall not be adjusted for rainfall intensity or antecedent moisture conditions.

b. ***Time of Concentration Calculation:*** The modified U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (T_c) calculation shall be employed (USDA-NRCS, 1986). The Tc shall be calculated by summing the travel time for sheet flow, shallow concentrated flow and channel flow, along the primary flow path.

i. For sheet flow segment:

1. Manning's roughness coefficient for sheet flow shall be obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986).
2. Maximum slope length for sheet flow shall be 100 feet.
3. The Kinematic wave method shall be used to estimate the travel time for sheet flow.

ii. For shallow concentrated flow segment:

1. The travel time for shallow concentrated flow using the velocity determined from Figure 3-1 of Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986).

iii. *For channel flow*

1. Manning's roughness coefficient for channel flow shall be determined using the method described in the District's Technical Policy *TECH-019, Standards for Floodplain Hydraulic Modeling*.
2. HEC-RAS velocity or the Manning's equation may be used to estimate the travel time for channel flow.
3. The discharge used to calculate velocity shall be estimated by integrating the Regional Regression Equation 13 (Thomas et al., 1997) with respect to area (which is 0.667 x the discharge value calculated with Regional Regression Equation 13).

c. ***Transform:*** The SCS Unit Hydrograph method shall be used.

d. ***Channel Routing:***

1.) ***Routing in Natural Channels:*** Runoff shall be routed using the Modified-Puls method for natural channels with the slope less than 1.5%. A storage discharge table is required if HEC-HMS is used. Such a table can be developed using cross-sections and slopes derived from a Manning normal depth analysis or HEC-RAS (COE, 2001). The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manual. Initial discharge to estimate HEC-RAS velocity for channel flow should be determined using discharge calculated with USGS Regression Equation 13 (Thomas et al., 1997).

2.) ***Routing in Constructed Channels and Steep Channel:*** Kinematic wave may be used for constructed channels and natural channels with slopes greater than 1%. Reach length, slope, bottom width and side slope may be obtained using the data utilized for watershed delineation (e.g. 2-foot contour interval contour maps, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs). Selection of Manning's n values shall conform to the guidance in Technical Policy *TECH-019, Standards for Floodplain Hydraulic Modeling*.. The number of subreaches shall be calculated using the methods described in the HEC-HMS User's Manuals.

e. ***Rainfall:*** The NOAA 14 Upper 90% rainfall shall be used as described in the District's Technical Policy *TECH-010, Rainfall Input for Hydrologic Modeling.* Point rainfall depth shall be evaluated for a watershed, based on the latitude and longitude of the centroid of the watershed. If appreciable elevation change occurs on a watershed, users should use different values for higher and lower elevations.

f. ***Rainfall Aerial Reduction:*** Aerial reduction shall be applied to watersheds larger than 1 square mile. Aerial reduction shall be estimated using Hydro-40 (National Weather Service, 1984) for the watershed and event of interest (i.e. same tables as Arizona State Standard).

g. ***Rainfall Distribution:*** The following rainfall distributions shall be used, with the highest peak discharge selected in order to determine the critical (i.e. storm that produces the highest discharge) :

1. **SCS Type II 3-hr Storm:** The 3-hr distribution shall be used as the local storm. In general, this includes watersheds with a time of concentration (T_c) equal to or less than three hours (Haan et al 1994).

3. **SCS Type I (24 hr):** The SCS Type I rainfall (NRCS, 1986) may apply for general storms on watersheds with times of concentration (T_c) greater than three hours.

D. **Comparison of peak discharge**: The peak discharge shall be compared with the peak discharge obtained from USGS Regression Equation 13 (Thomas et al., 1997) and/or the equation developed by Eychaner (1984) (See Appendix), and existing regulatory discharge estimate.

REFERENCES

Aldridge, B. and J. Garrett. 1973. *Roughness Coefficients for Stream Channels in Arizona.* US Department of the Interior Geological Survey. Tucson, AZ.

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona.* Revised in 1998.

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National Weather Service. 1984. *Depth-Area Ratios in the Semi-Arid Southwest United States*, NOAA Technical Memorandum NWS Hydro-40

Phillips, J., and S. Tadayon. 2006. *Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona*: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

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U.S. Army Corps of Engineers (COE). 1998. *HEC-1 Flood Hydrograph Package, Users Manual*, CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. *HEC-RAS, River Analysis System, Hydraulic Reference Manual*, CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. *Geospatial Hydrologic Modeling Extension HEC-GeoHMS*, (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

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APPROVED BY:

_____ _____

Suzanne Shields, P.E. **Date**
Director and Chief Engineer

Appendix

1.) USGS Regression Equation 13: The current regional regression relationship for southern Arizona is regression equation 13 from Thomas et al (1994). This method predicts peak discharge in cfs (Qp) as a function of watershed Area (square miles) only. It has the form:

$$Qp100 = 10^{(5.52-2.42*A^{-0.12})}$$

2.) Eychaner 1984 (rural): This is a USGS publication that was prepared in cooperation with the City and County. It presents a series of regression equations that rely on watershed area (sq. miles), main channel slope (%), channel length (miles) and a shape factor to account for the differences in runoff noted between long watersheds and more traditionally-shaped watersheds. The equation for the 100 year peak discharge is:

$$Qp100 = 10^{(3.044+0.646(\log A)-0.49(\log A)^2+0.706(\log S)-0.367(\log S)^2-0.614(\log S)(LogSh))}$$

The shape factor (Sh) is calculated as (channel length)2/(Area)

3.) Eychaner 1984 (urban): This equation adjusts Eychaner's rural equation to account for the amount of impervious area, channel lining and channel modification. It is:

$$Qp100 = 7.7A^{0.15}(13 - BDF)^{-0.32}Qp100^{0.82}$$

The Basin Development Factor (BDF) is a scoring factor to account for the degree of urbanization. The specific scoring is based on four factors described in pages 10-13 of the manual.The lower, middle and upper portions of a watershed are scored separately and the results are summed. The maximum BDF score is 12, and a score of 0 indicates that the rural equation should be used. (The Qp100 in the equation is the Qp100 calculated using Eychaner's rural method described in section 2 above.)

Appendix B FEMA MT-2 Form, General Documentation and Correspondence

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☒ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301 480287	City of Katy Harris County	TX TX	480301 48201C	0005D 0220G	02/08/83 09/28/90
040073	Pima County	AZ	04019C	1618K 1619K	02/08/99
040078	City oif Tucson	AZ	04019C	1619K	02/08/99

2. a. Flooding Source: West Speedway Wash

b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: WSpeedway

4. FEMA zone designations affected: A (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

a. The basis for this revision request is (check all that apply)

☐ Physical Change ☒ Improved Methodology/Data ☐ Regulatory Floodway Revision ☐ Base Map Changes

☐ Coastal Analysis ☒ Hydraulic Analysis ☒ Hydrologic Analysis ☐ Corrections

☐ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes

☒ New Topographic Data ☐ Other (Attach Description)

Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following structures (check all that apply)

Structures: ☐ Channelization ☐ Levee/Floodwall ☒ Bridge/Culvert

☐ Dam ☐ Fill ☐ Other (Attach Description)

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☒ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Evan Canfield, Ph.D., PE, C.F.M.	Company: Pima County Regional Flood Control	
Mailing Address: 97 E. Congress, Tucson AZ, 85701	Daytime Telephone No.: 520 243 1800	Fax No.: 520 243-1821
	E-Mail Address: evan.canfield@rfcd.pima.gov	
Signature of Requester (required): H. Evan Canfield	Date: 5/5/10	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Andrew Dinauer, Engineering Administrator	Community Name: City of Tucson	
Mailing Address: P.O. Box 27210 Tucson, AZ 85726-7210	Daytime Telephone No.: 520 791- 4251	Fax No.:
	E-Mail Address: adinaue1@ci.tucson.az.us	
Community Official's Signature (required):	Date: 5/4/10	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Howard Evan Canfield	License No.: 41917	Expiration Date: 3/31/2011
Company Name: Pima County Regional Flood Control	Telephone No.: 520 403-6378	Fax No.:
Signature: H. Evan Canfield		Date: 5/5/10

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☒ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

Registered Professional Engineer (Civil) CERTIFICATE NO. 41917 HOWARD EVAN CANFIELD Date Signed 5/5/10 ARIZONA, U.S.A. Seal (Optional)

Expires 3/31/2011

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☒ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Evan Canfield, Ph.D., PE, C.F.M.	Company: Pima County Regional Flood Control	
Mailing Address: 97 E. Congress, Tucson AZ, 85701	Daytime Telephone No.: 520 243 1800	Fax No.: 520 243-1821
	E-Mail Address: evan.canfield@rfcd.pima.gov	
Signature of Requester (required): H/ Evan Canfield	Date: 5/5/10	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Suzanne Shields, PE Chief Engineer	Community Name: :Pima County Flood Contro	
Mailing Address: 97 E Congress St Tucson, AZ 85701	Daytime Telephone No.: 520 243-1880	Fax No.: 520 243-1821
	E-Mail Address: suzanne.shields@rfcd.pima.gov	
Community Official's Signature (required): Suzanne Shields	Date: 5/5/10	

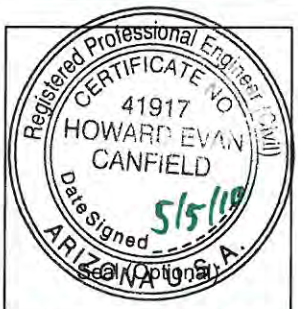
CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Howard Evan Canfield	License No.: 41917	Expiration Date: 3/31/2011
Company Name: Pima County Regional Flood Control	Telephone No.: 520 243-1836	Fax No.:
Signature: H/ Evan Canfield		Date: 5/5/10

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☒ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans



Expires 3/3/2011

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3.25 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: West Speedway Wash
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section B) ☐ No existing analysis ☒ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)
at Silverbell Rdi	1.42	N/A	1458

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model HEC-HMS
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit	Atthe confluence with Silvercroft Wash	St# 33		
Upstream Limit	5060 ft above Silverbell	St# 7701		

2. Hydraulic Method/Model Used

HEC-RAS

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs may help verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. **These tools do not replace engineering judgment.** CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. Review of your submittal and resolution of valid modeling discrepancies may result in reduced review time.

4. Models Submitted

Models Submitted	Natural Run	Floodway Run	Datum
Duplicate Effective Model*	File Name: N/A Plan Name: N/A	File Name: N/A Plan Name: NA	NA
Corrected Effective Model*	File Name: WSpeedway Plan Name: Plan01	File Name: Plan Name:	NAVD88
Existing or Pre-Project Conditions Model	File Name: N/A Plan Name:	File Name: Plan Name:	
Revised or Post-Project Conditions Model	File Name: N/A Plan Name:	File Name: Plan Name:	
Other - (attach description)	File Name: N/A Plan Name:	File Name: Plan Name:	

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☒ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:
   - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
   - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot.

   b. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☒ No
   If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR/CLOMR requests, does this request have the potential to impact an endangered species? ☐ Yes ☒ No

   If Yes, please submit documentation to the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA). Section 9 of the ESA prohibits anyone from "taking" or harming an endangered species. If an action might harm an endangered species, a permit is required from U.S. Fish and Wildlife Service or National Marine Fisheries Service under Section 10 of the ESA.

   For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: West Speedway Wash
Note: Fill out one form for each flooding source studied

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization ..... complete Section B
Bridge/Culvert ..... complete Section C
Dam/Basin ..... complete Section D
Levee/Floodwall ..... complete Section E
Sediment Transport..... complete Section F (if required)

Description Of Structure

1. Name of Structure: Culvert #1

Type (check one): ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure: Silverbell Rd

Downstream Limit/Cross Section: West of Silverbell Rdl

Upstream Limit/Cross Section: East ofSilverbell Rd

2. Name of Structure:

Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

3. Name of Structure:

Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure: .

Downstream Limit/Cross Section: .

Upstream Limit/Cross Section: .

NOTE: For more structures, attach additional pages as needed.

B. CHANNELIZATION

Flooding Source:

Name of Structure:

1. Accessory Structures

The channelization includes (check one):

- ☐ Levees [Attach Section E (Levee/Floodwall)]
- ☐ Superelevated sections
- ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)]
- ☐ Other (Describe):
- ☐ Drop structures
- ☐ Transitions in cross sectional geometry
- ☐ Energy dissipator

2. Drawing Checklist

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Hydraulic Considerations

The channel was designed to carry (cfs) and/or the -year flood.

The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions
☐ Other locations (specify):

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: West Speedway Wash

Name of Structure: Culverts #1 (Existing)

1. This revision reflects (check one):

☒ Bridge/culvert not modeled in the FIS
☐ Modified bridge/culvert previously modeled in the FIS
☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): HEC-RAS
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

- ☒ Dimensions (height, width, span, radius, length)
- ☒ Shape (culverts only)
- ☒ Material
- ☐ Beveling or Rounding
- ☒ Wing Wall Angle
- ☐ Skew Angle
- ☐ Distances Between Cross Sections
- ☐ Erosion Protection
- ☐ Low Chord Elevations – Upstream and Downstream
- ☐ Top of Road Elevations – Upstream and Downstream
- ☒ Structure Invert Elevations – Upstream and Downstream
- ☐ Stream Invert Elevations – Upstream and Downstream
- ☐ Cross-Section Locations

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

D. DAM/BASIN

Flooding Source:

Name of Structure:

1. This request is for (check one): ☐ Existing dam ☐ New dam ☐ Modification of existing dam

2. The dam was designed by (check one): ☐ Federal agency ☐ State agency ☐ Local government agency ☐ Private organization

   Name of the agency or organization:

3. The Dam was permitted as (check one):

   a. ☐ Federal Dam ☐ State Dam

      Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

      Permit or ID number Permitting Agency or Organization

   b. ☐ Local Government Dam ☐ Private Dam

      Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm?

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport).
   If No, then attach your explanation for why debris/sediment analysis was not considered.

6. Does the Base Flood Elevation behind the dam or downstream of the dam change?

   ☐ Yes ☐ No If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

   Stillwater Elevation Behind the Dam

FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)		
50-year (2%)		
100-year (1%)		
500-year (0.2%)		
Normal Pool Elevation		

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

☐ upgrading of an existing levee/floodwall system
☐ a newly constructed levee/floodwall system
☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc.	Station	to
☐ structural floodwall	Station	to
☐ Other (describe):	Station	to

c. Structural Type (check one):

☐ monolithic cast-in place reinforced concrete
☐ reinforced concrete masonry block
☐ sheet piling
☐ Other (describe):

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency?

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers:
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers:
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers:
4. A layout detail for the embankment protection measures. Sheet Numbers:
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers:

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater).	☐ Yes	☐ No
2.0 feet above the 1%-annual-chance stillwater surge elevation	☐ Yes	☐ No

E. LEVEE/FLOODWALL (CONTINUED)

2. Freeboard (continued)

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope landside is:

b. The maximum levee slope floodside is:

c. The range of velocities along the levee during the base flood is: (min.) to (max.)

d. Embankment material is protected by (describe what kind):

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

E. LEVEE/FLOODWALL (CONTINUED)

4. Embankment Protection (continued)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:

☐ Overall height: Sta. ; height ft.

☐ Limiting foundation soil strength:

Sta. , depth to

strength ϕ = degrees, c = psf

slope: SS = (h) to (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

c. Summary of stability analysis results:

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is hours.

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one):

☐ UBC (1988) or ☐ Other (specify):

b. Stability analysis submitted provides for:

☐ Overturning ☐ Sliding If not, explain:

c. Loading included in the analyses were:

☐ Lateral earth @ P_A = psf; P_p = psf

☐ Surcharge-Slope @ , ☐ surface psf

☐ Wind @ P_w = psf

☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = %g

☐ 1%-annual-chance significant wave height: ft.

☐ 1%-annual-chance significant wave period: sec.

d. Summary of Stability Analysis Results: Factors of Safety.

Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)

(Note: Extend table on an added sheet as needed and reference)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is ft. to ft.

c. Settlement of the levee crest is determined to be primarily from :

☐ Foundation consolidation
☐ Embankment compression
☐ Other (Describe):

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: acres
Draining to ponding area: acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

f. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No

If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is cfs

h. The length of levee system used to drive this seepage rate in item g: ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants:
For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No

Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

E. LEVEE/FLOODWALL (CONTINUED)

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No

If the answer is No to any of the above, please attach supporting documentation.

11. Maintenance Plan

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No
If No, please attach supporting documentation.

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

F. SEDIMENT TRANSPORT

Flooding Source:

Name of Structure:

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume acre-feet

Debris load associated with the base flood discharge: Volume acre-feet

Sediment transport rate (percent concentration by volume)

Method used to estimate sediment transport:

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition:

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport:
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

Explanation of Fee Payment

This LOMR is based on better data. The previous A-Zone did not follow the topography in the area. The new mapping uses FEMA-compliant Lidar data which greatly improves the topographic data used for the mapping. The hydrology was also updated using this better data.

An existing box culvert is included in the model. Since the culvert has been in place since 1986, it was included in the previous mapping.

Because this LOMR is based on better data, it is eligible to be reviewed without fee as described in the December 14, 2009 review fee schedule.

Appendix C: Survey Field Notes

Pima County Regional
FLOOD CONTROL
DISTRICT

PIMA COUNTY
REGIONAL FLOOD CONTROL DISTRICT
97 EAST CONGRESS STREET, THIRD FLOOR
TUCSON, ARIZONA 85701-1797

SUZANNE SHIELDS, P.E.
DIRECTOR

(520) 243-1800
FAX (520) 243-1821

January 2, 2009

Craig S. Kennedy, CFM, Program Specialist
Engineering Management Branch
Mitigation Directorate
FEMA
500C Street SW
Washington, DC 20472

Re: Re: Acceptability of LiDAR

Dear Mr. Kennedy:

The Pima Association of Governments (PAG) has contracted with Sanborn to generate ortho rectified aerial photography and LiDAR. Figure 1 shows the extent of the LiDAR coverage for Pima County and the FIRM Special Flood Hazard Areas. The next version of Flood Insurance Rate Maps for Pima County will be converted to the North American Vertical Datum of 1988 (NAVD88). Attached to this letter you will find a draft letter from Sanborn indicating the vertical accuracy of the LiDAR meets FEMA's Map Modernization requirements.

The Pima County Regional Flood Control District (District) requests that the documentation in the draft letter be examined by FEMA to verify the LiDAR and topography created from this data would meet FEMA's vertical requirements for mapping to the NAVD88 Datum. If acceptable, the District will request PAG to have Sanborn seal the documentation so that it may be used in FEMA re-mapping processes. The District understands the digital maps generated from the LiDAR would need to be re-projected to FEMA's UTM coordinate system for LOMR applications.

Please call me at 520-243-1800, should you have any questions with this request.

Sincerely,

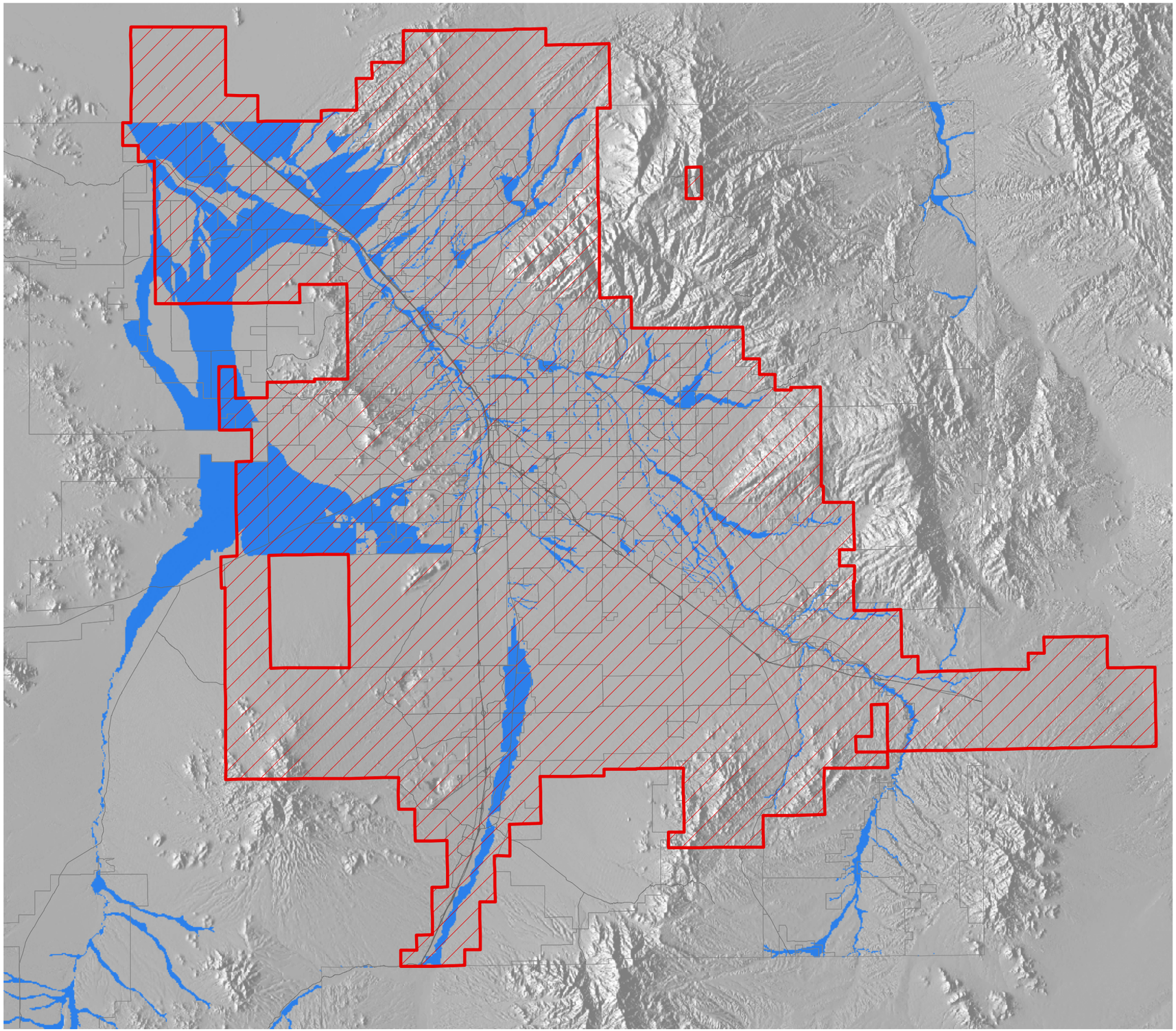
R. "Terry" Hendricks, CFM, Chief Hydrologist
Planning and Development Division

RTH/cd

Cc: Steve Whitney, GIS Manager, Pima County Department of Transportation
Kenneth Maits, Senior GIS Analyst, PC Regional Flood Control District
Manny M. Rosas, GIS Administrator, Pima Association of Governments.

Enclosures

Exhibit 1:
2008 LiDAR Coverage and FEMA Special Flood Hazard Areas



2008 LiDAR Coverage

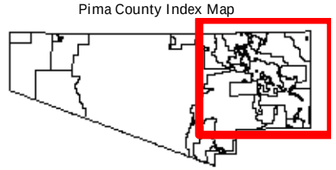
FEMA Floodplains

Major Streets

Jurisdiction Lines

Not Shown: Western Pima County, including Ajo and LiDAR coverage on Tohono O'dham Nation.

Pima County Index Map



Index Map Scale 1:5,250,000

Pima County Regional Flood Control District

Scale 1:415,000

\\gislib\rfcd\projects\imd\ken\lidar08\fema_08cov.mxd km

Corporate Headquarters:
Colorado Springs
Colorado

Ann Arbor
Michigan

Charlotte
North Carolina

Ft. Collins
Colorado

Pelham
New York

Portland
Oregon

Sacramento
California

St. Louis
Missouri

Sanborn
Middle East

Mumbai
India

30 December 2008

Manny Rosas, GIS Administrator
Pima Association of Governments
177 N. Church Ave.
Suite 405
Tucson, AZ 85701

Re: FEMA Results for the PAG 2008 Ortho Project (Contract – 08-5951-01)

Dear Mr. Rosas,

Attached you will find the results of the FEMA checkpoints for PAG 2008 LiDAR data. Sanborn's contracted Arizona State Registered Land-Surveyor, Greg Thompson, performed a review of the report and is in agreement with the results.

Background

To ensure the accuracy of the PAG 2008 LiDAR data, Sanborn was contracted to implement a project plan that included the integration of FEMA checkpoints as part of the QA/QC process. To support this initiative, Sanborn collected 69 checkpoints as part of the control survey effort. This meets the minimum standards for vertical accuracy testing and reporting as defined in FEMA's map modernization requirements. FEMA recommends 20 checkpoints in each of the major land cover categories representative of floodplains being mapped; this normally requires a minimum of 60 checkpoints for at least three land cover categories. The three categories surveyed were:

1. Bare Earth and Low Grass
2. High Grass, Weeds, and Crops
3. Brush lands/low trees

Field data was acquired using GPS equipment and static surveying methods. Sanborn team surveyed all checkpoint following the procedures in NOAA Technical Memorandum NOS NGS-58, "Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm and 5 cm)" and use NGS' latest Geoid Model to compute NAVD88 orthometric heights accurate to 5-cm at the 95% confidence level. (The x and y coordinates of checkpoints will be accurate to 2-cm at the 95% confidence level.)

Final adjusted results were adjusted to Arizona State Plane Coordinates, Central Zone NAD83-92 (HARN), NAVD88, in units of International Foot.

Testing Methodology

As stated in the Guidelines and Specifications for Flood Hazard Mapping Partners (April 2003), Section A.87.6.1, "The Root Mean Square Error (RMSE) is the square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent source of higher accuracy for identical points…TINs (and DEMs derived therefrom) should normally have a maximum RMSE of 18.5 centimeters, equivalent to

2-foot contours, in flat terrain. The following are the results from the PAG 2008 Ortho Program.

Bare Earth:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1001837.162	410093.611	2587.031	2587.530	+0.499
7	999345.782	449442.944	2441.401	2441.640	+0.239
20	933721.166	412981.849	2439.091	2439.310	+0.219
17	933650.558	412993.658	2438.451	2438.660	+0.209
15	897369.501	552863.803	1937.257	1937.430	+0.173
3	1159921.689	349431.234	4294.062	4294.210	+0.148
8	1005806.086	434836.185	2509.196	2509.340	+0.144
9	1000927.946	448200.185	2446.309	2446.400	+0.091
13	994444.372	503631.914	2655.984	2656.070	+0.086
11	994513.846	503595.055	2658.012	2658.090	+0.078
18	955798.751	425094.504	2540.814	2540.880	+0.066
2	906521.919	540616.247	1946.585	1946.640	+0.055
12	987338.200	503575.338	2542.972	2542.930	-0.042
14	965580.705	519074.819	2667.182	2667.120	-0.062
21	955893.647	425085.496	2541.302	2541.240	-0.062
5	1021871.892	457772.536	2472.149	2472.080	-0.069
6	1033139.499	445741.877	2610.656	2610.580	-0.076
16	939704.593	416728.203	2432.726	2432.640	-0.086
10	985754.835	454784.703	2313.130	2312.980	-0.150
19	939508.793	416651.451	2432.802	2432.630	-0.172
22	1027485.930	416573.872	2740.833	2740.650	-0.183
4	1156429.917	365109.827	4055.003	outside	*

Average dz	+0.053
Minimum dz	-0.183
Maximum dz	+0.499
Average magnitude	0.139
Root mean square	**0.171 (foot)**
Std deviation	0.166

Medium Vegetation:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1187028.525	351518.925	4080.561	4080.540	-0.021
2	1117108.620	363592.785	3587.077	3586.940	-0.137
3	1073972.909	383419.761	3240.515	3240.590	+0.075
4	1010832.502	410849.441	2643.786	2643.990	+0.204
5	1005445.314	419156.617	2579.495	2579.880	+0.385
6	1045092.088	435136.157	2724.009	2724.050	+0.041

7	1069748.640	446273.392	2760.125	2760.050	-0.075
8	1033371.126	464364.855	2518.606	2518.310	-0.296
9	1054207.161	418935.174	2886.854	2886.950	+0.096
10	955203.805	487660.945	2178.734	2179.130	+0.396
11	997532.713	434803.804	2460.164	2460.250	+0.086
12	979509.921	492673.940	2417.792	2418.190	+0.398
13	995655.491	465569.990	2344.777	2344.690	-0.087
14	997550.935	482620.376	2598.648	2598.550	-0.098
15	1001334.429	474026.061	2493.153	2493.240	+0.087
16	990196.690	487542.780	2546.083	outside	*
17	990519.334	490352.801	2559.039	2559.110	+0.071
18	998219.739	493708.248	2936.804	2937.080	+0.276
19	996795.607	504234.682	2727.497	2727.370	-0.127
20	988245.902	501104.027	2560.988	2560.870	-0.118
21	985960.009	501595.086	2553.169	2553.130	-0.039
22	997446.853	506178.000	2694.613	2695.140	+0.527
23	987398.768	503506.302	2546.335	2546.410	+0.075
24	985971.797	501493.493	2552.516	2552.570	+0.054
25	997540.656	506124.929	2707.864	2708.230	+0.366
26	991206.370	506306.455	2518.406	2518.250	-0.156
27	978945.698	519233.465	2782.405	2782.330	-0.075
28	978935.642	519272.398	2784.006	2784.080	+0.074
29	965555.375	519044.382	2666.260	2666.260	+0.000
30	897298.425	552978.606	1937.352	1937.730	+0.378
31	910066.011	514280.384	2003.658	2003.840	+0.182

Average dz	+0.085
Minimum dz	-0.296
Maximum dz	+0.527
Average magnitude	0.167
Root mean square	**0.217 (foot)**
Std deviation	0.203

High Vegetation:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1041505.790	408998.331	2868.881	2869.410	+0.529
4	1007421.616	441240.211	2501.880	2502.270	+0.390
9	988302.547	500937.045	2557.959	2558.170	+0.211
10	993323.041	504876.742	2616.818	2616.900	+0.082
3	944799.536	483176.205	2406.404	2406.480	+0.076
6	993338.640	505132.410	2616.096	2616.130	+0.034
13	995168.385	519848.931	2773.051	2773.040	-0.011
8	996811.199	504124.980	2733.504	2733.470	-0.034
14	995094.857	519807.072	2771.624	2771.590	-0.034
5	995053.089	492295.493	2741.552	2741.500	-0.052
7	986911.443	504348.439	2463.848	2463.780	-0.068

11	986965.447	504425.310	2458.159	2458.090	-0.069
12	993296.411	506167.522	2598.730	2598.640	-0.090
16	919968.908	521623.590	2003.520	2003.130	-0.390
15	909979.986	514314.158	2004.186	2003.740	-0.446
2	988498.629	488163.006	2506.243	outside	*

Average dz	+0.009
Minimum dz	-0.446
Maximum dz	+0.529
Average magnitude	0.168
Root mean square	**0.240 (foot)**
Std deviation	0.248

Sanborn concludes that the overall RMSE of the LiDAR data is within PAG 2008 Ortho project requirements, as it meets the +/- 15.0 cm (0.492 foot) RMSE at 95% confidence for all three categories. RMSE is an indicator of overall accuracy of the product and is not used for individual point accuracy.

Please contact me at (719) 593-0093 extension 5645 or Jamie Young (General Manager – ext. 5602) if you have any question regarding the report.

Sincerely,

Andrew Lucero
Sanborn
Senior Project Manager

Evan Canfield

From: Kenneth Maits
Sent: Monday, May 03, 2010 12:20 PM
To: Evan Canfield
Subject: FW: PAG 2008 Orthos/Lidar

From: Curtis, Edward [mailto:Edward.Curtis@dhs.gov]
Sent: Tuesday, November 10, 2009 2:44 PM
To: Manny M. Rosas
Cc: Terry Hendricks; Lucero, Andrew; Caldwell, Jason; Akl, Pascal
Subject: RE: PAG 2008 Orthos/Lidar

Mr. Rosas –

I apologize for the delay in responding to you regarding the Sanborn LiDAR report. Pascal Akl of Michael Baker, Jr. reviewed the updated July 2009 report on behalf of FEMA and advised me that all of the concerns raised in his May 18, 2009 memorandum titled "Pima County, CA [sic] Sanborn LiDAR Report Items" were addressed in the updated report except the comment that the original report lacked a sufficient number of checkpoints in urban areas and dense vegetation areas. No additional checkpoints were surveyed in such arease to permit analysis of data accuracy in these land cover categories. However, in the data voids analysis section of the updated report (p. 16), Sanborn states the following: "*Specific areas, dense vegetation or undergrowth near small streams, for example, prevents the LiDAR pulses to fully penetrate to the true ground surface. Thus, for mapping products such as floodplain or contour mapping, LiDAR data must often be manually supplemented with breaklines and mass-points to accurately model the terrain surface.*" As long as the data is used with caution and supplemented with additional ground survey data where necessary in accordance with this statement, I am satisfied that the terrain data meets FEMA standards for use in detailed flood studies.

Please contact me if you have any questions regarding our review and comments.

Ed Curtis, P.E., CFM
Risk Analysis Branch
FEMA Region IX
(510) 627-7207 - office
(510) 295-5249 - mobile

From: Manny M. Rosas [mailto:MRosas@pagnet.org]
Sent: Tuesday, November 10, 2009 7:29 AM
To: 'Lucero, Andrew'; 'Caldwell, Jason'
Cc: 'Terry Hendricks'; Curtis, Edward
Subject: PAG 2008 Orthos/Lidar

Hi Andy,
I resent Sanborn's Version 3 document produced in July 2009 and yet to receive any comments from FEMA, Pima County and Michael Baker Inc. therefore
please proceed with direct communications with Michael Baker Inc (Pascal Akl) to resolve all issues regarding the FEMA guidelines

Thank You
Manny

Manny M. Rosas Jr.
GIS Administrator

Pima Association of Governments

177 N Church Ave. Suite 405
Tucson, Arizona 85701

520-792-1093 (tel)
520-620-6981 (fax)

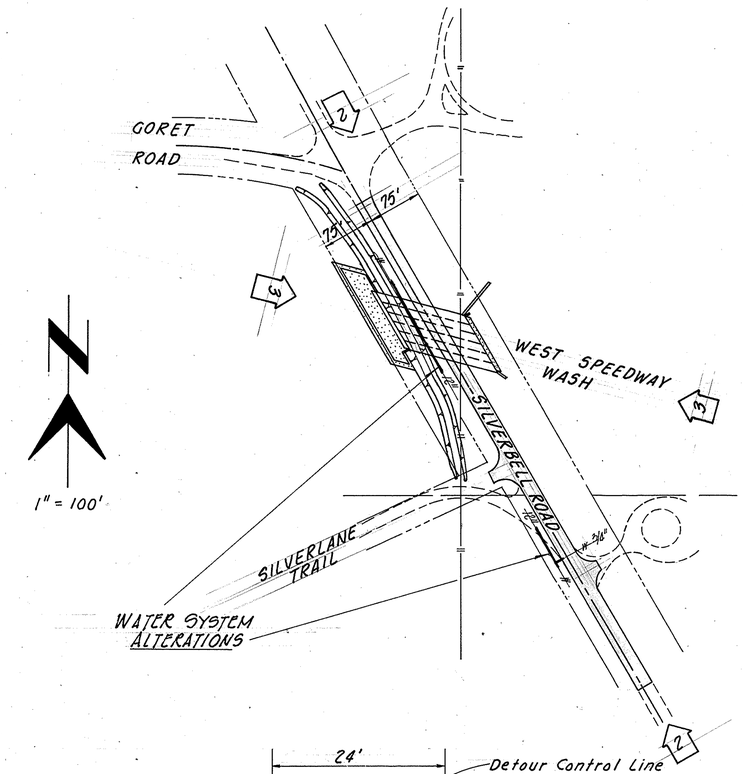
Appendix D: Hydrologic Analysis Supporting Documentation

(models, spreadsheets and supporting information is provided digitally in the TDN disk)

Appendix E: Hydraulic Analysis and As-Built Drawings for Hydraulic Structures

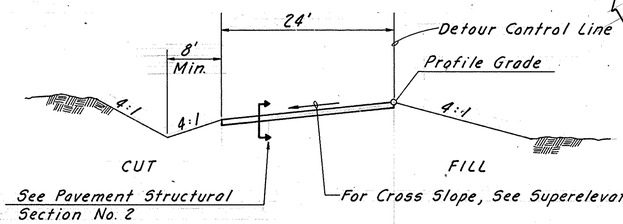
(models, spreadsheets and supporting information is provided digitally in the TDN disk)

WEST SPEEDWAY WASH
BOX CULVERT
AT SILVERBELL ROAD
JOB NO. 652

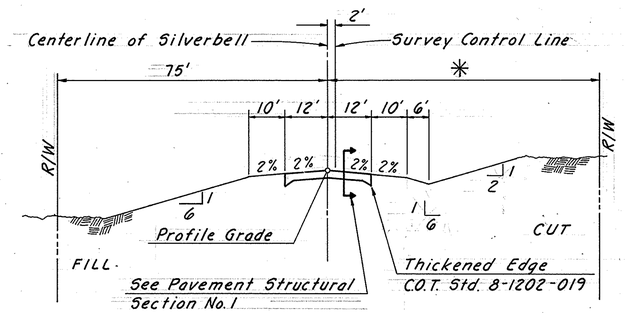


WATER ALTERATION NOTES:

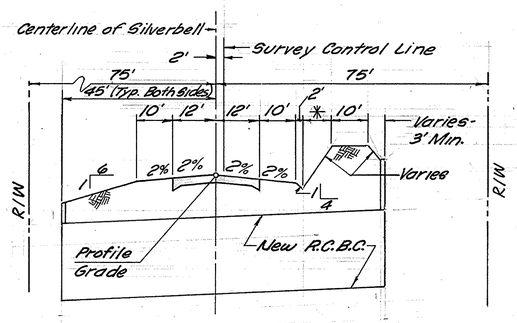
1. ALL WATER SYSTEM ALTERATION CONSTRUCTION WORK TO CONFORM TO TUCSON WATER STANDARD SPECIFICATIONS AND DETAILS EXCEPT WHEN SUPERSEDED BY SPECIAL SPECIFICATIONS.
2. WATER SYSTEM ALTERATION PRE-CONSTRUCTION PROCEDURE: THE CONTRACTOR SHALL CONTACT MR. HANK LEON, FIELD ENGINEER, TUCSON WATER (791-2665) PRIOR TO ANY WATER WORK. NO ALTERATION WORK IS TO BEGIN UNTIL WRITTEN AUTHORIZATION HAS BEEN ISSUED.
3. THE CONTRACTOR IS TO MAKE EVERY EFFORT TO INSURE THE SAFE INTEGRITY OF THE WATER SYSTEM. THE USE OF HEAVY EQUIPMENT OVER AND AROUND WATER FACILITIES WILL BE WITH THE FULL AWARENESS OF THEIR WHEREABOUTS AND VULNERABILITY. REPAIR TO DAMAGED WATER FACILITIES DETERMINED BY THE FIELD INSPECTOR AS AVOIDABLE WILL BE THE RESPONSIBILITY OF THE CONTRACTOR.
4. RECONNECTIONS TO EXISTING WATER SYSTEM SHALL BEGIN BEFORE 10:00 A.M. IN THE WORK DAY TO ALLOW FOR COMPLETED CONNECTION PRIOR TO END OF WORK DAY.
5. SHUT-DOWN OF WATER SYSTEM REQUIRING THE OPERATION OF WATER VALVES WILL BE COORDINATED THROUGH TUCSON WATER FIELD INSPECTOR.
6. COSTS INVOLVED IN MAKING REPAIRS TO WATER FACILITIES DAMAGED BY OTHER UTILITIES OR THEIR REPRESENTATIVES IN THE INSTALLATION OF THEIR FACILITIES ARE THE SOLE RESPONSIBILITY OF THAT UTILITY.
7. TESTING AND DISINFECTION TO BE AS PER SD-900 AND SD-950.
8. ALL EXCAVATION, BEDDING AND BACKFILL TO BE AS PER SD-100.



DETOUR - TYPICAL SECTION
STA. 7+36.00 TO STA. 17+37.34



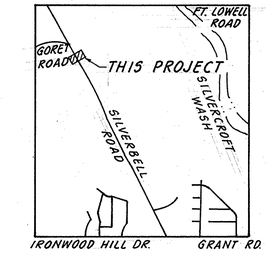
SILVERBELL ROAD - TYPICAL SECTION
STA. 10+50.00 TO STA. 18+40.00



SILVERBELL ROAD - MOD. SECTION
STA. 11+93 TO STA. 12+61

✳ Varies: 75' from Sta. 7+36.00 to 13+80.00, 30' from 13+80.00 to 20+00.00

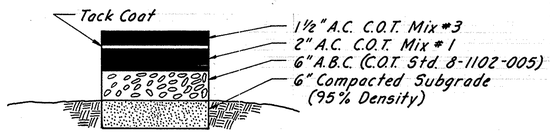
✳ Varies: From 7' at Sta. 11+93.00 to 10' at Sta. 12+61.00



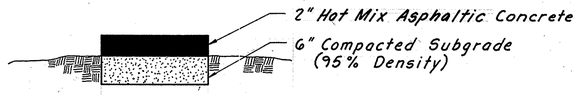
LOCATION PLAN
SCALE: 3" = 1 MILE

CITY OF TUCSON
STANDARD DETAILS

8-1202-012	No. 1 Bituminous Conc. Mixture Diagram
8-1202-013	Mineral Aggregate Mix No. 2
8-1202-019	Thickened Pavement Edge
8-1207-002	Detail for Adjustment of Water Valve Boxes & Cover



PAVEMENT STRUCTURAL SECTION NO. 1



PAVEMENT STRUCTURAL SECTION NO. 2

LEGEND

	Exst. Swale
	New Ditch
	Concrete
W.V.	Water Valve
P.P.	Power Pole
MB Ped.	Mt. Bell Pedestal
FH	Fire Hydrant
San. MH	Sanitary Manhole
GM	Gas Meter
S	Sanitary Sewer
W	Water
G	Gas
III	1/16 Section Line
II	1/4 Section Line
x	Existing Fence
Existing R/W	Existing Right-Of-Way
	Center line
	Easement
	Existing Pavement
	New Pavement
	Pavement Removal

INDEX OF SHEETS

AS BUILT

INSP. FIELD BOOK NO. 1542
☐ INSPECTORS COPY ☐ SURVEYORS COPY
INSPECTED BY Frank Mlaren
REC'D, MAPS & RECORDS, DATE
"AS BUILT" BY R.J.L. DATE May 8, 1986
CONTRACTOR MAYA Construction
CONST. COMPLETED, DATE April 2, 1986
FINAL COST $358,004.78
REMARKS

APPROVALS:

DIRECTOR, TUCSON WATER — DATE 8 Aug 85

PIMA COUNTY DEPARTMENT OF WASTEWATER MANAGEMENT — DATE 22 Aug 85

Two working days before you dig, CALL FOR THE BLUE STAKES 792-2211 Blue Stake Center CALL COLLECT

Johnson · Brittain & Associates, Inc.
ENGINEERS · PLANNERS · SURVEYORS
630 East 9th Street · Tucson, Arizona 85705
Phone (602) 623-4314

NO.	DATE	REVISION	BY	CH.	APPR.

CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD
1 OF 7

DRWN. BY DCB 1985
DSGN. BY RDB 1985
CHKD. BY RDB 1985
APPD. CITY ENGINEER 8/6/85 1985
APPD BY 8/6/85 1985
REF —— SCALE: AS SHOWN
PLAN NO. D-85-01


BM #1, Sta. 10+25.00, 75' Lt.
1/2" Rebar, Elev. 2296.18
BM #2, Sta. 14+77.06, 86' Rt.
Brass Disc, Elev. 2299.79
BM #3 (C.O.T. F.B. #1252 ¢ #1416)
Aluminum Capped Rebar Stamped K-129
18' East of Silverbell Road
20' North of Police Academy Entrance
Elev. = 2296.06
Sta. 12+61.00 Silverbell Rd. = Sta. 10+00.00 West Speedway Wash
Sta. 12+61.00
New 6-10' x 6' x 128' R.C.B.C.
A.D.O.T. Std. Det. CB-6, 45° Skew
See Sheet 3
New Drainage Easement
Sta. 10+50.00
Begin New Pvmt.
Meet Exst. Pvmt.
Sawcut, Tack & Join
Exist. 36" C.M.P. to Remain. It Was Ab. Abandon and Plug w/ Conc. @ Both End.
Sta. 11+50± to Sta. 13+25±
Exst. 12" C.A. Pipe to be abandoned
Sta. 12+95± 21' Rt.
1-22 1/2° Bend
Inv. = 2284.46
New Drng. Esmt.
Sta. 15+26.27
Intersection of 1/16th Section Line & Silverbell Cst. Centerline
Fnd. Brass Disc.
Remove 162 S.Y. Exst. Conc.
See Spillway Detail, Sheet 6
Exst. R/W
P.C. 8+70.60
P.T. 11+02.27
Fnd. 60d Nail
Sta. 15+46± to Sta. 16+40±
Exst. 12" C.A. Pipe to be abandoned
Sta. 15+83.7
New 79 L.F. 48" R.C.P., 34°17'19" Skew Lt.
W/1-Headwall, ADOT Std. C-14.20
For Driveway See Sheet 4
Survey Control Line
Sta. 18+40.00
End New Pvmt., Meet Exst. Pvmt.
Sawcut, Tack & Join
SILVERBELL ROAD
S 30° 58' 50" E
Abandoned
Adjust Water Valves
C.O.T. Std. 8-1207-002
Brace Power Pole During Construction
Sta. 14+54 to Sta. 15+03, 20' Rt.
New 49 L.F. 18" R.C.P.
Temp. Cst. Esmt. For Side Street See Sheet 4
Sta. 22+80.38
Fnd. 1/2" I.P. - P.C.
GORET ROAD
New Drng. Esmt.
S 75°58'50" E
Sta. 11+50± to Sta. 11+80±
30 L.F. new 12" C.A. Pipe, N. & S. Connect to exst. 12" C.A. Pipe, N. with C900 PVC Flex Coupling and Connect to New 12" C.A. to D.I. Adaptor, South.
Sta. 12+95± to Sta. 13+25±
30 L.F. new 12" C.A. Pipe, N & S. Connect to new 12" C.A. to D.I. Adaptor, N. and Connect to exst. 12" C.A. Pipe with C900 PVC Flex Coupling, South
Sta. 11+80± to Sta. 12+95±
115 L.F. new 12" Class 51 Ductile Iron Pipe.
Sta. 11+80± 21' Rt.
1-22 1/2° Bend
Inv. = 2284.46±
Sta. 15+76± to Sta. 16+10±
34 L.F. new Class 51 Ductile Iron Pipe
Sta. 16+10± to Sta. 16+40±
30 L.F. new 12" C.A. Pipe, N. & S. Connect to new 12" C.A. to D.I. Adaptor, N. and Connect to exst. 12" C.A. Pipe with C900 PVC Flex Coupling, South
Sta. 15+76± 22' Rt.
1-22 1/2° Bend
Inv. = 2282.82
Sta. 16+10± 22' Rt.
1-22 1/2° Bend
Inv. = 2282.82
Sta. 14+77.06, 86.00' Rt.
1/16th Section Corner
Fnd. Brass Disc.
40 L.F. of wood post & rail fence to be relocated
New locations of 40 L.F. of fence
N 88° 39' 50" E
SILVERLANE TRAIL
Sta. 15+46± to Sta. 15+76±
30 L.F. new 12" C.A. Pipe, N. & S. Connect to exst. 12" C.A. Pipe with C900 PVC Flex Cpl., N. and Connect to new 12" C.A. to D.I. Adaptor, South
Service Tie Over
Sta. 16+28±
3/4" Cu., +5'
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CURVE DATA
Δ = 02° 20' 52"
R = 5653.66'
T = 115.85'
L = 231.67'
Silverbell Centerline Reestablished Based on C.O.T. F.B. #1252
9 10 11 12 13 14 15 16 17 18 19
2300 2295 2290 2285
200' V.C.
Finish Grade @ Cst. ¢
-0.1485%
-1.6296%
+0.2947%
Begin New Pvmt.
10+50.00 2297.89
6-6'x10' Conc. Box Culvert 12+61
BVC 12+80 2297.55
13+00 97.51
13+25 97.41
13+50 97.26
13+75 97.07
14+00 96.84
14+25 96.56
14+50 96.23
14+75 95.85
EVC 14+80 2295.77
PVI 13+80 Elev. 2297.40 Corr. = -0.37
BVC 15+50 2294.63
48" R.C.P. 15+80 INLET INV. 87.80 OUTLET INV. 86.90
PVI 16+50 Elev. 2293.00 Corr. = +0.48
EVC 17+50 2293.29
18+40.00 2293.56 End New Pvmt.
15+75 94.25
16+00 93.94
16+25 93.68
16+75 93.34
17+00 93.27
17+25 93.25
93.20 92.80
Exst. 12" C.A. Pipe
Exst. Ground @ Cst. ¢
C900 PVC Flex Cpl.
66 L.F. 30' New C.A. Pipe Roll Short Sections
D.I./C.A. Adaptor
65 L.F. 30'± New C.A. Pipe Roll Short Sections
30'± New C.A. Pipe Roll Short Sections
104 L.F. 115 L.F. Class 51 Ductile Iron Pipe
Exst. 8" Sewer Inv. = 2282.82
Connect to exst. 12" C.A. Pipe @ Sta. 11+50±
Sta. 11+80± 1-22 1/2° Bend Inv. = 2284.46
Sta. 12+95± 1-22 1/2° Bend Inv. = 2284.46
Connect to exst. 12" C.A. Pipe @ Sta. 13+25±
Connect to exst. 12" C.A. Pipe @ Sta. 15+46±
Sta. 15+76± 1-22 1/2° Bend
Sta. 16+10± 1-22 1/2° Bend
Connect to exst. 12" C.A. Pipe @ Sta. 16+40±
Class 51 Ductile Iron Pipe 34 L.F. 49 L.F.
AS BUILT
MAY 8, 1986
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD
2 OF 7
DRWN BY D.M., D.D. 1985
DSGN BY D.W. 1985
CHKD. BY R.D.B. 1985
APPD BY
CITY ENGINEER
SCALE: HORIZ 1" = 40' VERT 1" = 4'
PLAN NO. D-85-01
NO. DATE REVISION BY CH. APPR.


GORET ROAD
SILVERBELL
ROAD
Sta. 12+61.00
New 6 - 10' x 6' x 128' R.C.B.C.
ADOT Std. Det. CB-6, 45° Skew
Exst. 36" CMP
To Remain
Sta. 12+25.00, 40' Lt.
Anchor Assembly
Exst. Conc. Pad
64 Sy. To Be Removed
Sta. 12+25.00, 40' Lt.
New Cutoff Wall
See Detail D
Exst. Cutoff Wall
To Be Removed
Sta 10+48.11, 67.15' Lt.
Beg. New Bank Protection
① Curve Data
Δ = 29° 30' 00"
R = 410.00'
T = 107.94'
L = 211.10'
10'
2300.0
2' Thick
Dumped Rip Rap
3
1
2
1
2'
Compact Berm to 95% Density
Permeable Filter Blanket
SECTION B-B
New Downstream Apron
ADOT Std. CWA-1
New Wingwalls
Downstream: ADOT Std. CWG-7
Upstream: ADOT Std. CWL-2, Type A
H=8', l=10'
A
A
New Drng. Esmt.
S 75° 58' 50" E
Sta. 12+50, 14' Lt., End New Bank Protection
For End Condition See Detail F
Sta. 13+62.50, 40' Lt.
Begin Flared Cable Terminal
Sta. 13+99.71, 44' Lt.
End Flared Cable Terminal
Sta. 12+61.00 Silverbell Road =
Sta. 10+00.00 West Speedway Wash
Reconstruct exst.
M.H. per P.C.W.W.M.
Std. Det. 205
Elev. = 2295.43
San MH
New Drng. Esmt.
New Spillway
See Sheet 6
New 75.00 L.F. Guard Rail Type A
ADOT Std. C-10.01
1-Flared Breakaway Cable Terminal
Assembly ADOT Std. C-10.15
1-Guard Rail Anchor Assembly
ADOT Std. C-10.21
Sta. 15+81.50, 13' Rt.
End Flared Breakaway Cable Terminal
Sta. 16+19.00, 13' Rt.
Anchor Assembly
Add 12' Wing Wall,
Move Guard Rail ± 2'
Sta. 15+44.25, 17' Rt.
Begin Flared Breakaway
Cable Terminal
New Drainage Esmt.
Sta. 10+75.29, 38' Rt.
Begin Flared Breakaway
Cable Terminal
Sta. 11+12.50, 34' Rt.
End Flared Breakaway Cable
Terminal. Begin Guardrail
New Concrete Apron
See Detail E
Channel ℄
Sta. 11+75.00, 34' Rt.
New Bridge Guard Rail Type A
ADOT Std. C-10.01
2-Flared Breakaway Cable Terminals
Assembly ADOT Std. C-10.15
2-Guard Rail Anchor Assembly
ADOT Std. C-10.21
Buried & Bolt Anchor (Timber Post)
ADOT Std. C-10.23
175 L.F. Upstream Side
125 L.F. Downstream Side
Sta. 12+99.80, 41' Rt.
Anchor Assembly
Exst. Saguaro
Protect in place
B
B
3'
21'
2'
Toe of Bank
Protection
3
1
7'
5'
Fill As Required Behind
New Bank Protection
Compact To 90% Density
6" Class "A" Concrete w/
6 x 6 - W2.1 x W2.1 WWF
SECTION A-A
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7
8
9
10
11
12
13
14
15
16
2295
2290
2285
2280
2300.00
2298.52
2296.0
2296.38
Finish Grade @ ℄
Top Of New Bank Protection
Sta. 12+50.00
Top Of Exist. North Bank
Exst. Tel.
Exst. 12" Water
Exst. 2" Gas
2289.64
2289.00
2288.95
0.5000%
Finish Grade @ ℄
Toe Of Bank Protection
86.00
87.00
Exst. Ground @ Channel ℄
5'
Toedown
New 12" Water
Sta. 10+48.11
Sta. 11+22.00
2286.70
Grade to meet
exst. channel
AS BUILT
MAY 8, 1986

CITY OF TUCSON, ARIZONA

DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION

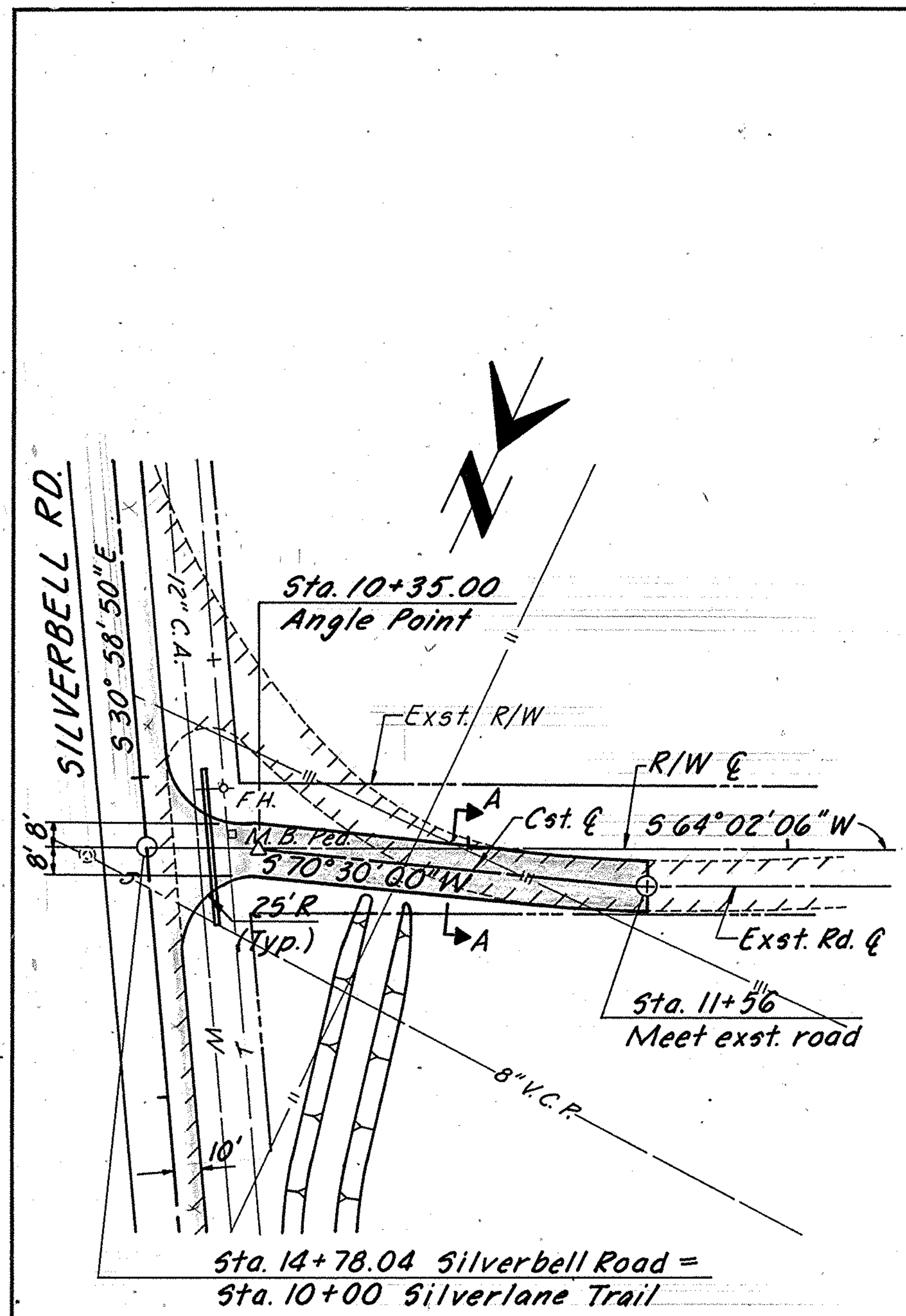
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD

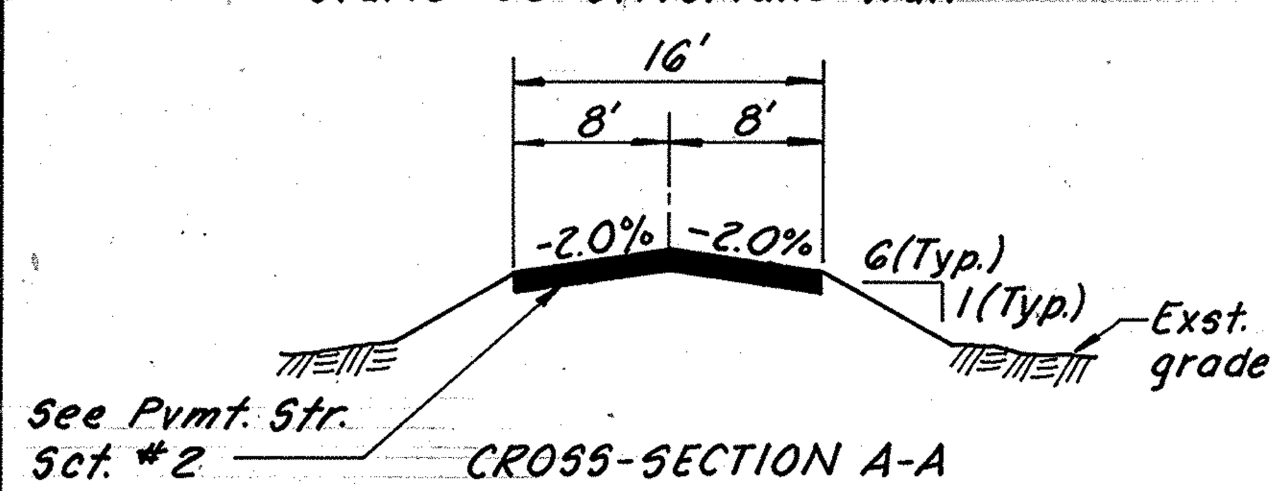
3 OF 7

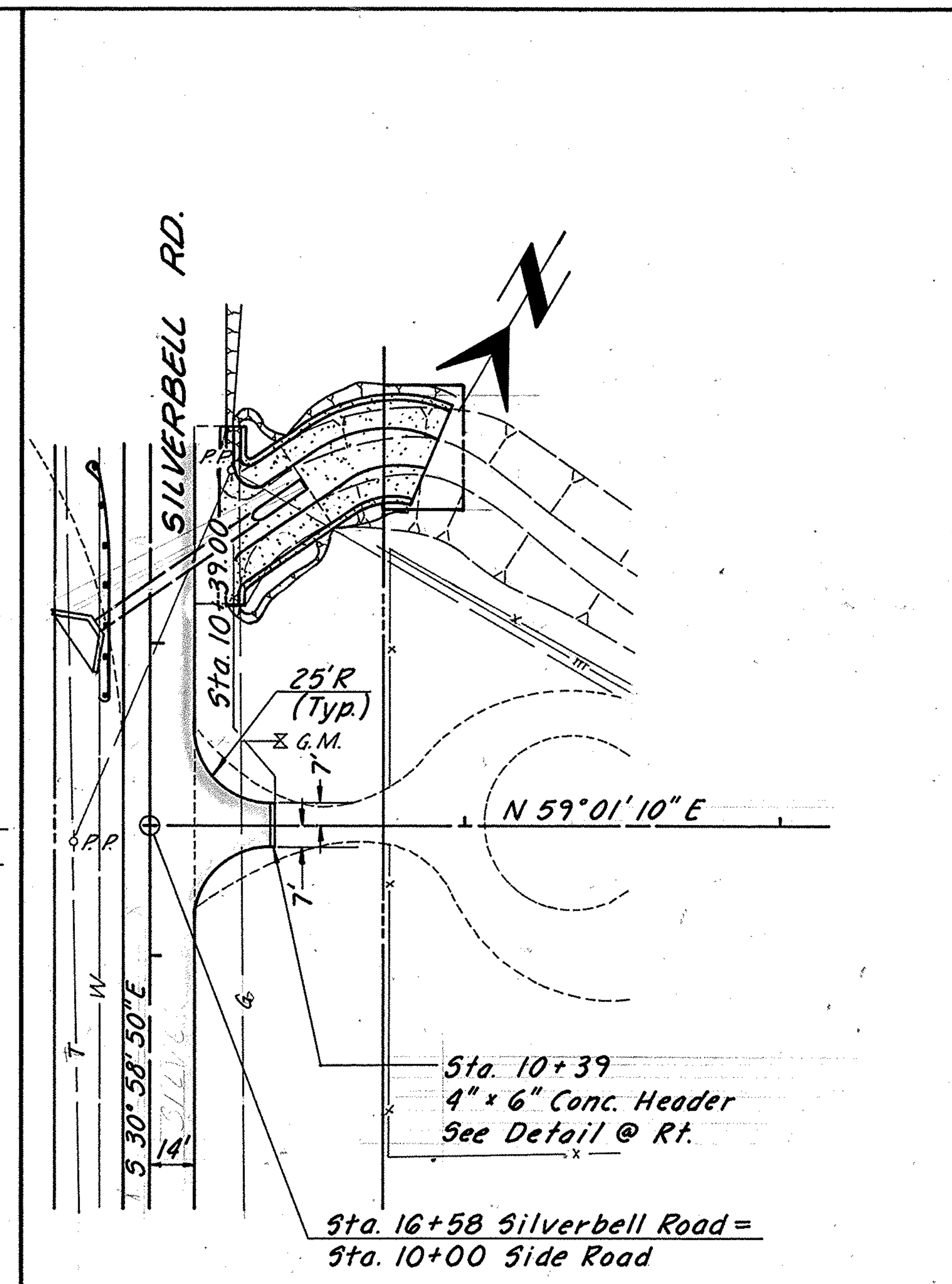
DRWN. BY	DCB, DAD	1985	APPD. BY	[signature] CITY ENGINEER	REF.		SCALE: H: 1" = 40' V: 1" = 4'
DSGN. BY	DCB	1985					
CHKD. BY	RDB	1985	APPD. BY	[signature]		PLAN NO.	D-85-01

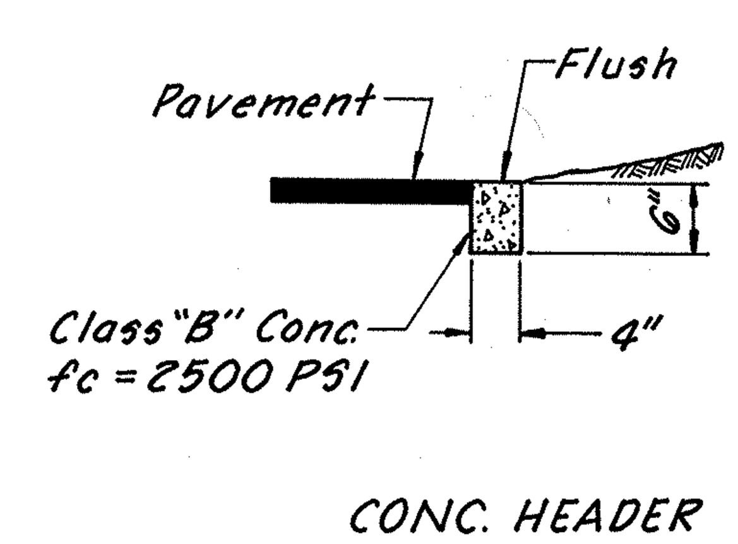
NO.	DATE	REVISION	BY	CH.	APPR.

W. SPEEDWAY









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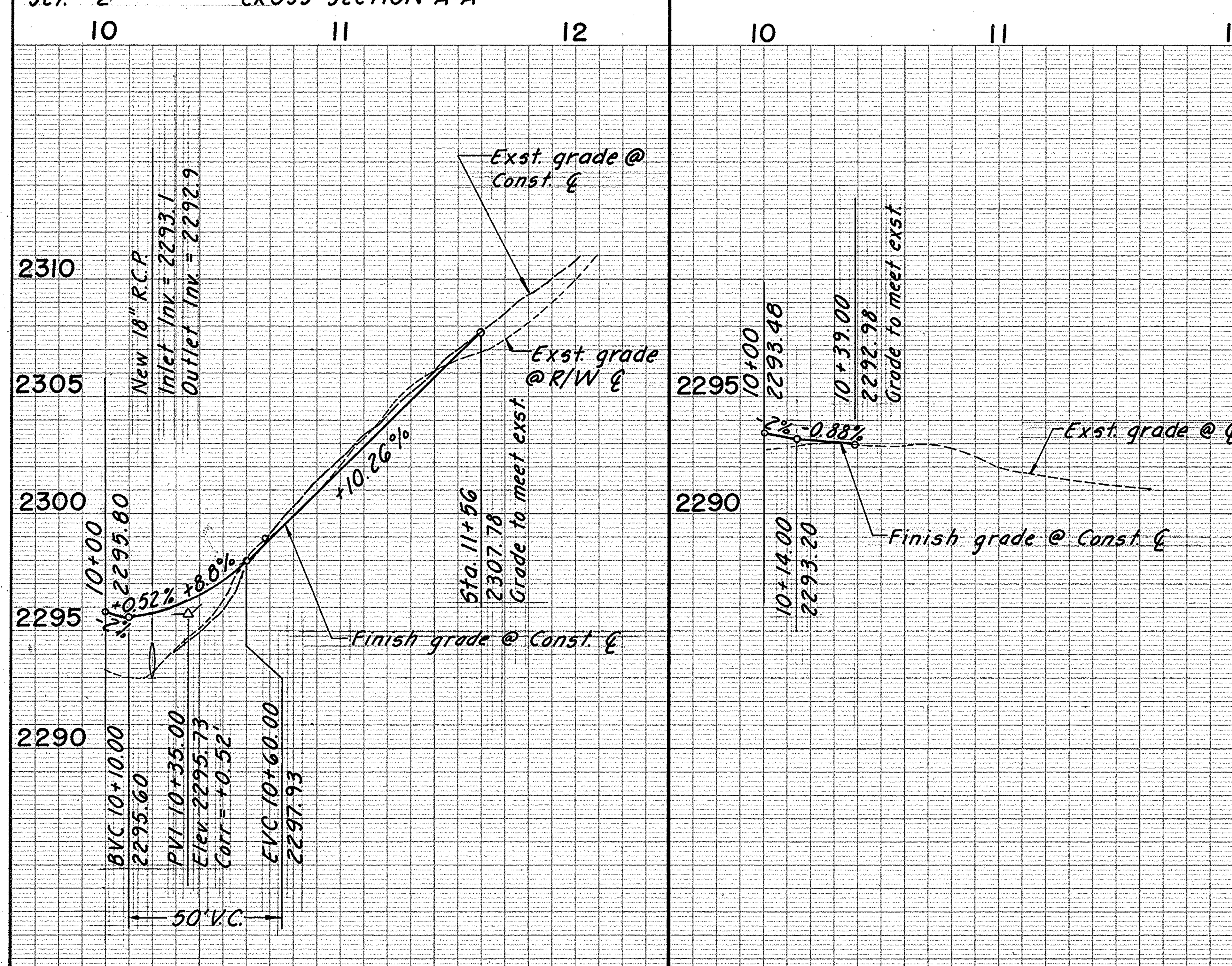


AS-BUILT
MAY 8, 1986

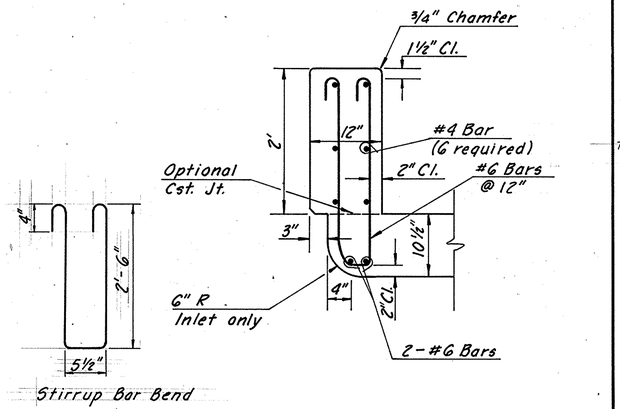
NO.	DATE	REVISION	BY	CH.	APPR.

CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD

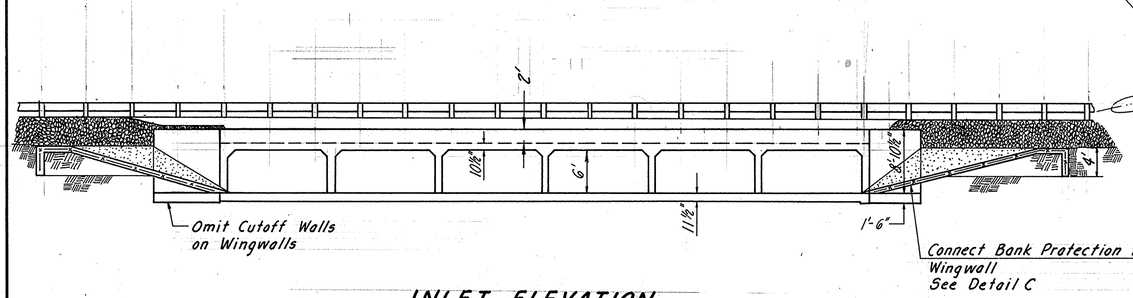
4 OF 7

DRWN BY DM 1985
DSGN BY DM 1985
CHKD. BY RDB 1985
APPD BY [signature] 8/85
APPD BY [signature] CITY ENGINEER 8/85
REF
SCALE H: 1" = 40' V: 1" = 4'
PLAN NO. D-85-01

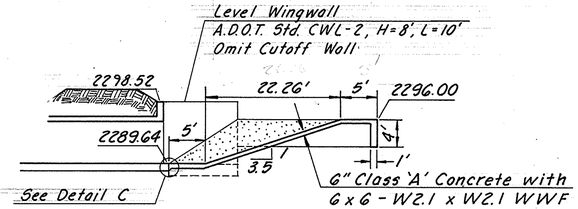
WEST SPEEDWAY



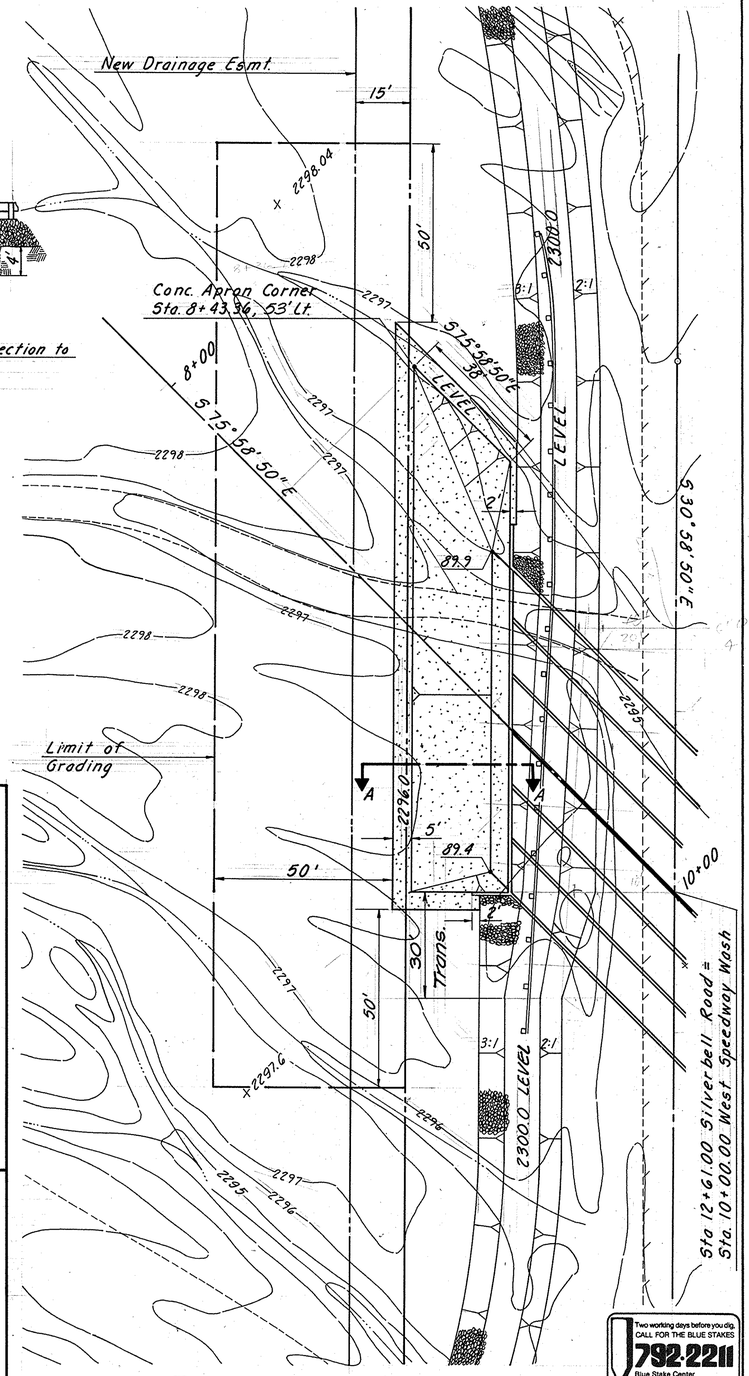
A SPECIAL HEADWALL SECTION
(UPSTREAM ONLY)
1" = 1'-0"



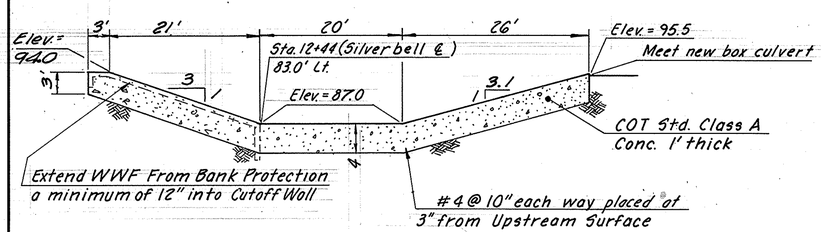
INLET ELEVATION
1" = 10'



SECTION A-A
1" = 10'

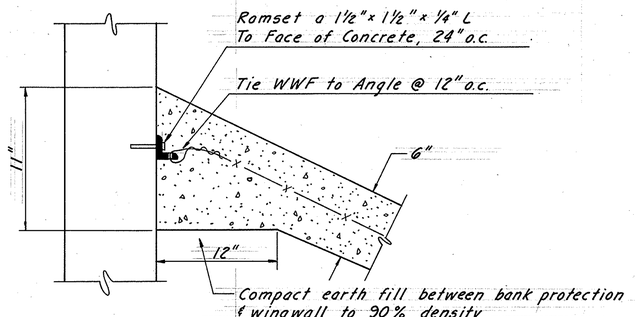


E BOX CULVERT INLET
1" = 20'

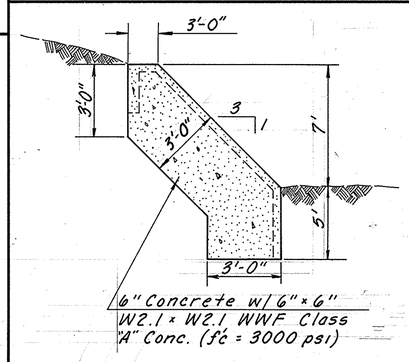


D 1'x 4'x 70' CUT OFF WALL (C.O.W)
(LOOKING DOWNSTREAM)
1" = 10'

DETAIL B - Not Used



C BANK PROTECTION CONNECTION
TO WINGWALL OR BOX CULVERT
N.T.S.



F BANK PROTECTION
END CONDITION

AS BUILT
MAY 8, 1986

NO.	DATE	REVISION	BY	CH.	APPR.

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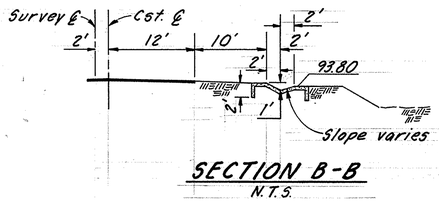
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION

WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD

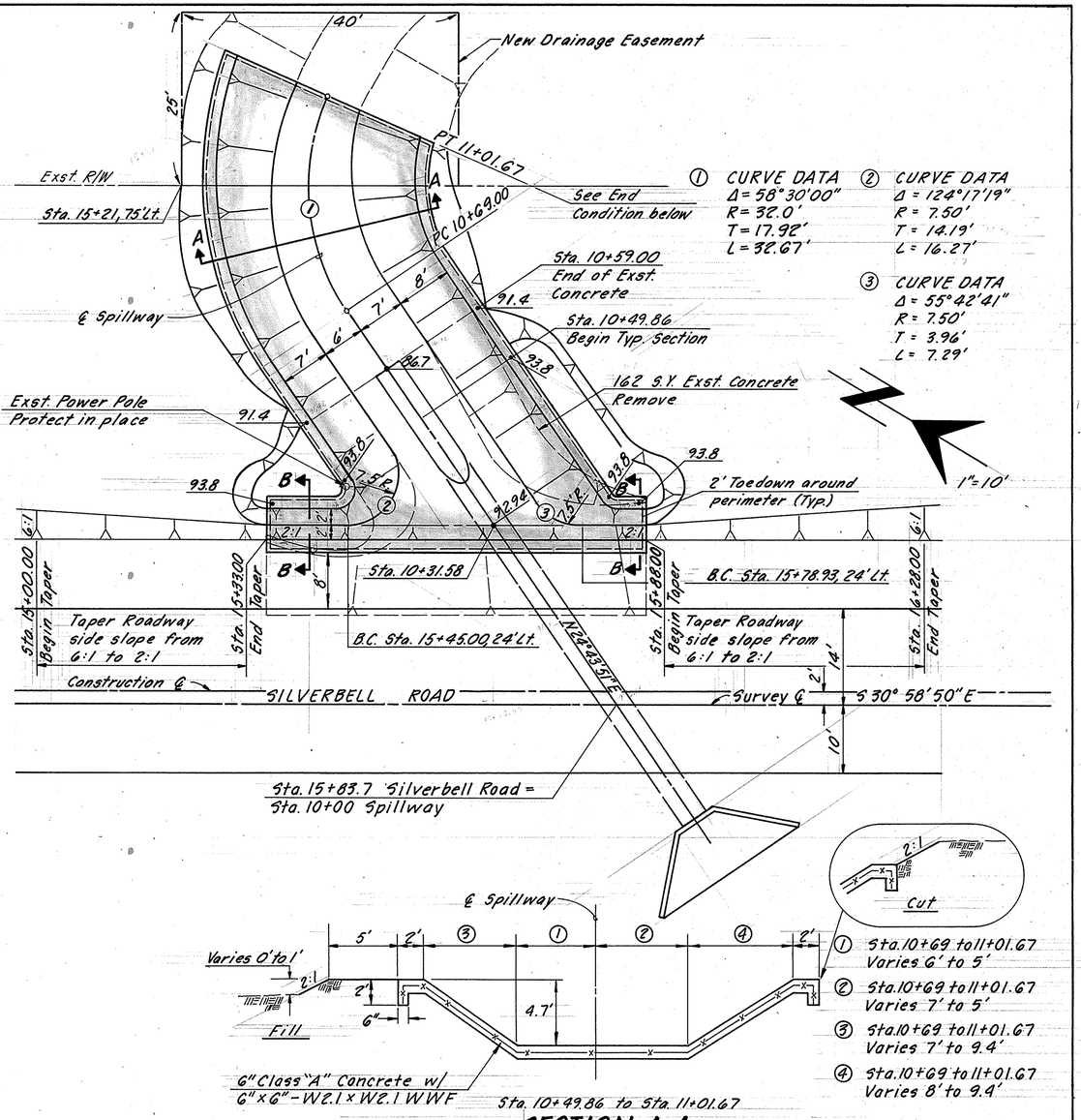
5 OF 7

DRWN BY DAD, DCB 19 85
DSGN BY DCB 19 85
CHKD BY RDB 19 85
APPD BY _____ CITY ENGINEER 19 85
APPD BY _____ 19 85
REF _____ SCALE AS SHOWN
PLAN NO. D-85-01

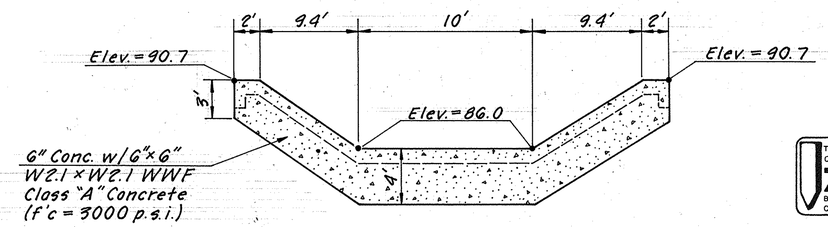
(E) SPEEDWAY



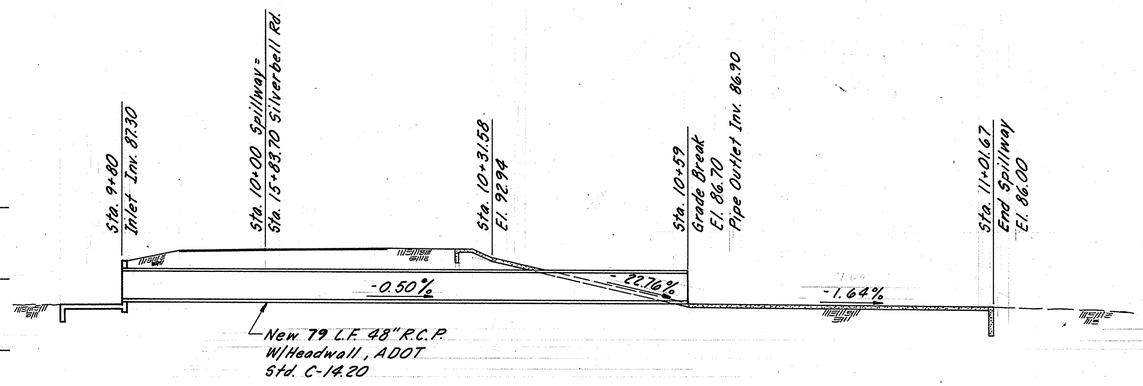
SECTION B-B
N.T.S.



SECTION A-A
N.T.S.



STA. 11+01.67 END CONDITION
N.T.S.



SPILLWAY ℄ SECTION
1"=10'

AS-BUILT
MAY 8, 1986

SPILLWAY DETAIL

Two working days before you dig, CALL FOR THE BLUE STAKES
792-2211
Blue Stake Center
CALL COLLECT

NO.	DATE	REVISION	BY	CH.	APPR.

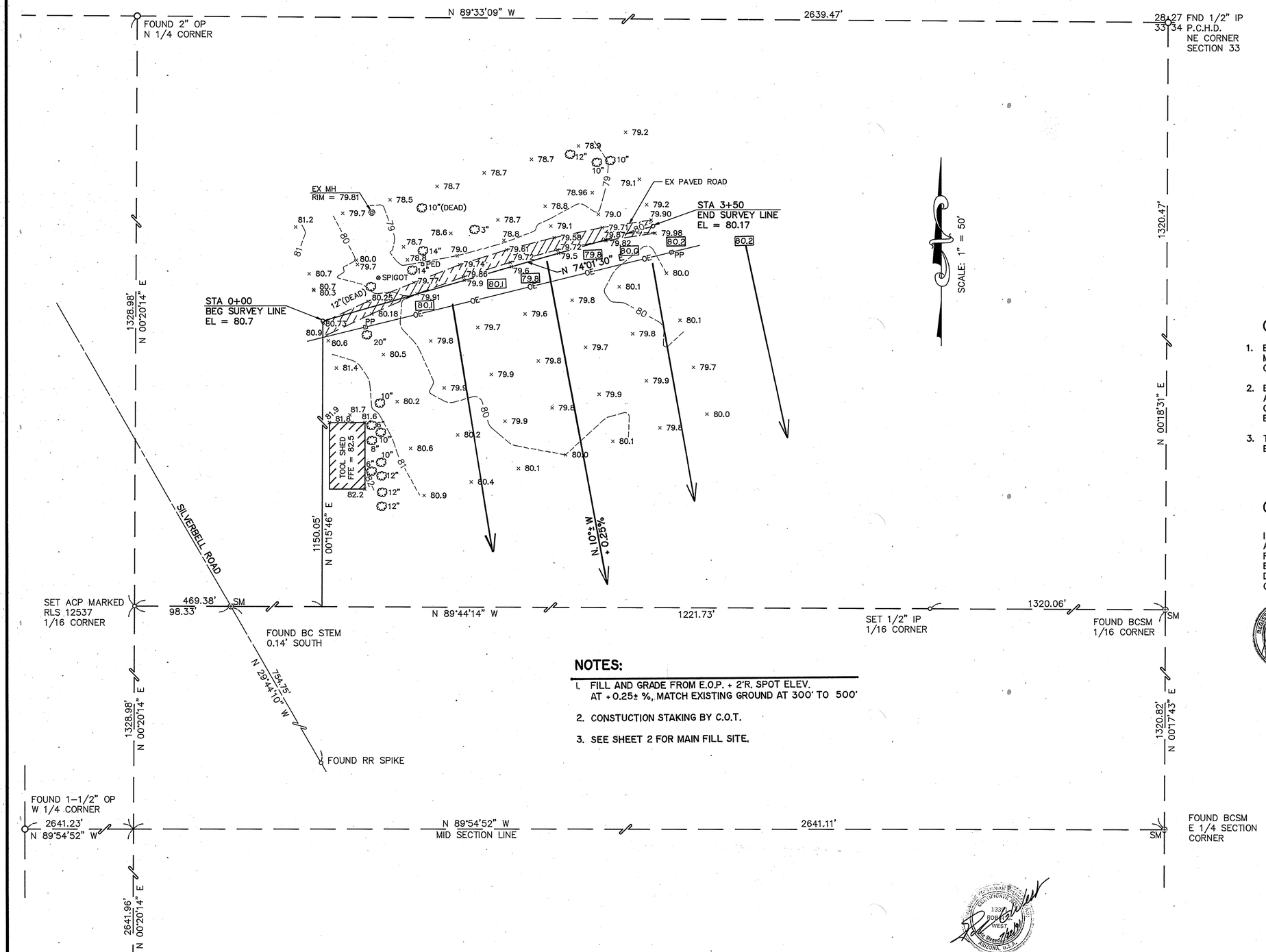
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION — ENGINEERING DIVISION

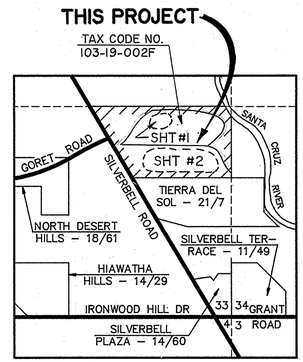
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD

6 OF 7

DRWN BY DAD 19 85
DSGN BY K M 19 85
CHKD BY RDB 19 85
APPD CITY ENGINEER 8/5 1985
APPD BY D. Carroll 19 85
REF ____ SCALE AS SHOWN
PLAN NO. D-85-01

BEGIN DETOUR ROAD
Sta. 8+93.74, 9.0' Rt. Silverbell Road =
Sta. 51+50.30 Detour Road
Detour Control Line
0.02 ft./ft.
0.02 ft./ft.
0.02 ft./ft.
Inside Edge of Detour
Exst. Saguaro Protect in place
Exst. 36" C.M.P. to Remain Until Box Culvert is Constructed
SUPERELEVATION DIAGRAM
New Drng. Esmts.
Exst. R/W
P.C. 51+79.93
P.C. 8+70.60
P.T. 11+02.27
Fnd. 60d Nail
P.C. 57+87.58
2" STL.
S 28° 37' 58" E
S 30° 58' 50" E
S 40° 58' 50" E
P.T. 58+87.06
Temp. Cst. Esmt.
S 50° 58' 50" E
Grade & Pave (Pvmt. Sect. 2) Goret to meet new Detour
After demolition of Detour, Regrade & Repave to Original Condition (Pvmt. Sect. 1)
P.R.C. 52+40.93
S 30° 58' 50" E
P.C. 55+98.49
P.T. 54+29.00
P.T. 57+03.21
24 TYP.
Exst. Power Pole Protect in Place
Temporary Detour Use By Contractor During Construction
Grade & Pave (Pvmt. Sect. 2) Silverlane Trail to meet new Detour
See Sheet 1 for Typical Section
Detour Control Line
Sta. 52+74 - New 60 L.F. x 24" ⌀ C.M.P. - 12 Gauge, 0° Skew
Sta. 56+50 - New 60 L.F. x 24" ⌀ C.M.P. - 12 Gauge 0° Skew (Radial)
GORET RD.
SILVERLANE TRAIL
END DETOUR ROAD
Sta. 17+22.96, 9' Rt. Silverbell Road =
Sta. 60+14.99, Detour Road
① CURVE DATA Δ = 02°20'52" R = 5653.66' T = 115.85' L = 231.67'
② CURVE DATA Δ = 10°00'00" R = 570.00' T = 49.87' L = 99.48'
③ CURVE DATA Δ = 13°58'48" R = 250.00' T = 30.65' L = 61.00'
④ CURVE DATA Δ = 20°00'00" R = 300.00' T = 52.90' L = 104.19'
⑤ CURVE DATA Δ = 36°19'40" R = 296.62' T = 97.32' L = 188.07'
TEMPORARY DETOUR
Johnson · Brittain & Associates, Inc.
ENGINEERS · PLANNERS · SURVEYORS
630 East 9th Street · Tucson, Arizona 85705 Phone (602) 623-4314
Two working days before you dig, CALL FOR THE BLUE STAKES
792-2211
Blue Stake Center CALL COLLECT
100' V.C.
100' V.C.
100' V.C.
2300
2295
+2.00%
+3.00%
-1.20%
-0.40%
-3.00%
+1.69%
P.V.I. 54+00.30 Elev. = 2299.40 Corr. = +0.10'
Sta. 52+70 60 L.F. x 24" ⌀ C.M.P. - 12 Gauge Inlet Inv. = 2296.47 Outlet Inv. = 2296.0
Finish Grade @ Detour Control Line
Exst. Grade @ Detour Control Line
Sta. 56+50 60 L.F. x 24" ⌀ C.M.P. - 12 Gauge Inlet Invert = 2295.07 Outlet Invert = 2294.5
Begin Detour Road Meet Existing Grade
End Detour Road Meet Exst. Grade
AS BUILT MAY 8, 1986
NO. DATE REVISION BY CH. APPR.
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION ENGINEERING DIVISION
WEST SPEEDWAY WASH BOX CULVERT AT SILVERBELL ROAD
7 of 7
DRWN. BY DCB 1985
DSGN. BY RDB 1985
CHKD. BY RDB 1985
APPD. BY CITY ENGINEER
REF.
SCALE: HORIZ. 1" = 40' VERT. 1" = 4'
PLAN NO. D-85-01





LOCATION PLAN

SECTION 33, T 13 S, R 13 E, GSRBM
PIMA COUNTY, ARIZONA
SCALE: 3" = 1 MILE

GENERAL NOTES:

1. BASIS OF BEARING: THE NORTH LINE OF LOT 1 AS SHOWN ON THE PLAT MAP OF TIERRA DEL SOL, MAPS AND PLATS BOOK 21 AT PAGE 7, RECORDS OF PIMA COUNTY, ARIZONA, BEARING BEING N 89° 44' 14" W.
2. BASIS OF ELEVATION: RAILROAD SPIKE IN EAST FACE OF POWER POLE AT THE NORTHWEST CORNER OF SILVERBELL ROAD AND GORET ROAD PER CITY OF TUCSON AS SHOWN IN CITY FIELD BOOK 1529 AT PAGE 36, ELEVATION = 2299.05.
3. THE LEGAL DESCRIPTION FOR THE SUBJECT PROPERTY IS AS SHOWN BY PIMA COUNTY TAX CODE NUMBER 103-19-001F.

CERTIFICATION:

I, FREDERICK J. STURNIOLO, R.L.S., HEREBY CERTIFY THAT THE BOUNDARY AND EXISTING TOPOGRAPHY INFORMATION REPRESENTED HEREIN IS THE RESULT OF SURVEYS PERFORMED UNDER MY DIRECTION, AND THAT THE BOUNDARY AND EXISTING TOPOGRAPHY INFORMATION IS ACCURATELY DEPICTED ON THESE PLANS. THIS CERTIFICATION IS MADE WITH RESPECT ONLY TO THE BOUNDARY AND EXISTING TOPOGRAPHY INFORMATION SHOWN.

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
12537
FREDERICK J. STURNIOLO
Frederick J. Sturniolo
Expires 6-30-93
ARIZONA, U.S.A.

Frederick J. Sturniolo
FREDERICK J. STURNIOLO, REGISTERED LAND SURVEYOR
ARIZONA REGISTRATION NO. 12537

NOTES:

1. FILL AND GRADE FROM E.O.P. + 2'R. SPOT ELEV. AT +0.25± %, MATCH EXISTING GROUND AT 300' TO 500'
2. CONSTUCTION STAKING BY C.O.T.
3. SEE SHEET 2 FOR MAIN FILL SITE.

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
13378
ROBERT L.
WEST
Robert L. West
Expires 6-30-93
ARIZONA, U.S.A.

AS BUILT
11-15-93

SHEET 1 OF 2

DATE: JUNE 18, 1991
JOB NO: 91038
REVISIONS:
⚠ ADDED FILL GRADES & NOTES
MBB 7-91

ROUGH GRADING PLAN

PRECISION LAND SURVEYING
7301 EAST 22ND STREET, SUITE 11E
TUCSON, ARIZONA 85710
(602) 298-3200

91114-1 JUNE 18, 1991

NOTES:

1. GRADE 20'W×2'D "V" GRADER DITCH, STA 8+50 230'L± TO STA 15+20 20'R±, [99.9] = SPOT ELEV.
2. INSTALL 18' CMP 30'± LONG UNDER ROADWAY, STA 15+20 20'R± TO STA 15+41 41'R±, MATCH EXISTING CHANNEL INVERT APPROX. 80.5', PIPE SUPPLIED BY C.O.T.
3. TOTAL FILL VOLUME AT BOTH SITES = 54,000C.Y.±. EXCESS IMPORT IS TO BE USED IN THIS AREA BORDERED BY THE ROAD AND THE LANDFILL EMBANKMENT OR DISPOSED OF BY THE CONTRACTOR AT THE DIRECTION OF THE ENGINEER.
4. SEE SPECIAL PROVISIONS OF E-84-16 SILVERCROFT WASH DRAINAGE IMPROVEMENT FOR HAULAGE, CLEARING, COMPACTION, ETC. OWNER WILL INSTALL TEMPORARY IRRIGATION AND RESEED THESE AREAS.

AS BUILT
11-15-93

PRECISION LAND SURVEYING
7301 EAST 22ND STREET, SUITE 11E
TUCSON, ARIZONA 85710
(602) 298-3200

SHEET 2 OF 2

DATE: JUNE 18, 1991
JOB NO: 91038
REVISIONS:
⚠ ADDED FILL GRADES & NOTES
MBB 7-91

ROUGH GRADING PLAN

91114-2 JUNE 18, 1991

D-85-01 7B

Appendix F: Erosion and Sediment Transport Analysis Supporting Documentation

None