

ROGER ROAD
WASTEWATER TREATMENT PLANT
LEVEE CERTIFICATION
FOR
SANTA CRUZ RIVER – EAST BANK:
SOUTH OF W. EL CAMINO DEL CERRO

May 30, 2008

Prepared by:

Psomas
800 E. Wetmore Road, Suite 110
Tucson, AZ 85719

Prepared for:

Pima County Regional Flood Control District
97 E. Congress Street, 2nd Floor
Tucson, Arizona 85701-1797



Psomas 08001-01

ROGER ROAD WASTEWATER TREATMENT PLANT
LEVEE CERTIFICATION
FOR
SANTA CRUZ RIVER – EAST BANK:
SOUTH OF W. EL CAMINO DEL CERRO

Location:

The study area is located in
Sections 20, 21 and 28 of Township 13 South, Range 13 East

Prepared for:

Pima County Regional Flood Control District
97 E. Congress Street, 2nd Floor
Tucson, Arizona 85701-1797

May 30, 2008

Prepared by:

Psomas
800 E. Wetmore Road, Suite 110
Tucson, AZ 85719

Psomas 08001-01

Table of Contents

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
1.0	INTRODUCTION	1
1.1	Study Description	1
1.2	Certification Requirements	1
1.3	Data and Parameters	4
2.0	GENERAL CRITERIA	5
3.0	DESIGN CRITERIA	6
3.1	Freeboard	6
3.2	Closures	7
3.3	Embankment Protection	11
3.4	Embankment and Foundation Stability	13
3.5	Settlement	14
3.6	Interior Drainage	14
3.7	Other Design Criteria	14
4.0	OPERATIONS PLANS AND CRITERIA	15
4.1	Closures	15
4.2	Interior Drainage Systems	15
4.3	Other Operation Plans and Criteria	15
5.0	MAINTENANCE PLANS AND CRITERIA	16
6.0	CERTIFICATION REQUIREMENTS	17

List of Figures

<u>Figure</u>	<u>Title</u>	<u>Location</u>
1	Vicinity Map	2
2	Location Map	3
3	Work Map (Sheets 1-4)	Pocket Folder

List of Tables

<u>Table</u>	<u>Title</u>	<u>Page</u>
1	FREEBOARD ANALYSIS	6
2	TOEDOWN ANALYSIS	13

List of Appendices

<u>Appendix</u>	<u>Title</u>
1	LEVEE CERTIFICATION REQUIREMENTS 44 CFR Ch.1 (10-1-05 Edition) §65.10 Fact Sheet – Requirements of 44 CFR Section 65.10
2	EFFECTIVE FLOOD INSURANCE STUDY (FIS) Table 2: Summary of Discharges Flood Profile: Santa Cruz River HEC-2 Output Files USGS PEAK STREAM FLOW
3	HYDRAULIC ANALYSIS Psomas Ground Survey (March 21, 2008 and April 1, 2008) Psomas Ground Survey (May 22, 2008) Datum Conversion HEC-RAS Output Files
4	AS-BUILTS Santa Cruz River – at El Camino Del Cerro Roger Road WWTP Sewer Improvements – Additional Dike Protection Roger Road Treatment Plant – Sludge Pond Drainageway
5	THE PIMA COUNTY EFFLUENT GENERATION AND UTILIZATION REPORT 2006 TRES RIOS DEL NORTE, PIMA COUNTY GEOTECHNICAL ENGINEERING REPORT, ROGER ROAD SEWAGE TREATMENT PLANT LEVEE CERTIFICATION, SANTA CRUZ RIVER BANK ADJACENT TO ROGER ROAD PLANT, TUCSON, ARIZONA LEVEE MAINTENANCE AND OPERATIONS PLAN ROGER ROAD WASTEWATER TREATMENT PLANT FLOW DIAGRAM, PHOTOS, DETAILS AND DESCRIPTIONS

1.0 INTRODUCTION

The following text will serve as the documentation to show the Roger Road Wastewater Treatment Plant (WWTP) levee meets the requirements of Section 65.10 of the National Flood Insurance Program (NFIP) regulations.

1.1 STUDY DESCRIPTION

The levee investigated by this study is the constructed east bank of the Santa Cruz River, upstream of the El Camino Del Cerro Bridge. The reach length is approximately 1.7 miles. The levee is located in Tucson, Arizona. The study area is in portions of Section 20, 21, and 28 of Township 13, Range 13, Gila & Salt River Base & Meridian. A vicinity map is provided as Figure 1. A location map is provided as Figure 2.

Landward of the levee is the Roger Road Wastewater Treatment Plant (WWTP).

From the USGS historical recorders, the peak on record for the Santa Cruz River within the study area occurred on October 2, 1983 (52,700 cfs). A significant event of recent occurred on July 31, 2006 (7,200 cfs). The data is from USGS station ID 09482500: Santa Cruz River at Tucson, Arizona. The annual peak stream flow historical records are provided in Appendix 2.

1.2 CERTIFICATION REQUIREMENTS

The FEMA requirements in Section 65.10 are separated into five categories:

1. General Criteria
2. Design Criteria
3. Operations Plans and Criteria
4. Maintenance Plans and Criteria
5. Certification Requirements

The remainder of this report will identify the requirements established in the five categories and demonstrate full compliance with each. Text, figures and calculations will be provided as support. 44 CFR Ch.1 (10-1-05) Section 65.10 and Fact Sheet – Requirements of 44 CFR Section 65.10: Mapping of Areas Protected by Levee Systems is provided in Appendix 1. Portions of the Fact Sheet are utilized within the text to describe the requirements necessary for certification.

VICINITY MAP

LOCATION MAP

1.3 DATA AND PARAMETERS

The effective Flood Insurance Study (FIS) for Pima County, Arizona, revised February 8, 1999, was utilized for the hydraulic analysis. From Table 2 of the effective FIS, the 100-year (base flood) peak discharge of the Santa Cruz River (above confluence with Rillito Creek) is 60,000 cfs. Portions of the effective FIS is provided in Appendix 2.

The effective HEC-2 model of the Santa Cruz River, provided by Pima County Regional Flood Control District (PCRFCDD) was utilized as the initial hydraulic analysis. Cross section 25.81 is the cross section immediately upstream of the El Camino Del Cerro Bridge. Approximately 9500 feet upstream of the bridge is cross section 27.61, the most upstream cross section representing the east bank levee. The vertical datum of the FIS HEC-2 analysis is NGVD29. The HEC-2 output files of the effective FIS of the Santa Cruz River are provided in Appendix 2. Figure 3, Work Map, illustrates cross section locations and the effective water surface elevations (NGVD29) of the FIS.

A Geodetic Control Point was identified near the project area, providing a vertical datum conversion. Located on West El Camino Del Cerro (Township 13 South, Range 13 East, Index Code N07), the conversion from NGVD29 to NAVD88 is +2.23 feet. The datum conversion is provided in Appendix 3.

A ground survey of the east bank levee (Cross Sections 25.81–27.70) was performed by Psomas on March 21, 2008, and April 1, 2008. Approximately 5-9 spot elevations were recorded for each cross section, spanning from the natural grade of the channel bottom, across the levee top, to the landward side of the levee to demonstrate the levee condition. Elevations were documented for both vertical datum, NGVD29 and NAVD88. Based on the approximate location of the spot elevations in relation to the cross section's horizontal stationing, the ground survey points were incorporated into the hydraulic model ground geometry, replacing the existing geometry within those stations of the corresponding cross section. The survey notes and data table are provided in Appendix 3. Figure 3, illustrates cross section location, spot elevations and survey line identifications.

The effective FIS HEC-2 model was trimmed to the study area and approximately 2000 ft upstream (Cross Sections 25.81–27.99). The reach length at each cross section is approximately 500 feet. The revised geometry of the Santa Cruz River was analyzed using HEC-RAS. The downstream boundary condition of the HEC-RAS analysis performed by Psomas is the water surface elevation (WSE) immediately upstream of the Camino del Cerro Bridge at cross section 25.81 of the effective FIS HEC-2 model: 2233.78' (NGVD29). At cross sections where the WSE of the effective HEC-2 model and the Psomas HEC-RAS model differ, the greater WSE was utilized in the freeboard analysis. The Psomas HEC-RAS analysis is provided in Appendix 3. Figure 3, illustrates cross section location and water surface elevations of the effective HEC-2 analysis and the Psomas HEC-RAS analysis, both on the NGVD29 datum. A disk containing both the HEC-2 data file and the HEC-RAS project information is provided.

2.0 GENERAL CRITERIA

For the purpose of the NFIP, FEMA will only recognize levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards. Section 65.10 of the NFIP regulations describes the types of information FEMA needs to recognize, on NFIP maps, that a levee system provides protection from the flood that has a 1-percent chance of being equaled or exceeded in any given year (base flood).

The hydraulic analysis of the Santa Cruz River within the study area demonstrates complete conveyance of the base flood.

3.0 DESIGN CRITERIA

For the purposes of the NFIP, FEMA has established levee design criteria for:

1. Freeboard
2. Closures
3. Embankment Protection
4. Embankment and Foundation Stability
5. Settlement
6. Interior Drainage
7. Other Design Criteria

3.1 FREEBOARD

The levee along the Santa Cruz River is a riverine levee. For riverine levees, a minimum freeboard of 3 feet above the base flood is required. An additional 1 foot of freeboard is required within 100 feet on either side of structures, in this case the El Camino Del Cerro Bridge. At the upstream end of the levee, an additional 0.5 foot of additional freeboard is required. The top of levee elevations were provided by the Psomas ground survey.

Both the effective FIS HEC-2 analysis and the Psomas HEC-RAS analysis were evaluated for the freeboard requirements. The greater WSE of the two analyses was utilized to illustrate the freeboard requirements have been provided. Table 1 summarizes the freeboard analysis. All elevations are on the NGVD29 vertical datum (22XX.XX').

Table 1
FREEBOARD ANALYSIS

Cross Section	Station	Levee Top (ft)	Freeboard (ft)	Water Surface Elevation	
				FIS HEC-2 (ft)	Psomas HEC-RAS (ft)
27.99	--			73.02	73.14
27.89	--			69.35	69.05
27.80	--			68.48	68.37
27.70	--			66.24	65.28
27.61	(194+00)	69.53	4.38	64.25	65.15
27.51	189+00	68.87	3.79	62.76	65.08
27.42	184+00	68.06	3.62	61.99	64.44
27.33	179+00	66.43	3.90	60.42	62.53
27.23	174+00	64.93	7.78	57.15	57.01
27.14	169+00	63.15	5.57	57.58	57.55
27.04	164+00	61.94	5.30	56.6	56.64
26.95	159+00	60.46	7.20	53.26	53.05
26.85	154+00	59.27	8.00	51.27	50.95
26.76	149+00	58.26	6.71	51.31	51.55
26.66	144+00	57.32	7.87	48.91	49.45
26.57	139+00	56.83	9.55	47.28	46.06
26.47	134+00	56.04	9.23	46.79	46.81
26.38	129+00	54.83	7.28	47.55	46.99
26.28	124+00	54.30	8.05	44.95	46.25
26.19	119+00	50.03	9.05	40.68	40.98
26.09	04+87.5	47.69	8.65	37.35	39.04
26.00	09+87.5	45.63	7.07	35.71	38.56
25.91	14+77.5	45.85	8.06	34.47	37.79
25.81	19+77.5	41.33	7.48	33.78	33.85

Cross sections 25.81 and 25.91 represent the 500 feet upstream of the El Camino Del Cerro Bridge. A minimum of 7.5 feet of freeboard is provided approaching the bridge, exceeding the four foot minimum freeboard requirement for hydraulic structures.

Cross section 27.61 represents the upstream end of the levee. 4.4 feet of freeboard is provided at the upstream end of the levee, exceeding the 3.5 foot minimum freeboard requirement for the end of the levee structure.

Through the study area, the remaining cross sections (26.00 – 27.51), a minimum of 3.6 feet of freeboard is provided, meeting the freeboard requirement.

3.2 CLOSURES

The levee closure requirement is that all openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice.

On May 1, 2008, Psomas completed a site visit to evaluate hydraulic structures within the levee. Within the study area, three (3) separate 42” CMP culverts outlet into the Santa Cruz River. Each culvert maintains an operating flap gate, incorporated into the structure.

A site visit was conducted on May 1, 2008. Photos of the study area were recorded by numeral, from downstream to upstream. All photographs presented in this report are provided in Figure 3, sheets 2 and 3. Photo 4 illustrates the 42” CMP (projecting) with a flap gate. The culvert is located approximately 100 feet upstream of Cross Section 26.09.



Photo 4: 42” CMP (projecting) w/ flap gate

Photo 13 illustrates the 42" CMP (square headwall with apron) with a flap gate. The culvert has stair access, and is located approximately 100 feet downstream of cross section 26.85.



Photo 13: 42" CMP (square headwall) w/ flap gate and stair access

Photo 16 illustrates the 42" CMP (projecting with apron) with a flap gate. The culvert is located approximately at cross section 27.04.



Photo 16: 42" CMP (projecting) w/ flap gate, concrete apron

In addition to the culvert outlets with flap gates, a 36" CMP, mitered to slope, has been plugged with concrete. Photo 15 illustrates the plugged culvert, located approximately 50 feet downstream of cross section 26.95.



Photo 15: 36" CMP (mitered to slope), plugged

The active outfall of the Roger Road WWTP is located approximately 70 feet upstream of cross section 26.66. From *The Pima County Effluent Generation and Utilization Report 2006* (Appendix 5), the treatment plant has a capacity of 41 MGD. The facility receives daily average flows of approximately 38 MGD (when Randolph Park WRF is in operation and the Tucson Boulevard diversion structure is in place). The outfall is a 7'x7' reinforced concrete box culvert (RCBC). At the levee, the outfall is converted to an 84" CMP mitered to the concrete headwall and apron. In 2006, 28,373.9 acre-ft (approx. 40 cfs at steady flow) of effluent was discharged into the Santa Cruz River at the active outfall.

No closure is provided at the active outfall. The outfall is the conveyance outlet to the Effluent Pump Station, approximately 770 feet upstream within the treatment plant. A weir, flap gates and pumps are located within the treatment plant.

From a Psomas ground survey (May 22, 2008), the ground elevation at the Effluent Pump Station is 2256.02' NAVD88 (Point 11021), equivalent to 2253.79' NGVD29. The 100-year WSE at the active outfall, interpolated between cross sections 26.66 and 26.76, is 2249.95' NGVD29. The interpolated velocity head at the active outfall is 2.69 feet. In addition to the WSE, the hydraulic grade elevation at the active outfall is 2252.64' NGVD29, which is 1.15 feet below the ground surface at the Effluent Pump Station. Therefore, no breakout will occur

at the pump station during the 100-year WSE conditions of the Santa Cruz River. The Psomas Ground Survey (May 22, 2008) is provided in Appendix 3. The Roger Road WWTP Flow Diagram, provided by John W. Sherlock – Water & Power Superintendent, is provided in Appendix 5.



Photo 11: Active outfall, 84” CMP, Roger Road WWTP

Immediately upstream of the levee certification at cross section 27.61, a two-barrel reinforced concrete pipe (RCP) culvert conveys stormwater generated within the landward watershed to the Santa Cruz River. Photo 20 illustrates the culvert inlet on the landward side.

Closures discussed in this section are covered by the Pima County Operations and Maintenance Plan, provided in Appendix 5.



Photo 20: culvert inlet, upstream of project area

3.3 EMBANKMENT PROTECTION

To address the requirements for embankment protection, the as-builts plans for the levee were evaluated. Three (3) sets of certified as-builts have been provided in Appendix 4. Each as-built set will be referenced by number in this section.

1. Santa Cruz River – at El Camino Del Cerro
2. Roger Road WWTP Sewer Improvements – Additional Dike Protection
3. Roger Road Treatment Plant – Sludge Pond Drainageway

As-built #1 represents the downstream portion of the study area, cross sections 25.81 to 26.09 (Stations 19+77.5 to 04+87.5, respectfully). As-built #2 represents the upstream portion of the study area, cross sections 26.19 to 27.61 (Stations 119+00 to 194+00, respectfully).

Throughout the study area, the levee is constructed of soil cement. The side slope of the levee is 1H:1V. The toe of the soil cement was designed to a depth 8.0 feet below the finished flow line. However, at cross sections 26.28, 26.38, and 26.47 (Sta 124+00 – 134+00) the toe of the soil cement was designed to 10.0 feet below the finished flow line.

From *Tres Rios del Norte Pima County* (West Consultants, Inc., August 2003), provided in Appendix 5, the 50-year sediment transport model demonstrates general equilibrium of the Santa Cruz River. Areas of deposition and erosion are generally less than 4 feet in depth. A minimum toe-down depth of 8.0 feet within the study area is sufficient.

Review of historical records supports this evaluation. The flowline at the edge of the soil cement in most areas of the project reach has experienced aggradation, a condition that has not impacted the available freeboard for the levee. At Cross Sections 26.57-26.66, the original

flowline of soil cement is exposed by less than one foot. Photo 9 shows the original construction ground surface currently under flows derived from the WWTP. The comparison of 1984 flowline elevations to 2008 flowline elevations is provided in Table 2.



Photo 9: Original Construction Flowline, Cross Sections 26.57 – 26.66

Table 2
TOE-DOWN ANALYSIS

Cross Section	Section ID	Station	As-Builts (1984)			Survey (2008)	Δ Flow Line (ft)	Toe Depth (ft)
			Flow Line	Toe	Toe Depth	Flow Line		
			(ft)	(ft)	(ft)	(ft)		
27.99	--	--	--	--	--			
27.89	--	--	--	--	--			
27.80	--	--	--	--	--			
27.70	--	--	--	--	--	46.92		
27.61	--	(194+00)	--	--	--	51.76		
27.51	C	189+00	44.67	36.66	8.01	49.40	4.73	12.74
27.42	C	184+00	43.00	34.99	8.01	49.12	6.12	14.13
27.33	C	179+00	41.33	33.32	8.01	42.40	1.07	9.08
27.23	C	174+00	39.67	31.66	8.01	45.72	6.05	14.06
27.14	C	169+00	38.00	29.99	8.01	44.67	6.67	14.68
27.04	C	164+00	36.33	28.32	8.01	43.23	6.90	14.91
26.95	C	159+00	34.67	26.66	8.01	42.50	7.83	15.84
26.85	B	154+00	33.00	24.99	8.01	33.26	0.26	8.27
26.76	B	149+00	31.33	23.32	8.01	32.20	0.87	8.88
26.66	B	144+00	29.67	21.66	8.01	28.91	-0.76	7.25
26.57	B	139+00	28.00	19.99	8.01	27.38	-0.62	7.39
26.47	B	134+00	26.33	16.33	10.00	26.72	0.39	10.39
26.38	A	129+00	24.67	14.66	10.01	24.76	0.09	10.10
26.28	A	124+00	23.00	12.99	10.01	23.30	0.30	10.31
26.19	A	119+00	21.33	13.33	8.00	26.59	5.26	13.26
26.09	1/2	04+87.5	24.42	16.40	8.02	27.31	2.89	10.91
26.00	1/2	09+87.5	22.75	14.75	8.00	26.27	3.52	11.52
25.91	1/2	14+77.5	21.08	13.08	8.00	26.95	5.87	13.87
25.81	1/2	19+77.5	19.38	11.38	8.00	24.44	5.06	13.06

Expected wind and wave action, ice loading, or impacts of debris were not evaluated for the embankment protection. These conditions are not expected to significantly impact a riverine levee located in the basin of arid southwestern valley. Table 2 summarizes the toe down analysis of the embankment as-builts as designed and as surveyed by Psomas 24 years after construction. All elevations are on the NGVD29 vertical datum (22XX.XX').

3.4 EMBANKMENT AND FOUNDATION STABILITY

Embankment and foundation stability and settlements is addressed in *Geotechnical Engineering Report: Roger Road Sewage Treatment Plant Levee Certification, Santa Cruz River Bank Adjacent to Roger Road Plant, Tucson, Arizona* (Terracon, April 25, 2008), provided in Appendix 5.

In summary, the geotechnical analysis provides evidence of stability against settlement, slope failure, and seepage. Terracon completed geotechnical investigations utilizing field exploration (test borings with continuous lithologic logs, subsurface samples and penetration resistance measurements) and laboratory testing of water content, dry density, percent fines and plasticity index. The original geotechnical design for the soil cement bank protection was performed by Desert Earth Engineering, a company acquired by Terracon. The geotechnical engineer is the same for both the current analysis and the original analysis. The seepage analysis and slope stability analysis are referenced from the original design report.

3.5 SETTLEMENT

Please see section 3.4.

3.6 INTERIOR DRAINAGE

As previously addressed, three (3) separate 42" CMP culverts with flap gates outlet through the east bank levee. Each culvert conveys stormwater from landward watersheds. The flap gates operate automatically, dependant on hydraulic conditions. The Roger Road WWTP facilities provide basins to retain the 100-year rainfall generated onsite. Minor basins with no outlets have been identified on Figure 3.

3.7 OTHER DESIGN CRITERIA

In unique situations, FEMA may require that other design criteria and analyses be submitted to show the levee provides adequate protection. At this time, no other design criteria have been identified by FEMA.

4.0 OPERATIONS PLANS AND CRITERIA

For a levee system to be recognized as providing protection from the base flood, the levee system must be operated in accordance with an officially adopted maintenance plan. All operations, whether manual or automatic, must be in accordance with an officially adopted operation manual. Operations are to account for closures, interior drainage systems, as well as other operation plans and criteria. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility of maintenance.

4.1 CLOSURES

Closure operations are documented in *The Pima County Flood Control District Levee Maintenance and Operations Plan for Pima County, Arizona*, October 17, 2007. The operation plan specifies operation activity to be performed, frequency of performance, and person by name or title responsible for their performance. A copy of the operation plan is provided in Appendix 4.

4.2 INTERIOR DRAINAGE SYSTEMS

As previously addressed, three (3) separated 42" CMP culverts with flap gates outlet through the east bank levee. Each culvert conveys stormwater from large landward watersheds. The flap gates operate automatically, dependant on hydraulic conditions. The Roger Road WWTP facilities provide basins to retain the 100-year rainfall generated onsite. Minor basins with no outlets have been identified on Figure 3.

4.3 OTHER OPERATION PLANS AND CRITERIA

FEMA may require other operating plans and criteria to ensure that adequate protection is provided in specifications. At this time, no additional operating plans or criteria has been established for the Roger Road WWTP levee.

5.0 MAINTENANCE PLANS AND CRITERIA

For a levee system to be recognized as providing protection from the base flood, the levee system must be maintained in accordance with an officially adopted maintenance plan. All maintenance activity must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility of maintenance.

The east bank levee on the Santa Cruz River is maintained in accordance with *The Pima County Flood Control District Levee Maintenance and Operations Plan for Pima County, Arizona*. The maintenance plan specifies maintenance activity to be performed, frequency of performance, and person by name or title responsible for their performance. A copy of the maintenance plan is provided in Appendix 5.

6.0 CERTIFICATION REQUIREMENTS

Data submitted to support the levee system complies with the structural requirements has been certified by a Registered Professional Engineer. Certified as-built plans of the levee have been provided in Appendix 4.