

Sedimentation Study for the J Street Drain and Oxnard Industrial Drain DRAFT Report

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Prepared for

Ventura County Watershed Protection District



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EXECUTIVE SUMMARY

Ventura County Watershed Protection District is conducting a Phase 1 preliminary design to reconstruct approximately 2.2 miles of J Street Drain from its outlet at Ormond Beach to Redwood Street in the City of Oxnard, California. To assist with evaluation of channel outfall design alternatives, a sedimentation study for J Street Drain and Oxnard Industrial Drain was required to determine the expected sediment loading that may be deposited at the channel outlet/Ormond Beach Lagoon. Analysis of areas contributing to the Ormond Beach Lagoon was conducted using the RUSLE2 program. This analysis was based on GIS data as well as field observed information.

The results indicate that on a long time-scale average approximately 341 tons (332 cubic yards) of sediment per year enters the lagoon. This result appears reasonable when compared to other study results in the region, when adjusted for slope. There is a significant range of uncertainty ($\pm 100\%$) associated with this result due to the variability and sensitivity of the base management conditions. The results indicate that Industrial and Rice Road Drains contribute 95% of the sediment yield and delivery to the Ormond Lagoon. Hueneme and J Street Drains together contribute the remaining 5%. The sediment delivered to the lagoon is approximately 59% sand, 26% silt and 15% clay. Future climate change could alter the sediment yield to Ormond Lagoon to approximately 546 tons/year in wet climate and 126 tons/year in a dry climate based on historical regional trends.

1.0 BACKGROUND AND APPROACH

The purpose of this study was to determine the expected sediment yield and composition of sediment from several urban and agricultural watersheds near Oxnard, California which outlet to the Ormond Beach Lagoon. The drainage system is predominantly concrete lined and therefore channel bed and bank erosion were not considered to be major sediment contributors. Evaluation of channel bed and bank erosion is not included in this report.

J Street Drain is located in the City of Oxnard, Ventura County; see Figure 1 (Project Location Map). Ventura County Watershed Protection District is conducting a Phase 1 preliminary design to reconstruct approximately 2.2 miles of J Street Drain from its outlet at Ormond Beach to Redwood Street in the City of Oxnard, California; see Figure 2 (Watershed Overview Map). To assist with evaluation of channel outfall design alternatives, a sedimentation study for J Street Drain and Oxnard Industrial Drain was required to determine the expected sediment loading that may be deposited at the channel outlet/Ormond Beach Lagoon.

The Ormond Beach Lagoon (downstream of J Street drain outlet) carries flow from the J Street Drain outlet into the Pacific Ocean. Because the Ormond Beach Lagoon is also being studied, all of the sediment inputs to the lagoon were required. This includes sediment inputs from Hueneme Drain, J Street Drain, Industrial Drain and Rice Road Drain. After a site visit and data collection using primarily GIS data, the RUSLE2 program was used to calculate the expected sediment yield from the study area.

Figure 1: Project Location Map

Figure 2: Watershed Overview Map

2.0 INTRODUCTION TO RUSLE2

The US Department of Agriculture (USDA) has developed a powerful windows based program, the Revised Universal Soil Loss Equation, Version 2 (RUSLE2) (USDA, 2007b). The RUSLE2 program uses the built-in RUSLE2 equation to calculate the average annual soil loss (in tons/acre/year) by allowing the user to describe the specific site conditions. The RUSLE2 equation has been modified since the previous USLE and RUSLE1 equations. This program includes compilation of data researched by the USDA for input to the program. It is applicable to many field conditions such as cropland, pastureland, rangeland, disturbed forest areas, construction sites, surface mine reclamation, military training lands, parks, and waste disposal areas/landfills. The primary function of the program is to calculate sediment yield from overland flow.

This program has been adopted to calculate the average annual soil loss for the study area watersheds. It presents the significant advantage over other analysis methods for this particular study in that it does not require hydrologic analysis of design storms.

The USDA-NRCS RUSLE2 equation and a discussion of the input parameters are outlined below (USDA, 2003).

$$a_i = r k l s c p$$

$$A = \sum_{n=1}^{365} a_i$$

Where,

- a_i – Average daily soil loss, in tons/acre
- r – Rainfall-runoff erosivity factor
- k – Soil-erodibility factor
- l – Slope length
- s – Slope steepness
- c – Cover management factor
- p – Support practices factor
- A – Average annual soil loss in tons/acre

A complete discussion of the theory and capabilities of the RUSLE2 program is contained in USDA (2003).

3.0 ANALYSIS OVERVIEW

It was determined that due to very low slopes in the project area, the simple uniform slope calculation method would be adequate for this analysis. Using this analysis method, the following input values were required by the RUSLE2 program:

- Climate Location Zone
- NRCS Soil Type

- Overland Flow Length
- Average Slope
- Base Management Condition
- Contouring, strips/barriers, diversion/terrace, sediment basins, and/or subsurface drainage conditions

The following sections will discuss the methods used to obtain these input parameters, and the post RUSLE2 analysis.

3.1 DATA COLLECTION

The initial investigation included review of available documentation and GIS data. Preliminary sediment analysis areas were identified as possible sediment sources from aerial images. These primarily included agricultural fields, parks, vacant lots, construction areas, dirt roads and parking lots, and construction sites. Areas which were highly developed such as residential or commercial areas are not expected to contribute a significant amount of sediment to the watershed, and were therefore not included in the analysis. Additional collected data is shown in Attachment 1 (Photo Log) and Attachment 2 (RUSLE2 Input Data).

This study took advantage of Geographic Information System (GIS) analysis and therefore a priority was set on obtaining quality GIS data. The following list shows GIS data used for analysis.

- Digital topographic maps of the watersheds based on LiDAR data (Ventura County, 2001)
- Recent digital aerial photographs of these watersheds (Ventura County, 2006)
- Ventura County crop type data in GIS shapefile format (Ventura County, 2007a)
- Ventura County land use data in GIS shapefile format (Ventura county, 2007b)
- Soil survey data in GIS shapefile format (USDA, 2007a)

In addition to the GIS data, several additional sources of information were obtained:

- *J Street Drain Channel Improvement Study and Preliminary Design*, (URS, Inc., 2005)
- *City of Oxnard Floodplain Analysis Industrial Drain, Rice Road Drain, J Street Drain, Hueneme Drain, and Ormond Lagoon*, (TetraTech, Inc., 2005)
- As-built drawings for existing channels (J Street, Industrial Drain, Hueneme Drain and Rice Road Drain) (Ventura County, 2007c)

3.2 SITE VISIT

HDR conducted a field visit on January 28, 2008 to investigate these areas identified as the major potential sediment contributors. A photo log is shown in Attachment 1 (Photo Log) documenting the field visit. Land use practices were verified with the aerial images and land use/crop data. Based on the field information, the sediment analysis areas were revised to reflect the current conditions. Some of the initial areas had been developed (i.e. a farm field to homes) and were revised accordingly. The final sediment analysis areas are shown in Figure 2 (Watershed Overview Map).

3.3 CLIMATE LOCATION ZONE

Rainfall-runoff erosivity factor (r) distributions (also called R-factor) have been developed for the various zones in the United States by the NRCS. For the contiguous United States there are 120 separate zones. An R factor zone distribution map is provided in Figure 3 [R factor distribution zones for the US (Renard et al., 1993)]. Based on this map, it is determined that the study area is located in Zone 25. For verification of this information, a GIS shapefile showing the R factor for the entire United States was downloaded from NRCS/USDA website which showed isolines of annual R factor for the entire United States (USDA, 2007b). This data was in agreement with the Renard et al. (1933) R factor zone.

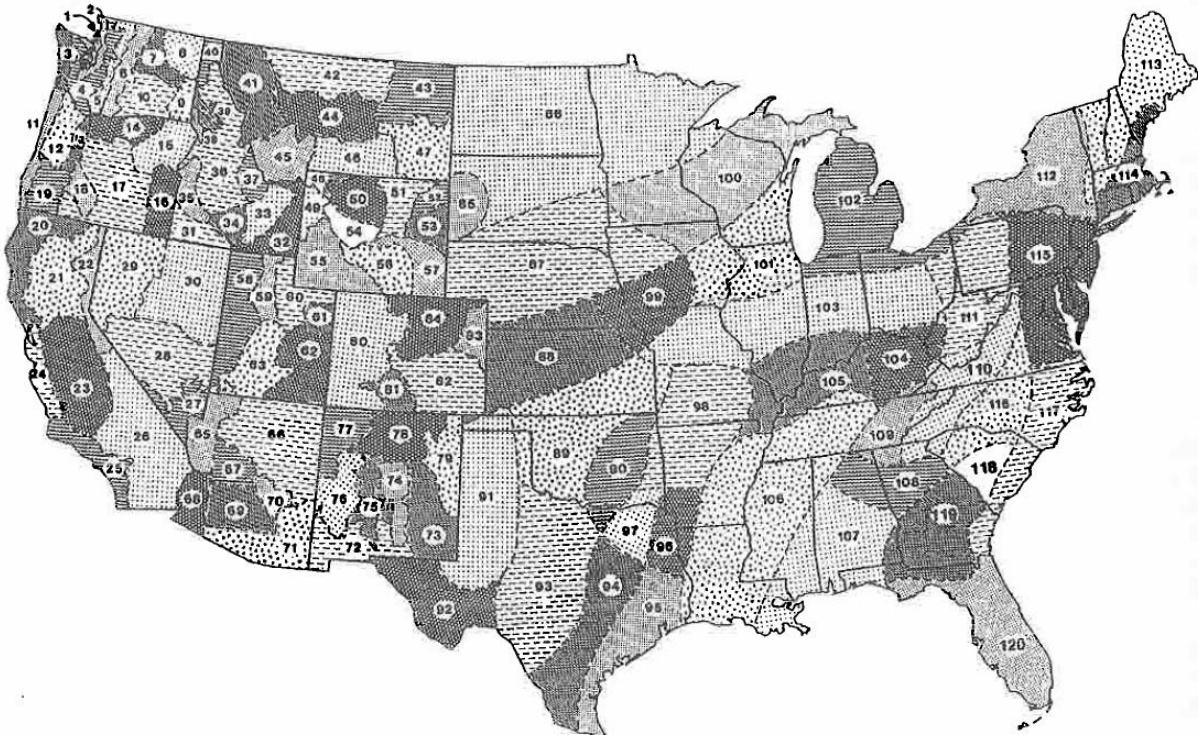


Figure 3: R factor distribution zones for the US (Renard et al., 1993)

3.4 NRCS SOIL TYPE

Soil survey data was downloaded from the NRCS website in GIS shapefile format for the soils in Ventura County (NRCS, 2007a). The soils layer was clipped to the project watershed to determine the soil types in the watershed; see Table 1 (Soil Types within Study Area). The RUSLE2 program has a database of all NRCS soil types and their properties. Using the GIS interface, the predominant soil type was determined for each sediment yield area. Soils with a single classification (i.e. sandy loam) were considered similar enough to be included in one sediment area. If one or more soil type of a different classification was found within a sediment area and comprised more than 10% of the total area, the sediment analysis area was divided to better represent the variations in soil type.

Table 1: Soil Types within Study Area

Classification	USDA Soil			Description	
	Type	% Sand	% Silt		% Clay
Loamy Sand	Hm	83.5	9.0	7.5	Hueneme loamy sand, loamy substratum
	MeA	78.5	16.5	5.0	Metz loamy sand, 0 to 2 percent slopes
Sandy Loam	Cc	66.8	19.2	14.0	Camarillo Sandy Loam
	PcA	65.1	18.9	16.0	Pico sandy loam, 0 to 2 percent slopes
	Hn	67.9	19.6	12.5	Hueneme sandy loam
Loam	Cd	43.0	38.5	18.5	Camarillo Loam
	Ce	43.0	38.5	18.5	Camarillo Loam, sandy substratum
	MoA	39.8	37.7	22.5	Mocho loam, 0 to 2 percent slopes Pico loam, sandy substratum, 0 to 2 percent slopes
	PsA	43.8	40.2	16.0	slopes
Silty Clay Loam	Pa	18.1	50.9	31.0	Pacheco silty clay loam

Source: USDA (2007).

3.5 OVERLAND FLOW LENGTH

A representative overland flowpath was determined for each sediment analysis area using the GIS interface. This determination was based on topographic information and aerial images. The GIS program was used to calculate the length of the representative flowpath.

3.6 AVERAGE SLOPE

The average slope for the representative overland flowpath was determined using the topographic information for the site (Ventura County, 2001). An upstream elevation, downstream elevation, and overland flowpath length were used to calculate the average slope for the sediment analysis area. Review of the site topography supported the conclusion that a uniform slope analysis was appropriate for this study.

3.7 BASE MANAGEMENT CONDITION

The base management condition was selected based on several data sources. These included: site visit notes and photos, Ventura County crop data (VC, 2007a), Ventura County land use data (VC, 2007b), and aerial images (VC, 2006). There is some variation within the available base management factors in the RUSLE2 program. Selection of these factors influences the sediment yield results. Generally, the most conservative, reasonable base management condition was selected for each sediment yield area.

Some of the areas were determined to be industrial land use, with a fraction of the area being bare soil. For these areas, the sediment yield obtained from the RUSLE2 program was adjusted to account for this. These areas are noted in Attachment 3 (RUSLE2 Output) for the individual sediment area results.

3.8 ADDITIONAL PRACTICE FACTORS

The RUSLE2 program allows for additional practice factors to be included in the analysis, such as contouring, strips, barriers, diversions, terraces, sediment basins, and subsurface drainage. Generally, these were not observed within the watershed and were therefore not included in the analysis. The notable exception is the contouring practices for the agricultural areas. For these areas with contoured furrows, the contouring practices and the calculated slope were inputs to the model.

3.9 POST RUSLE2 ANALYSIS

After the RUSLE2 program was run, a sediment yield was obtained for each sediment analysis area in tons/acre/year. Using the calculated area from the GIS shapefile, the total yield in tons/year was obtained. The results were also broken down into yield of sand, silt and clay, which was determined using their percentage in the predominant soil type within the sediment area times the total yield.

4.0 RESULTS

The data collected for the site was entered into the RUSLE2 program. The complete results are presented in Attachment 3 (RUSLE2 Output Data). The results are summarized in Table 2 (Sediment Analysis Results Summary) and Figure 4 (Sediment Analysis Results).

The study area watershed had an area of approximately 7948 acres, of which 2146 acres was determined to be a potential sediment yield area (the remaining was highly developed). Within the study area, there are approximately 1040 acres of agricultural land, mostly within the Rice Road Drain watershed. The elevations within the study area range from near 82 feet at the watershed head of Rice Road Drain to sea level at Ormond Lagoon.

Based on the field observations, it was observed that most of the sediment areas drained directly to concrete drain channels, paved streets, or storm drain networks. Very little sediment accumulation was observed in these channels, streets, or pipes, see Attachment 1 (Photo Log). Therefore, it was concluded that almost all sediment which left the sediment analysis areas would be transported to the Ormond Beach Lagoon without significant deposition. Additionally, with one exception, no earthen channels were observed within the system which would contribute significant amounts of sediment to the Lagoon. The one exception to this is the Industrial Drain from approximately 400 feet downstream of Hueneme Road to Ormond Lagoon, which is an earthen channel and may be subject to erosion. Site observations at this location did not indicate large-scale bank erosion; see Attachment 1 (Photo Log). However, as noted previously, this study did not consider channel bank or bed erosion in the analysis.

4.1 RESULTS OVERVIEW

Within the study area (7948 acres), approximately 341 tons of sediment per year is delivered to the lagoon; see Table 2 (Sediment Analysis Results Summary). Overall, the watersheds had an average yield of 0.16 tons/acre/year from 2146 ac of sediment yield area, although specific sediment yield areas had a yield ranging from 0.00075 to 0.97 tons/acre/year. Using an estimated unit weight of 76.1 pounds/cubic foot for unconsolidated sand, silt and clay composite, the estimated yield is 332 cubic yards (0.21 acre-feet) of sediment per year to the Ormond Lagoon. The results indicate that Industrial and Rice Road Drains contribute 95% of the sediment yield and delivery to the Ormond Lagoon; see Figure 4 (Sediment Analysis Results). Hueneme and J Street Drains together contribute the remaining 5%. Additionally, based on soil composition, the makeup of the sediment is expected to be 59% sand, 26% silt and 15% clay as noted in Figure 5 (Relative Grain Size Distribution in Sediment Yield). Graphically it is clear from Figure 6 (Sediment Results Map) that the agricultural areas contribute the most sediment to the watershed.

Table 2: Sediment Analysis Results Summary

Drain	Watershed Area ac	Sediment Yield Area ac	Avg. Yield T/ac/yr	Yield T/yr	Sand Yield T/yr	Silt Yield T/yr	Clay Yield T/yr	Yield (% of total) %
Hueneme	586	50	0.043	2.1	1.4	0.45	0.26	2%
J Street	1352	73	0.027	2.0	1.0	0.61	0.31	3%
Industrial	2776	883	0.10	89	50	24	15	45%
Rice Road	3234	1141	0.22	248	148	63	37	50%
Total	7948	2146	0.16	341	201	88	53	100%

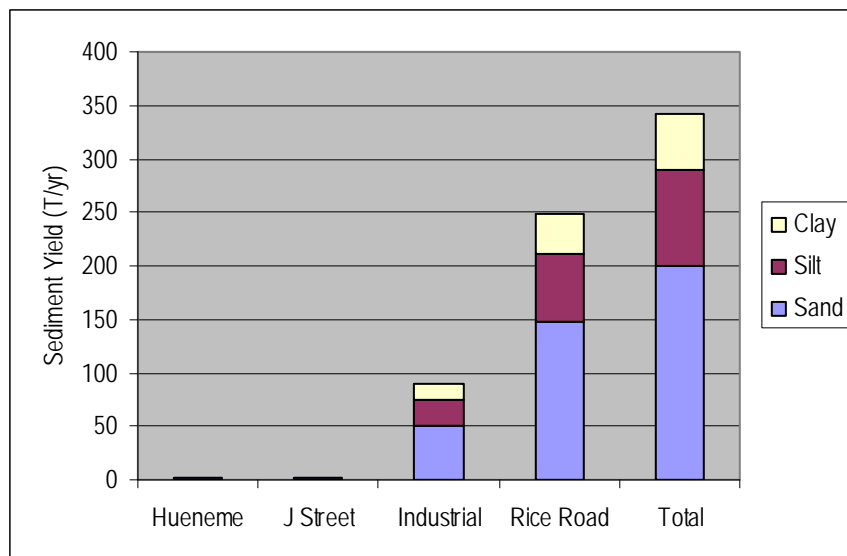


Figure 4: Sediment Analysis Results

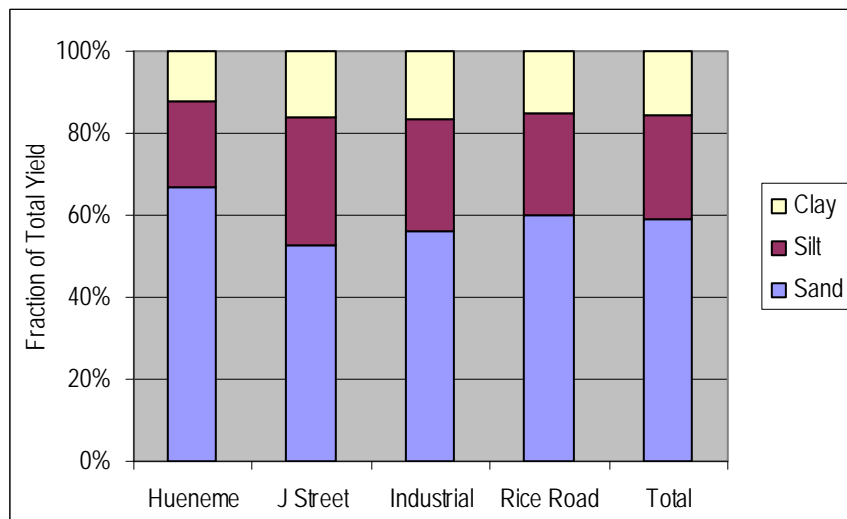


Figure 5: Relative Grain Size Distribution in Sediment Yield

Figure 6: Sediment Results Map

4.2 COMPARISON TO PREVIOUS STUDIES

The results obtained from the RUSLE2 analysis were compared to other sediment yield studies in the region. General results for sediment yield in agricultural land within southern California range from 0.4 to 23.1 tons/acre/year (Inman and Masters, 2000). Additional studies have focused on overall watershed yields for southern California rivers using gauge data (Inman and Jenkins, 1999) and modeling (USDA, 1992). Selected results from these studies are shown in Table 3 (Selected Results of Previous Studies).

For comparison, the J Street study area is 12 square miles, 18% agricultural land (60% of the non-urban area), the headwater elevation is near 82 feet, and the net sediment yield was 0.16 tons/acre/year. The results of previous regional studies indicate much higher yield rates. However, there are several distinct differences between the study area and the regional studies. The regional studies have sediment yield from mountainous areas surrounding the lowland, which are expected to have significantly higher yield rates. When adjusted for slope, the results of this study are comparable to those shown in Table 3. Additionally, an overview of the results (Attachment 3) for specific agricultural fields gives results of 0.10 to 0.97 tons/acre/year, which is similar to values quoted by Inman and Masters (2000) and Inman and Jenkins (1999), although somewhat lower.

Table 3: Selected Results of Previous Studies

River	Develop-ment ¹	Area (mi ²)	Period of Record	% Ag. Land	Headwater Elev. (ft)	Yield (T/ac/yr) ²			Yield (T/ac/yr) ³
						Total (1944-1995)	Dry (1944-1968)	Wet (1969-1995)	Total
Ventura	M	188	1929-1995	40	6500	4.8	1.7	7.6	12.7
Santa Clara	M	1594	1927-1995	26	9500	4.1	0.9	7.1	7.1
Calleguas Creek	N	248	1968-1995	60	4000	4.3	1.6	6.8	4.8
San Diego Creek	E	118	1977-1995	12	1900	1.6	0.8	2.3	1.8

1. E = extensively developed, M = moderately developed, N = natural.

2. Based on measured gauge data.

3. Based on RUSLE modeling (USDA, 1992).

Source: Inman and Jenkins (1999).

4.3 SENSITIVITY ANALYSIS

The results described previously contain potential sources of uncertainty, which should be considered. Because no site-specific sediment yield data was available, it was not possible to calibrate the model. Therefore an awareness of the sensitivity of the model results to the input data is important. The following input values are fairly well known due to the nature of the data available and probably present only a minimal source of uncertainty:

- Climate Location Zone
- NRCS Soil Type
- Overland Flow Length

- Average Slope

The primary source of uncertainty within the RUSLE2 input values is the base management condition (i.e. land use, crop type, farming practices, and vegetative cover). This base management condition information was not easily determined for the conditions observed at time of the site survey. There is also limited information about how these base management conditions were developed for the RUSLE2 program, and how to differentiate between similar-sounding base management titles. Additionally, the base management conditions may change over time as crops are rotated, vegetated areas are graded, and weather conditions change vegetation, etcetera.

After some sensitivity analysis, it was determined that the results may vary by as much as $\pm 100\%$ for the overall sediment yield results. However, the relative proportion of sediment yield between the watersheds, as well as the relative distribution of grain size is expected to be significantly more accurate.

4.4 FUTURE CHANGES AND UNCERTAINTY

This sediment study was conducted using data gathered during 2008, and approximates the expected average sediment yield at this time. Results are calculated for average annual results, which are based on a long time scale (50+ years). A single very wet year could produce sediment yield significantly higher than the calculated average, while a single dry year could produce little to no sediment yield.

Potential changes to the watershed could alter the sediment yield of the watershed, which includes potential development and urbanization. The potential development of the agricultural areas of the watershed would probably lead to a decrease in the amount of sediment delivered to the Ormond Lagoon. This is due to protection of the soil with pavement and buildings.

Climate change is a significant uncertainty in terms of the future response of the watershed. Inman and Jenkins (1999) performed an analysis of regional sediment yield data, and showed that the sediment yield for Calleguas Creek may increase by a factor of 1.6 in a wet climate, or decrease by a factor of 2.7 in a dry climate; Table 3 (Selected Results of Previous Studies). Other analyzed rivers in the region had similar responses to climate variability. Assuming similar future trends for the J Street and Oxnard Industrial Drain system, the sediment yield to Ormond Lagoon could be 546 tons/year in wet climate and 126 tons/year in a dry climate.

5.0 CONCLUSIONS

Sediment yield analysis of areas contributing to the Ormond Beach Lagoon was conducted using the RUSLE2 program. This analysis was based on GIS data as well as field observed information. The results indicate that on a long time-scale average approximately 341 tons (332 cubic yards) of sediment per year enters the lagoon. This result appears reasonable when compared to other study results in the region, when adjusted for slope. There is a significant range of uncertainty ($\pm 100\%$) associated with this result due to the variability and sensitivity of the base management conditions. The results indicate that Industrial and Rice Road Drains contribute 95% of the sediment yield and delivery to the Ormond Lagoon. Hueneme and J Street Drains together contribute the remaining 5%. The sediment delivered to the lagoon is approximately 59% sand, 26% silt and 15% clay. Future climate change could alter the sediment yield to Ormond Lagoon to approximately 546 tons/year in wet climate and 126 tons/year in a dry climate based on historical regional trends.

6.0 REFERENCES

- Inman D.L. and S.A. Jenkins (1999). Climate change and the episodicity of sediment flux of small California rivers. *Journal of Geology*, Vol. 107, p. 251-270.
- Inman D.L. and P.M. Masters (2000) *Report on existing conditions technical appendix to water quality chapter of EIR for spectrum 8*. Prepared for the City of Irvine, EIR Planning area 40/spectrum 8.
- Renard, K. G., McCool, D. K., Cooley, K. R., Mutchler, C. K., and Foster, G. R. (1993), Rainfall-runoff erosivity factor (R). Chapter 2 In Renard, Foster and Weesies (eds) *Predicting Soil Erosion by Water-A Guide to Conservation Planning with the Revised Universal Soil Loss Equation RUSLE*, Publication ARS. U.S. Department of Agriculture, Washington, DC, in press.
- TetraTech, Inc. (2005). *City of Oxnard Floodplain Analysis Industrial Drain, Rice Road Drain, J Street Drain, Hueneme Drain, and Ormond Lagoon*, dated November 2005.
- United States Department of Agriculture (USDA) (2007a). Natural Resources Conservation Service (NRCS) Soils Database for Ventura County, California. <http://soildatamart.nrcs.usda.gov/>
- USDA (2007b). RUSLE2 Program Software (Build Date July 11, 2007). Available at <http://www.ars.usda.gov/Research/docs.htm?docid=6010>.
- USDA (2003) RUSLE2 User's Reference Guide. Prepared for USDA- Agriculture Research Service, Washington, D.C. <http://www.ars.usda.gov/Research/docs.htm?docid=6010>.
- URS, Inc (2005). *J Street Drain Channel Improvement Study and Preliminary Design*, dated November 17, 2005.
- Ventura County (VC) (2001). LiDAR topographic data for Oxnard, California.
- VC (2006). Aerial images of Oxnard, California.
- VC (2007a). Ventura County crop type data in GIS shapefile format for 2007.
- VC (2007b). Ventura County land use data in GIS shapefile format.
- VC (2007c). As-built drawing records for storm drain network in Oxnard, California (J Street, Industrial Drain, Hueneme Drain and Rice Road Drain).

Attachment 1 – Photo Log

Attachment 2 – RUSLE2 Input Data

Figure A – NRCS Soils Data
Figure B – Crop Data
Figure C – Land Use Data
Figure D – Topography
RUSLE2 Input Data

Attachment 3 – RUSLE2 Output Data

RULSE 2 Results Summary
RUSLE2 Program Output