Determination of Natural Turbidity Water Quality Conditions in the Lower Gabilan Creek Watershed based on the Reference Streams in Watersheds with Similar Hydrogeomorphic Conditions

Introduction

In this appendix to the turbidity TMDL technical report, staff applies a hydrogeomorphic approach to determine natural turbidity reference conditions for the streams in the lower Gabilan Creek watershed. The lower Gabilan Creek watershed is highly impaired for turbidity and the objective of the turbidity TMDL is to restore turbidity water quality to "natural" conditions. Determining natural conditions from water quality monitoring data in the watershed was not possible due to the magnitude of water quality impairments. Instead natural conditions were determined by analyzing monitoring data from reference streams in the Central Coast Region with similar hydrogeomorphic conditions.

Background

The hydrogeomorphic approach for classifying streams was developed by the U.S. Army Corp of Engineers (ACOE) as part of their nationwide approach for assessing the functions of wetlands for the ACOE 404 regulatory program (ACOE, 1995). The ACOE is directed under section 404 of the federal Clean Water Act to regulate the discharge of dredged or fill materials in "waters of the United States." For the hydrogeomorphic approach, staff selected reference sites by evaluating watershed geomorphic characteristics, hydrology, and land use along with analyzing water quality monitoring data. Based on this approach, turbidity monitoring data were summarized from streams and sloughs in watersheds with similar hydrogeomorphic characteristics to ones in the Gabilan Creek watershed. The Central Coast Region is one of nine hydrologic regions that the divide the State of California. The nine regions divide the state into areas with not only common hydrologic characteristics but generally into areas with common geomorphic features.

The ACOE hydrogeomorphic approach is designed for establishing chemical, physical and biological stream reference conditions for restoration projects based on the conditions of less disturbed reference sites (ACOE, 1995). The hydrogeomorphic classification system is based on the following three factors:

1. geomorphic setting
2. water source
3. hydrodynamics

In this classification system, geomorphic setting is the landform of a wetland, its geological landscape, and its topographic position in the landscape. Categories include depressional, riverine, and fringe. Examples of depressional wetlands in the Central Coast Region include seasonal freshwater marshes and marsh wetlands. Riverine wetlands are associated with a range geomorphic features such as steep uplands or low velocity streams in floodplains. Fringe wetlands are found along lakes and estuaries.

Water source is described as the location of water before it enters the wetland and sources include precipitation, lateral upstream or upslope surface flows, and groundwater. Flows can be a combination of all three types such as both groundwater and lateral upstream or upslope surface flow and in some waters may include all three types of flows. Wetlands generally have a dominance of one type of water source.

Hydrodynamics is the energy level of the moving water and the direction of the flow in a wetland. For example, the level of water energy of a wetland on a river floodplain is naturally much lower than a fast-flowing steeper gradient mountain stream. Categories of hydrodynamic direction are illustrated below in Figure 1 and are described as follows.

a) Vertical Fluctuations – are upward and downward movement of water in a wetland normally caused by evapotranspiration and precipitation. Depressional wetlands are examples of waters with vertical fluctuations of water.

b) Unidirectional Flow – are horizontal surface and subsurface flows and energy can vary.

c) Bidirectional Flow - are horizontal across the surface and examples are salt marshes and sloughs. Bidirectional flows are generally low velocity.

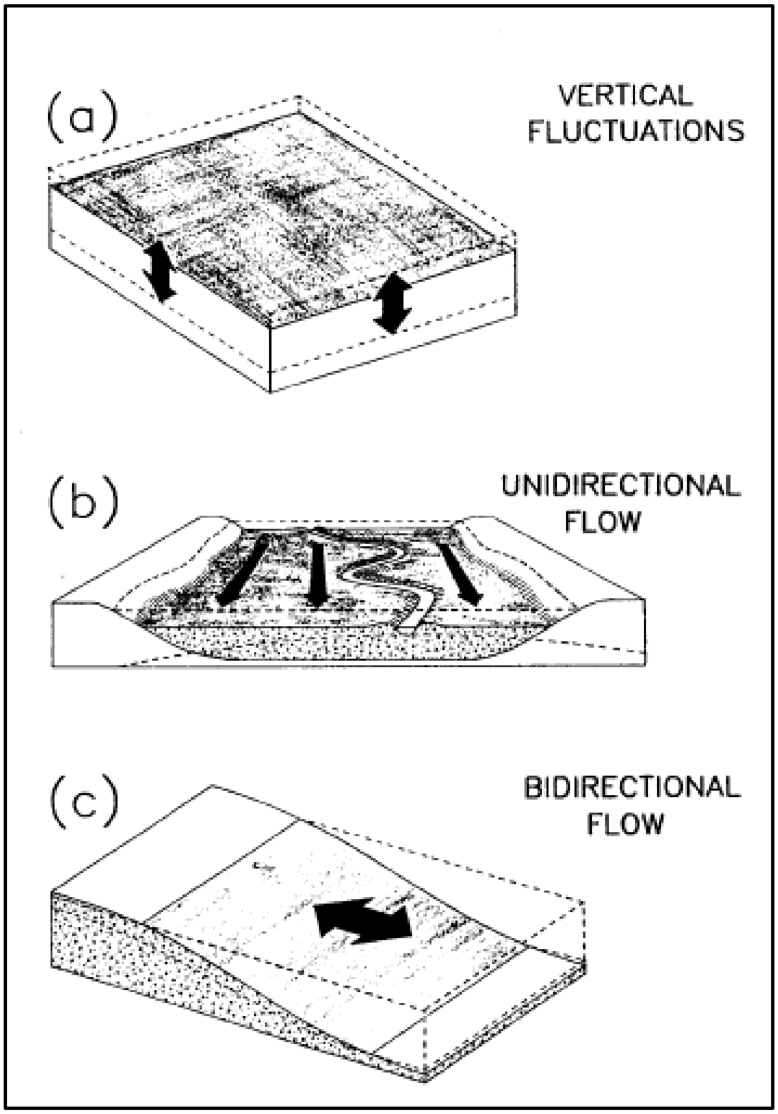

Figure 1. Illustration of categories of hydrodynamics based on dominant flow pattern (source: ACOE, 1995).

Methods

The purpose of this study is to determine natural turbidity water quality levels from reference sites outside of the lower Gabilan Creek watershed using the hydrogeomorphic approach for identifying reference site. The following steps were taken to identify reference sites and summarized turbidity monitoring data.

1) Identify the hydrogeomorphic characteristics of wetlands in the lower Gabilan Creek watershed;

2) Identify wetlands and watersheds with similar hydrogeomorphic characteristics and identify reference monitoring sites; and

3) Compile and summarize monitoring data from reference sites.

1) <u>The Hydrogeomorphic Characteristics of the Lower Gabilan Creek Watershed</u>

The following is a summary of the hydrogeomorphic characteristics of turbidity impaired waters in the lower Gabilan Creek watershed. Information used to develop this summary is from the watershed section of the TMDL technical report, watershed studies, and from field visits to the watershed. Information was also gathered from discussions with staff and stakeholders knowledgeable of the watershed.

The geomorphic setting of the lower/impaired sections of the Gabilan Creek watershed is flat alluvial valley landform below coastal foothill mountains. Stream channels in the watershed are characterized in a detailed study on the Reclamation Canal watershed (MCWRA, 2005) and the results are of this study are also included in the TMDL technical report.

Streams in in the lower Gabilan Creek watershed are perennial and supported naturally in large part by baseflow, which is groundwater entering streams along, runoff from precipitation. The watershed has natural intermittent stream flows from upland areas that drain to the lower valley. The watershed is highly modified and has anthropogenic inputs from urban stormwater, agricultural tile drains, and large surface water pumps. Surface stormwater runoff occurs after storm events but is enhanced in the watershed due to impervious surfaces in the developed urban and agricultural areas. Although the lower Gabilan Creek watershed is highly modified and has significant anthropogenic inputs, the predominant natural year-round water source in lower perennial streams appears to be baseflow.

In the lower Gabilan Creek watershed, streams generally flow in a northwesterly direction from the Gabilan Mountains towards the ocean across a low gradient alluvial plain. Waters at the base of the lower Gabilan Creek watershed flood plain are naturally slow-moving sloughs. Stream velocities diminish when the streams reach the slough systems at the bottom of the watershed in the Tembladero Slough and the Old Salinas River. The Old Salinas River and lower Tembladero Slough are brackish sloughs with tidal influence and depending on the tides, their flows can be bidirectional. Tide gates separate the Old Salinas River slough at the very bottom of the watershed from Moss Landing harbor and ultimately the Pacific Ocean. The tide gates are very old and separate some tidal inflows but not all and waters in the lower sloughs tend to be saline, which indicates bidirectional flow.

1. <u>Perennial riverine</u> wetlands in the lower river reaches of an alluvial part of the watershed with slow moving unidirectional flows. In the Gabilan Creek watershed this type of wetland includes:
    a. Lower Gabilan Creek
    b. Natividad Creek
    c. Alisal Creek
    d. Salinas Reclamation Canal
    e. Tembladero Slough (upper reach)

   f. Merritt Ditch
   g. Espinosa Slough
   h. Santa Rita Creek
2. Sloughs with slow-moving river dominant flows. In the Gabilan Creek watershed, this type of wetland includes:
   a. Tembladero Slough (lower reach tidally influenced)
   b. Old Salinas River Channel (tidally influenced)
   c. Alisal Slough (freshwater slough)

2) Identification of Reference Monitoring Sites:

Reference monitoring sites were select from stream in watersheds with similar hydrogeomorphic characteristics to the Gabilan Creek watershed. The reference sites were identified using a GIS model of the Central Coast Region along with staff knowledge and experience monitoring and assessing central coast streams. Key characteristics analyzed in the GIS model include slope and stream gradients, physical geology, topography, land use, and stream hydrology. Climatic characteristics were not included in the GIS model since the watersheds identified share the same regional coastal Mediterranean climate, which is influenced by their proximity to the Pacific Ocean.

Reference watersheds were identified with similar geomorphology, land use, and hydrology to the Gabilan Creek watershed. These are watersheds with mountainous headwaters draining to alluvial valleys and the valleys have slow moving perennial streams supported by groundwater baseflow along with some year-round anthropogenic inputs. These streams outlet on the coast into estuarine bays. Land uses are mixed with developed irrigated agriculture and urban areas. The surrounding foothills generally have a mix of native plant communities and rangeland. Watersheds identified with these characteristics from north to south in the region include the Pajaro River, San Luis Creek, Pismo Creek, Santa Maria River, Santa Ynez River, and South Coastal watersheds. Reference watershed streams and monitoring sites are listed in Table 1 along with their hydrogeomorphic category.

3) Results

Water quality monitoring data from the perennial riverine reference sites are summarized in **Error! Not a valid bookmark self-reference.** and from slough systems are summarized in **Error! Not a valid bookmark self-reference.**. Staff analyzed the quartile ranges of the monitoring data at reference sites and summarized the averages of the site quartile values. For example, the monitoring data summary in **Error! Not a valid bookmark self-reference.** indicates that the perennial stream reference sites have an average year-round median turbidity of 8 NTU, an average dry season median turbidity of 6 NTU, and an average wet season median turbidity of 11 NTU. Monitoring data from slough reference is limited to only two sites that have an average year-round median turbidity of 32 NTU, an average dry season median turbidity of 22 NTU, and an average wet season median turbidity of 37 NTU.

Table 1. Central coast reference watersheds, monitoring sites, and hydrogeomorphic categories.

Reference Waterbody	**Monitoring Site ID(s)**	**Hydrogeomorphic Category**
Lower Uvas Creek	305CAN, 305CAR	Perennial riverine
Watsonville Slough	305WSA	Slough
Lower Pajaro River	305CHI	Perennial riverine
Salsipuedes Creek	305COR	Perennial riverine
Lower Llagas Creek	305LCS	Perennial riverine
San Juan Creek	305SJA, 305SJN	Perennial riverine
Watsonville Creek (Elkhorn Slough)	306WAC	Perennial riverine
Chorro Creek	310CCC, 310TWB	Perennial riverine
San Luis Obispo Creek	310PRE, 310SLB	Perennial riverine
Pismo Creek	310PIS	Perennial riverine
Oso Flaco Creek	312OFN	Perennial riverine
Orcutt Creek (at Highway 1)	312ORI	Perennial riverine
Lower San Antonio Creek	313SAI	Perennial riverine
Santa Lucia Canyon-Santa Ynez River	314SYN, 314SYF	Perennial riverine
San Miguelito Creek-Santa Ynez River	314SYL	Perennial riverine
Dos Pueblos Canyon (Devereux Slough)	315DEV	Slough

Table 2. Summary of year-round, dry season, and wet season turbidity monitoring data from perennial riverine reference sites.

Waterbody Monitoring Site ID	**Season**	**Number of Samples**	**25th Percentile (NTU)**	**50th Percentile Median (NTU)**	**75th Percentile (NTU)**	**IQR* (NTU)**
Lower Uvas Creek (305CAN) (305CAN)	All	110	2	6	17	14
	Dry	29	1	4	14	13
	Wet	81	3	6	19	16
Lower Uvas Creek (305CAR) (305CAR)	All	29	4	8	15	11
	Dry	12	3	6	15	13
	Wet	17	5	9	13	8
Lower Pajaro Creek (305CHI) (305CHI)	All	13	29	59	46	215
	Dry	86	10	24	50	40
	Wet	91	72	196	612	540

Waterbody Monitoring Site ID	**Season**	**Number of Samples**	**25th Percentile (NTU)**	**50th Percentile Median (NTU)**	**75th Percentile (NTU)**	**IQR* (NTU)**
Salsipuedes Creek (305COR)	All	175	7	17	39	32
(305COR)	Dry	68	5	13	34	29
(305COR)	Wet	107	8	19	47	39
Lower Llagas Creek	All	151	2	4	7	5
(305LCS)	Dry	61	1	3	6	5
(305LCS)	Wet	90	2	4	9	8
San Juan Creek	All	167	7	14	22	15
(305SJA)	Dry	69	6	9	16	10
(305SJA)	Wet	98	10	17	27	17
San Juan Creek.	All	28	2	4	16	14
(305SJN)	Dry	10	2	3	6	4
(305SJN)	Wet	18	2	8	23	20
Watsonville Creek	All	29	1	3	8	7
(306WAC)	Dry	13	0	1	5	5
(306WAC)	Wet	16	3	5	11	9
Chorro Creek	All	313	1	2	3	2
(310CCC)	Dry	118	1	1	3	2
(310CCC)	Wet	195	1	2	3	2
Pismo Creek	All	168	0	2	6	6
(310PIS)	Dry	71	0	2	6	6
(310PIS)	Wet	97	0	2	6	6
San Luis Obispo Crk.	All	188	7	10	16	9
(310PRE)	Dry	80	7	10	14	6
(310PRE)	Wet	108	7	10	21	15
San Luis Obispo Crk.	All	178	0	0	2	2
(310SLB)	Dry	77	0	0	1	1
(310SLB)	Wet	101	0	1	5	5
Chorro Creek	All	434	1	1	2	2
(310TWB)	Dry	160	0	1	2	2
(310TWB)	Wet	274	1	1	2	1
Little Oso Flaco Crk.	All	181	7	19	39	32
(312OFN)	Dry	80	4	8	20	16
(312OFN)	Wet	101	15	25	50	35

Waterbody Monitoring Site ID	Season	Number of Samples	25th Percentile (NTU)	50th Percentile Median (NTU)	75th Percentile (NTU)	IQR* (NTU)
Orcutt Crk. at Hwy 1	All	199	9	22	89	80
(312ORI)	Dry	85	8	11	28	20
(312ORI)	Wet	114	13	53	171	158
Lower San Antonio Crk.	All	166	0	3	10	10
(313SAI)	Dry	68	0	2	9	9
(313SAI)	Wet	98	1	4	11	10
Santa Ynez River	All	153	2	6	14	12
(314SYF)	Dry	63	1	4	8	6
(314SYF)	Wet	90	5	9	20	16
Santa Ynez River	All	79	1	3	8	7
(314SYL)	Dry	26	0	2	4	3
(314SYL)	Wet	53	1	4	20	19
Santa Ynez River	All	220	0	3	11	11
(314SYN)	Dry	81	0	2	6	5
(314SYN)	Wet	139	0	4	14	14
Average	All		4	8	20	17
Average	Dry		3	6	13	10
Average	Wet		5	11	28	23

Table 3. Summary of year-round, dry season, and wet season turbidity monitoring data from slough reference sites.

Waterbody Monitoring Site ID	Season	Number of Samples	25th percentile (NTU)	Median (NTU)	75th percentile (NTU)
Watsonville Slough	All	142	14	40	110
(305WSA)	Dry	48	13	22	74
(305WSA)	Wet	94	15	48	112
Devereux Slough		25	14	24	45

Waterbody Monitoring Site ID	**Season**	**Number of Samples**	**25th percentile (NTU)**	**Median (NTU)**	**75th percentile (NTU)**
(315DEV)	Dry	10	11	23	37
(315DEV)	Wet	15	15	25	54
Average	All		14	32	77
Average	Dry		12	22	55
Average	Wet		15	37	83

References

Monterey County Water Resources Agency (MCWRA). 2005. Reclamation Ditch Watershed Assessment and Management Strategy: Part A Watershed Assessment

United States Army Corp of Engineers (ACOE). 1995. An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices