Lower Yuba River Large Woody Material Management Plan Pilot Study



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1.0 Introduction

On November 21, 2007, National Marine Fisheries Service (NMFS) issued a long-term biological opinion (BO) regarding the U.S. Army Corps of Engineers' (Corps) operation and maintenance of Daguerre Point and Englebright dams (NMFS, 2007). On December 20, 2011, the U.S. District Court ordered NMFS to file a new BO by February 29, 2012. The new BO, dated February 29, 2012, included an incidental take statement with several terms and conditions. Term and Condition D3 of the BO requires the Corps to "develop and implement a long term program to replenish instream woody material" (NMFS, 2012). In anticipation of Term and Condition D3, the Corps has prepared the *Lower Yuba River Large Woody Material Management Plan* (LWMMP), which includes the implementation of a Pilot Study starting in 2012 in order to enhance rearing conditions for spring-run Chinook and Central Valley steelhead (Corps, 2012).

In accordance with BO Term and Condition D3, the Corps proposed to initiate a pilot study to determine an effective method of replenishing the supply of large woody material (LWM) back into the lower Yuba River. As described in the LWMMP, the Pilot Study will use LWM from existing stockpiles at New Bullards Bar Reservoir for placement at selected sites along the lower Yuba River. The Pilot Study will include monitoring of placed materials. The goal of the Pilot Study is to evaluate the effectiveness of LWM placement in the lower Yuba River in order to develop a long term program (Corps, 2012). The purpose of this report is to document the implementation of the LWMMP Pilot Study.

2.0 Pilot Study Objectives

The overall goal of the LWMMP plan is to replenish and manage LWM in the lower Yuba River to improve habitat for juvenile salmonids and other non-listed fish species, by improving cover and diversity of instream habitat for rearing juvenile anadromous salmonids, and provide increased cover, invertebrate food sources, and micro-habitat complexity. The Corps recognizes that the accomplishment of this goal has to occur while maintaining recreation and public safety values.

The LWMMP will attempt to replenish and manage LWM in the Lower Yuba River in a "natural" way. Natural LWM distribution in a river system is dynamic and would be difficult to replicate through a highly controlled restoration plan. This pilot study will evaluate the efficacy of methods for placing LWM that are low impact, quickly implemented, and utilize naturally occurring flows to distribute LWM. The replenishment of LWM is expected to modify local flow dynamics to increase cover and diversity of instream habitat for the primary purpose of benefitting juvenile salmonid rearing.

3.0 Methods

3.1 Material Collection

Although Englebright and Daguerre Point dams have been implicated in the deficiency of LWM in the Lower Yuba River, these dams have no management plans for LWM, which flows freely over these dams during storm events. A large quantity of LWM does accumulate in New Bullards Bar Resevoir. The Yuba County Water Agency (YCWA) presently manages the LWM that is washed into New Bullards Bar Reservoir from the North Yuba River Basin upstream. A cable-and-buoy line (floating boom) spans the reservoir just upstream of the dam, which captures woody material that has entered and traveled downstream on the reservoir's surface. Currently woody material is pushed into and stored in shallow coves of the reservoir (Figure 1).

All woody material used in this pilot study was collected from stockpiles at New Bullards Bar Reservoir. The woody debris that accumulates on the reservoir consists of various materials, including leaves, twigs, branches, logs, root-wads, and trees. However, the quantity, size, and type of LWM entering New Bullards Bar Reservoir on an annual basis are not well known. In general, the most commonly available floating wood is generally small diameter material, with large diameter trees occurring less frequently and usually associated with flood events.



Figure 1. (a) Stockpiling of LWD in a cove at New Bullards Bar Reservoir (b) Staging area for LWM at Lower Gilt Edge Bar.

Woody material used for this pilot study was stockpiled during the 2013 water year. 2013 was a dry year and a relatively small amount of LWM accumulated in the New Bullards Bar Reservoir. As a result, a relatively small amount of LWM was available for use in the pilot study and all of the stockpiled wood at the reservoir was transported to the staging area (Figure 2). Wood was selected without discrimination and much of the woody material being used in the pilot study is smaller than desired; in years of excess LWM accumulation, selection of LWM will prioritize large pieces meeting minimum specifications.

3.2 Site selection

Prior to implementation of the LWMMP pilot study, several suitable sites had been identified along the Lower Yuba River within the Parks Bar to Hammon Bar reach, including: Upper Gilt Edge Bar, Parks bar, Lower Gilt Edge Bar, Lost Island, Long Bar, and Hammon Bar (Figure 4). Lower Gilt Edge Bar was selected as the best site for the pilot study due to ease of access and open floodplain.



Figure 4. Proposed LWM placement areas within the Parks Bar to Hammon Bar reach of the lower Yuba River (Corps, 2012).

The Lower Gilt Edge Bar is a point bar subject to inundation during annual high flows. The upstream half of the site is dominated by mixed cobble and largely devoid of vegetation. This half of Lower Gilt Edge Bar shows signs of recent inundation and is the focus area for the pilot study. Vegetation, dominated by willows (*Salix sp.*), is largely restricted to the shoreline.

The downstream half of Lower Gilt Edge Bar is dominated by mixed cobble and smaller sediment. This end of the site hosts small annual herbaceous vegetation sparsely distributed and a shoreline dominated by willows.

Within the Lower Gilt Edge Bar site, the flood plain was evaluated by cross referencing recent historical photos and flows; areas of frequent inundation were identified and prioritized for the placement of LWM (Figure 5). The study site is primarily inundated on the upstream portion of the point bar. Significant inundation also occurs along a swale where the river cuts across Lower Gilt Edge Bar. The upstream edge and swale areas of the study site will be priority locations for the placement of LWM.



Figure 5. Various historical inundation patterns at Lower Gilt Edge Bar (a) typical low flow May 2, 2013 (b) Typical high flow June 13, 2011

3.3 Placement of Large Woody Material

Specific sites for placing piles of LWM were selected to provide various subjection of LWM to natural flows. Pile locations vary in elevation and relative location on the point bar. With these concerns in mind all large debris piles were constructed using the same general methods (Figure 6). First a shallow pit was formed using a bobcat. Secondly, using an excavator, a key piece of LWM was transported from the staging area and placed into the shallow pit at the direction of Corps staff. Key pieces were generally oriented perpendicular to the predicted direction of high flows. Key pieces were selected for their large size or presence of root wad and are expected to provide significant stability. After placement of the key piece(s), assorted pieces were then placed onto and around the key piece to form a complex structure. Although this method was followed for all piles, each pile is unique in number of pieces and pile complexity. LWM piles were categorized as Root Wad, Log Jam, or Small Debris Pile depending on composition. In general piles were not anchored or stabilized beyond their inherent stability. The exception to this is Log Jam 5, which was ballasted with a small amount of cobble to prop the ends of the key pieces above the ground.

Small debris piles consisted of assorted woody material, randomly taken from the stockpile and placed utilizing a bobcat. Woody material in the small debris piles was generally limited to material that fit into the front loading bucket of a bobcat; individual pieces could be large in diameter, but none were significant enough in length to be considered key pieces. In a few cases, the excavator was used to construct some small debris piles and as a result, some larger pieces are present in Small Debris Piles. The description, "Small Debris Piles" refers to the absence of key pieces, and should not be used to make assumptions about the size of individual pieces of woody material in a small debris pile. It is expected that the majority of material in small debris piles will be mobile during inundation.

3.4 Data Collection

Data was collected during and after LWM placement. Piles were numbered sequentially in order of placement on site. Large piles were classified as "Log Jams" or "Root Wads" based on the type of key piece of LWM. If the key piece of LWM had a root wad, the pile was classified as "Root Wad". Pile construction and complexity was similar between root Wad and Log Jam Piles.

All Key Pieces and large associated pieces were measured and tagged for tracking. LWM pieces were tagged if they were greater than 1ft in diameter at middle and/or greater than 25ft in length. For each piece, the length and diameter at middle was recorded as well as the diameter of all root wads.

After placement of all woody debris, data was collected on all piles. Photos were taken of each pile from each cardinal direction (Appendix A). The diameter of each pile was taken across the north/south and east/west axes. A qualitative description of each pile was recorded. The location and perimeter of each completed pile was recorded using a Trimble GeoXH 6000 handheld GPS unit (submeter accuracy). GPS data was used to calculate the approximate elevation and area of each LWM pile.



Figure 6. Typical LWM pile construction **(a)** Shallow pit prior to placement of LWM **(b)** Placement of Key Piece **(c)** complete LWM pile after addition of assorted debris

4.0 LWM Placement Summary

From 10/21/2013 – 10/25/2013, woody material was transported from New Bullards Bar Reservoir to a staging area at Lower Gilt Edge Bar. From 12/10/2013 – 12/11/2013 LWM was placed on the Lower Gilt Edge Bar on the Lower Yuba River (Figure 7). LWM was distributed into 7 Root Wad piles, 12 Log Jam piles, and 15 small debris piles (Table 1). A field of scattered small debris remains on the foot print of the LWM staging area. Piles were placed on the flood plain between 182 and 191ft elevation.

After placing the LWM into piles, the total area covered by woody material, including the remnants of the staging pile was 19046 ft² (0.44 acres). The total area covered by log jams is 4220 ft² (0.097 acres). The total area covered by root wad piles is 1775 ft² (0.041 acres). The total area covered by small debris piles is 1755 ft² (0.04 acres). The remnants of the staging pile, consists of small debris and covers 11295 ft² (0.3 acres).



Figure 7. LWM Placement on Lower Gilt Edge Bar

	Latitude	Longitude	Elevation MSL (ft)	Overall Size	Area (sq ft)	LWM	Tag #	Length (ft)	Width (ft) (root wad only)	Diameter (ft)							
				North South		Key Piece	403	14	7'	2.5	Pile in small de						
Root Wad 1	39.22110328	-121.3517617	185.087	(NS) - 14'	249.03	Associated	407	11.5		1.5	mound behind						
				East West (EW) - 15'		Pieces	408	9		1.2	perpendicular wood on upstr						
						Key Piece	405	10	7	2	Deat wad least						
							412	12.6		1.5	wide, short log						
	20 224 40202	121 2520211	102.007	NS - 13'	200.27		413	10.5		2.8	perpendicular						
ROOT Wad 2	39.22140303	-121.3520311	183.087	EW - 16	288.37	Associated Pieces	414	7.8		2.8	inside pile und						
						TICCCS	415	12		2	Cobble mound						
							438	18.5		1.7	- located in hole						
				NS -14'	241.35	Key Piece	406	5	15	2	Root wad on up Large logs layin						
Root Wad 3	39.2215326	-121.3523643	185.37			Associated	416	9		1.7							
											Pieces	417	13		1	Cobble pile fair	
Root Wad 4	39.22164701	-121.3524998		55 NS - 15' EW - 13'	265.77	Key Piece	420	15	5.5	1.4	Root wad on w Lots of small w wad. Cobble m						
			185.355			7 Associated	421	13.5		1.1							
						Pieces	422	6.3		1.3	spread out, les						
	39.2220358	-121.3543353											425	3	7.5	2.5	Two root wads
Root Wad 5			184.503	EW - 13'	202.5 Ke	- 13' 202.5	Key Pieces	423	5	6.5	3	logs on upstrea					
							430	8	6.5	2.7	Placed in excav						
Root Wad 6	39.22154108	-121.3539091	185.483	NS - 11' EW - 16'	NS - 11' EW - 16'	NS - 11' EW - 16'	NS - 11' EW - 16'	244.55	Key Pieces	431	24		0.6	closer to the w river.			
						Key Piece	432	5	5.5	1.4							
							433	6		2	- Placed in excav						
De chara de T	20 22472525		405 552	NS- 12' EW - 19'			434	7	6	1.5	upland side. La						
KOOT Wad /	39.221/3525	-121.352/324	185.553		283.84	Associated Pieces	435	25		0.7	the pile. Uplar						
							436	9.5		1.2	downstream, a						
							437	10.7		1.3]						

Table 1. Summary of LWM placed at Lower Gilt Edge Bar December 2013

epression excavated by bobcat. mound of mixed sized cobble I root wad. Logs lined up almost to river flow. Lots of small pieces of ream side, closest to the river.

ted in center of the pile, several gs piled on upstream side. Large log to flow was laid down upstream of laying by itself. Smaller wood pieces der root wad and other short logs. d on upland side of pile, root wad e excavated by the bobcat.

pland side of pile in excavated hole. ng against it perpendicular to flow. rly spread out on upland side.

vater side of pile in excavated hole. voody debris placed around root nount on upland side. Pile more ss concentrated than other piles.

s place in excavated hole. Root ownstream end of the pile, linear am and downstream side of rock hill nge).

vated hole. Upland side mostly llel to flow, smaller pieces on side vater, mostly perpendicular to the

vated hole, cobble mound on arge pile of small debris on of root wad. Lots of small pieces in nd side more open. Small debris pile about 6 feet from main pile.

	Latitude	Longitude	Elevation MSL (ft)	Overall Size	Area (sq ft)	LWM	Tag #	Length (ft)	Width (ft) (root wad only)	Diameter (ft)															
						Key Piece	404	14		1.5	Placed in hole s														
	20 224 22052	424 2540520	104.047	NS - 13'	270.2		409	13		1.1	on upland side.														
Log Jam 1	39.22123852	-121.3518538	184.047	EW - 17'	2/8.2	Associated	410	11.5		2.2	toward upstrea														
						FIECES	411	13.5		1.4	-														
	20.22122266	121 2510212	195 126	NS - 22'	267.6	Key Piece	418	25		3	Largest central laying parallel,														
LOg Jam 2	39.22132200	-121.3519212	185.126	EW - 15'	307.0	Associated Pieces	445	10		1.6	mound on upla up and downst														
Log Jam 3	39.22149171	-121.3521002	184.091	NS - 14'EW - 21'	391.51	Key Piece	419	26		3.4	Large central lo end of log ends on upstream en debris underne small debris be downstream en mound on upla														
Log Jam 4	39.22171973	-121.3541544	194 422	184.422 NS - 18' EW - 20'	296.98	Key Piece	423	14		3.5	Key Pieces perp parallel to flow anchor the end														
			104.422			Associated Pieces	424	18		0.9	excavated hole size than the c														
				NS - 17'	17' 472.26	Key Piece	427	27	4	1	Logs placed lay														
Log Jam 5	39.22192349	-121.3542091	184.66			6 Associated	428	28.5		1.5	as a ballast and														
																			L VV - 20		Pieces	429	16.5		1.1
						Key Piece	439	16		1.8	Main logs perp														
							440	23		1.3	- logs on the upla														
Log Jam 6	39.22132276	-121.3536137	186.157	186.157 NS - 20' EW - 19'	NS - 20' EW - 19' 457.7	Associated	441	24		1.1	mound. Small														
						Pieces	442	19		1	downstream si														
							449	11		1.7															
						Key Piece	443	17		1.2	Key Piece on up														
				NS - 26'			444	10		1.6	on top of it. Ke														
Log Jam 7	39.22118837	-121.3532266	187.755	EW - 11'	301.74	Associated	446	25		1.3	iust upstream of														
						Pieces	447	16		1.3	_														
								448	15.5		1.8														

 Table 1. (Continued)
 Summary of LWM placed at Lower Gilt Edge Bar December 2013

scoured by bobcat. Mostly oriented ow. No real ballast, cobble mound . Lots of small debris in front and am side of the pile.

l log perpendicular to flow, others leaning against central log. Cobble and side of pile. Small debris pile in tream of largest log.

og perpendicular to flow, riverside s at a willow. Other large logs piled and, parallel with flow, lots of small eath larger logs. Second pile of ehind largest main log, on and, sheltered from flow. Cobble and side.

pendicular to flow, smaller pieces v. Upland side buried in rock to d in place. Small pieces of wood in e. Cobble in the area is a smaller obble in the rest of the site.

ving East/West. Located in e, rocks piled on upland end to serve d anchor the large logs. Located f rock hill (elevation change).

bendicular to river with smaller large land end laying parallel to the river. nst excavated hole and cobble debris pile on upstream and ides of the pile. Upstream pile has iment mixed in.

pland side of pile, other large logs ey Piece parallel to river, other large dicular to river. Small debris pile of main pile.

	Latitude	Longitude	Elevation MSL (ft)	Overall Size	Area (sq ft)	LWM	Tag #	Length (ft)	Width (ft) (root wad only)	Diameter (ft)	
Log lom 9	20 221 4965	121 2527066	196.91	NS - 10'	192 55	Associated	450	11		1.9	Placed on undis Smaller pieces
LOG Jain 8	39.2214805	-121.3537000	180.81	EW - 18'	182.55	Pieces	451	10		1.3	mound.
							452	8		2	Placed in excav
Log Jam 9	39.221342	-121.3528382	189.31	NS - 18' EW - 12'	214.51	Associated Pieces	453	8		1.1	not really anch
							454	13		1	
							455	10		1.2	Very spread ou
Log Jam 10	20 221/185/12	-121 2520070	197 722	NS - 16'	568 02	Associated Pieces	456	7		1.5	main large piec
	39.22140342	-121.3525075	107.752	EW - 25'	508.93		457	8		1.5	in the middle. I mound on upla
							458	6		2	
					221.77	Associated Pieces	459	8		1.3	In excavated ho Lots of small pieces on top o
Log Jam 11	39.22155774	74 -121.3531618	187.545	NS - 15' EW - 20'			460	8		1.4	
							461	5		1.6	
Las las 12	39 2219/361	-121 353406	190 013	NS- 16'	466.25	Associated	462	8		1.3	Spread out in e Lots of small pi
	55.22154501	-121.333400	190.015	EW - 26'	400.25	466.25 Pieces	463	13		1.1	the placement.
Small Debris Pile 1	39.2212173	-121.3517549	185.607	NS - 9' EW - 10'	78.98						Small pieces, or
Small Debris Pile 2	39.22160124	-121.3520674	183.204	NS - 11' EW - 9'	109.30						Medium sized I Located close t facing in all dire
Small Debris Pile 3	39.22168154	-121.3520954	182.023	NS - 11' EW - 9'	185.30						Largest piece ir Small pieces or hole excavated upland side.
Small Debris Pile 4	39.22176162	-121.3521855	182.734	NS - 15' EW - 9'	118.28						Small pile of as to less than a fo cobble.
Small Debris Pile 5	39.22183804	-121.3523667	182.931	NS - 8' EW - 6'	61.36						Small pile of as between two w downstream sig

 Table 1. (Continued)
 Summary of LWM placed at Lower Gilt Edge Bar December 2013

isturbed cobble, not excavated. on the side closer to the river, d in all directions. No cobble

vated hole, lots of small debris. Tall ood stacked on top of each other, nored at all.

at pile. Only a few logs on top of nall debris on the upstream end, ces parallel to the river. Empty gap Located in excavated hole, cobble and side.

ole, cobble mound on upland side. ieces. Tall, dense pile with many of each other.

excavated hole, not piled very high. ieces mixed in but no real pattern to ... Cobble pile on upland side.

riented in all directions.

logs and small root wad piece. to water, maybe 6 feet away. Logs rections.

n center of pile, parallel to flow. n top of it and around it. Placed in d by bobcat, cobble mound on

ssorted debris ranging from 2m long foot. Placed on top of undisturbed

ssorted debris. Placed directly willows on upstream and ides of the pile.

	Latitude	Longitude	Elevation MSL (ft)	Overall Size	Area (sq ft)	LWM	Tag #	Length (ft)	Width (ft) (root wad only)	Diameter (ft)	1
Small Debris Pile 6	39.22194461	-121.3525007	182.565	NS - 5' EW - 16'	157.40						Assorted debris. damage already willows.
Small Debris Pile 7	39.22199726	-121.3526525	182.739	NS - 14' EW - 11'	125.91						Woody Pieces n sand/sediment. cobble filled wit
Small Debris Pile 8	39.22185045	-121.3525705	184.261	NS - 7' EW - 7'	134.76						Assorted debris mound on uplar
Small Debris Pile 9	39.22195688	-121.353039	186.35	NS - 14' EW - 11'	175.39						In excavated ho in the middle of upland side, ass
Small Debris Pile 10	39.22175605	-121.3539933	185.412	NS - 12' EW - 13'	153.53						Assorted size de not excavated. sediment mixed
Small Debris Pile 11	39.22161415	-121.3537066	187.932	NS - 6' EW - 10'	83.24						Very small pile o
Small Debris Pile 12	39.22135322	-121.3533094	187.648	NS - 8' EW - 9'	98.72						Small debris pile change). Pieces Placed on undis Very small root
Small Debris Pile 13	39.22115178	-121.3531705	188.273	NS - 5' EW - 15'	171.92						Mostly small pie
Small Debris Pile 14	39.22128958	-121.352923	190.171	NS - 6' EW - 5'	63.76						Small pile, assor cobble, no excav
Small Debris Pile 15	39.22113309	-121.3539338	189.365	NS - 12' EW - 7'	37.50						Placed on undis Placed against v not likely to be i flows.

 Table 1. (Continued)
 Summary of LWM placed at Lower Gilt Edge Bar December 2013

. Placed next to willows, beaver observed on pile and nearby

nixed with rock and . Near existing depression in th standing water.

. Placed in excavated hole, cobble nd side.

ble, fairly spread out with bare spot f the pile. Cobble mound on sorted sizes of wood debris.

ebris. Placed on existing cobble, Small cobble, and some sandy d in.

of assorted size debris.

e next to cobble hill (elevation s mostly perpendicular to the river. sturbed cobble, no excavated pit. wad on upland side of pile.

eces mixed with soil/sediment.

rted sizes, placed on undisturbed wation.

sturbed cobble, not excavated. willow in area with weeds growing, inundated except in very high

5.0 Discussion

The short term outcome of this pilot study is uncertain due to its dependence on high flows. The 2014 water year has started out as one of the driest year on record. If this trend continues, it is possible that the LWM placed at the pilot study site will not be inundated. It is also possible that the study site will only receive partial inundation. In either case, the results of this study will be limited and the best course of action may be to postpone assessment until higher flows.

The expected outcome for this pilot study is that high flows will eventually inundate the pilot study flood plain during a large storm event. Smaller pieces of woody material will be mobilized while LWM piles remain relatively stable. LWM has been placed at different locations and elevations and will be subject to different hydraulic forces. Some LWM piles will be subject to greater or lesser forces depending on their location on the pilot study area. The variety in LWM placement conditions, including location on the point bar, elevation of pile, and size and orientation of woody material, is expected to result in a variety of effects. Some piles may be completely mobilized while others may reorient and stabilize in the flows. Many intermediate effects may also be observed in which portions of LWM piles are transported by flows. Woody material may be transported completely out of the pilot study site or only a short distance and deposited on the downstream end of the pilot study site.

The goal of this pilot study is to evaluate the efficacy of placing LWM on the flood plain and allowing seasonal flows to redistribute wood "naturally" into the Lower Yuba River. The LWM piles are expected to influence the local habitat by creating localized areas of scour, recruiting finer sediment, modifying flows, recruiting additional woody material, providing refuge for fish during periods of high flow, trapping organic matter, providing substrate for primary production, recruitment of terrestrial vegetation, and generally increasing the diversity of available habitat. Any LWM that is transported out of the pilot study area is expected to provide similar habitat benefits where ever it deposits.

6.0 References

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- Opperman, J, Merenlender A, Lewis, D. 2011. Maintaining Wood in Streams: A Vital Action for Fish Conservation. University of California, Division of Agriculture and Natural Resources. 2006.
- U.S. Army Corps of Engineers (Corps). 2012. Lower Yuba River Large Woody Material Management Plan. Sacramento District, Sacramento, CA.

Appendix A. Photo Documentation of LWM Piles

39.221103283, -121.351761657



39.221403029, -121.352031108



39.221532600, -121.352364268



39.221647012, -121.352499772



39.222035795, -121.354335286



39.221541082, -121.353909149



39.221735246, -121.352732392



39.221238520, - 121.351853758



39.221322664, -121.351921152



39.221491711, - 121.352100193



39.221719726, -121.354154412



39.221923494, -121.354209068



39.221322764, -121.353613740



39.221188374, -121.353226631



39.221486498, -121.353706586



39.221341995, -121.352838154



39.221485419, -121.352907938



39.221557742, -121.353161835



39.221943607, -121.353406040



39.221217302, -121.351754923



39.221601242, - 121.352067387



39.221681544, --121.352095424



39.221761622, -121.352185481



39.221838036, -121.352366684

North	West
View obstructed	
South	East
	View obstructed

39.221944606, -121.352500749



39.221997258, -121.352652485

39.221850452, -121.352570505

39.221956876, -121.353038955

39.221756052, -121.353993340

39.221614150, -121.353706639

39.221353222, -121.353309391

39.221151778, -121.353170538

39.221289579, -121.352922996

39.221133094, -121.353933773

Small Debris Field

Remnants of Staging Area

