

San Francisco Pier 94 2013 Construction Report and Native Plant Restoration Plan



Top photo: Delivering sediment to the site. Bottom photo: Site after grading.

Prepared for Golden Gate Audubon Society

by Mike Perlmutter

December 15, 2013

Introduction

San Francisco's Pier 94 is located along the south eastern bay shoreline of the city, on property owned and operated by the Port of San Francisco. Wetlands and parklands fringe the bay shore edge of this property, which is mostly developed and used for industry. Prior to San Francisco's development, which from the 1840's through the 1960's, filled and converted much of the Bay's shoreline to urban and industrial use, wetlands and native plant communities were once common along the shoreline. Today this part of the shoreline is primarily zoned for maritime industrial use and wetlands and associated habitats, are quite uncommon, so that even small sites like Pier 94 represent significant existing and/or restorable habitat.

Since 1997 Golden Gate Audubon has partnered with the Port of San Francisco to enhance shoreline features at Pier 94. After completing successful wetland and beach enhancement projects in 2006, Golden Gate Audubon is planning and implementing habitat enhancements in the adjacent upland areas of Pier 94. Large portions of these uplands are covered by hard compacted fill soils (comprised of rubble, furniture, rebar, and miscellaneous fill) and unpaved road-like surfaces that prohibit most vegetation growth. Plants that do occur in these ultra-harsh conditions are typically ruderal non-native invasives and provide little habitat value for wildlife (see 2012 monitoring report for more details on baseline vegetation composition). Golden Gate Audubon is enhancing these degraded areas by dressing them with a covering of imported sediment more conducive to native plant growth and then planting and seeding native plants into the imported sediment with the goal of establishing thriving native plant communities that will be the foundation for bird and wildlife habitat.

Beneficial Sediment Reuse

Beneficial sediment reuse for ecological habitat enhancement at Pier 94 and elsewhere (Aramburu Island, Montezuma Wetlands, Hamilton Field, etc.) could help set a positive precedent for similar projects throughout the Bay. There are many wetland and upland habitat enhancement and restoration projects around the Bay that could benefit from donations of "waste" sediment from mining, dredging, and excavation projects of clean local soils. Beneficial reuse offers an opportunity to more efficiently utilize sediment by diverting material away from the waste stream, reducing the cost and lost opportunities associated with disposal.

The need for sediments for restoration projects is ever increasing, especially as formerly abundant sediment sources become scarce and new demands are placed on the system from increasing acreages of tidal marsh restoration projects and rising sea levels. The amount of sediment transported by San Francisco Bay waters has notably declined as much of the sediment pulse from hydraulic mineral mining in the Sierra's has washed through the system out to sea. The sediment surplus period during the pulse of hydraulic mining sediment inflow has shifted to a period of sediment deficit, where there is less in-Bay sediment transport than the need for this sediment. Sediment accretion into new tidal marsh restoration projects is strained by this deficit, and the strain is compounded by rising sea levels. The strain may prevent new wetland restoration projects from accreting to the proper elevations needed for functioning mudflats and wetlands. The same strain may also detrimentally erode existing marshes and mud flats. Recognition of this problem will force restoration

planners to consider alternative sediment sources. Beneficial sediment reuse will become more pragmatic as a way to meet increasing sediment needs, while also capitalizing on material formerly considered and treated as waste.

2013 Sediment Donations

In the spring and summer of 2013, sediment donations were secured from Hanson Aggregates and from the Transbay Terminal and Central Subway excavations in San Francisco. Sediment delivery to the site began on March 21, 2013 and was completed on June 5, 2013. Approximately 3,865 tons of sediment were delivered to the site. Of this, approximately 650 tons of sediment came from the Central Subway excavation, approximately 1,715 tons came from the Transbay Terminal excavation, and about 1,500 tons came from Hanson. Hanson's sediment, which was stockpiled next to the restoration site, was delivered site via Hanson's on-site front-end loader. All other sediment was trucked in. 184 truckloads of sediment and were trucked in by the excavation projects, and more than 300 loads were delivered to the site via front end loader by Hanson.

Each sediment source varied in texture. The Hanson material had the highest clay content, followed by the Central Subway material. The Transbay material was notably sandier than the other two sediment sources.

Hanson Aggregates is a commercial sand-mining company that operates on Pier 94 adjacent to the enhancement site.

Hanson typically screens out fine-grain materials from the sands they mine from San Francisco Bay. There is no viable market for Hanson to sell these fine-grain materials which they typically stockpile and then transport to a disposal site. These fine-grained sediments though can be useful to habitat restoration projects, especially because the sediments generally match the local substrates, and the sediments are often relatively weed-free, a result of being buried deep underground for hundreds to thousands of years. Hanson partnered with Golden Gate Audubon and arranged a donation of these fine-grained materials to the habitat enhancement project at Pier 94: a win-win that saved Hanson the cost, logistics, and inefficiencies of disposal, while creating a net benefit for Pier 94 uplands through beneficial sediment reuse.

Additional sediment was donated to the project from two excavation projects in San Francisco's downtown South of Market Street area: construction of a new Transbay Terminal and a Central Subway project. Both of these projects excavated deep into native Colma formation sediments that were being disposed of at a cost to the projects. This Colma formation sediment, like the Hanson material, was appropriate for beneficial reuse at Pier 94, and like the Hanson sediments, was a good match the local substrate and was relatively weed-free, as a result of being buried deep underground for hundreds to thousands of years. This beneficial sediment reuse was another win-win that saved these projects the cost, logistics, and inefficiencies of disposal, while creating a net benefit for Pier 94 uplands.

Donated sediment sources and quantities	
Sediment source and type	Sediment Quantity (Tons)
Clayey	2,150
Central Subway excavation	650
Hanson sand mining spoils	1,500
Sandy	1,715
Transbay Terminal excavation	1,715
Total Tons	3,865
<i>For a daily chronicle of the sediment deliveries and other major construction events, see the subsequent table.</i>	

All sediment and delivery was generously donated. Hanson Aggregates arranged for delivery of their materials. Barnard Impreglio Healy Joint Venture (BIH) donated the material and the trucking from the Central Subway project. Local construction planner Kevin Lawson arranged truck delivery of the Transbay Terminal material. Had donated sediment not been available, the cost of purchasing dredged sediment from the Port of San Francisco is estimated to be \$25,350. The value of the donated trucking delivery of the sediment is estimated to be \$16,000. Together this represents a \$41,350 savings for the habitat enhancement project. Avoiding these costs allowed Golden Gate Audubon to advance this project. Having a local site where sediment could be donated, rather than disposed at cost, saved the suppliers money on their end, a win-win situation.

The beneficial reuse of sediment at Pier 94 may serve as a model approach for other restoration projects around San Francisco Bay.



Above: Delivery of trucked in sediment.

Right side photos:

Top: Piling of mined sediments.



Middle: Fine sediments are washed out from sands and collect in settling ponds.



Bottom: Fine sediments collected from the settling ponds. Noreen Weeden of Golden Gate Audubon Society stands next to the pile for scale.



Note - all photographs in this report were taken by Mike Perlmuter unless noted otherwise.

Construction log of major activities								
Date	Observer	Activity	# of trucks	Average cubic yards per truck	Sediment quantity delivered	Sediment source	Sediment notes	Notes
March 19-20, 2013		Yerba Buena Engineering installed wattles around sediment delivery site						
March 22, 2013	Mike Perlmutter	Sediment delivery begins - BIH	22	13	286	Central Subway excavation	Clayey	Active killdeer nest observed. Truck routed around nest to limit disturbance
March 23, 2013	Mike Perlmutter	Sediment delivery - BIH	28	13	364	Central Subway excavation	Clayey	
March 26, 2013	Eddie Bartley	Sediment delivery from Hanson	96	front end loader	500	Hanson sand mining spoils	Clayey	Killdeer nest gone, predation suspected. Sediment appears stable even in high winds.
March 27, 2013	Eddie Bartley	Sediment delivery from Hanson	95	front end loader	500	Hanson sand mining spoils	Clayey	
March 28, 2013	Noreen Weeden	Sediment delivery from Hanson	74	front end loader	500	Hanson sand mining spoils	Clayey	
May 29, 2013	Mike Perlmutter	Sediment delivery	20	13	260	Transbay excavation	Sandy	
June 3, 2013	Mike Perlmutter	Sediment delivery	50	13	650	Transbay excavation	Sandy	
June 3, 2013	Mike Perlmutter	Sediment delivery	9	10	90	Transbay excavation	Sandy	
June 5, 2013	Mike Perlmutter	Sediment delivery	55	13	715	Transbay excavation	Sandy	Final soil delivery
June 19, 2013	Mike Perlmutter	Grading						
June 19, 2013	Mike Perlmutter	Grading						
June 21, 2013	Mike Perlmutter	Grading						
June 25, 2013	Mike Perlmutter	Hydromulching, swale construction, weeding						
June 26, 2013	Mike Perlmutter	Hydromulching						

Wildlife

Wildlife use of the site during construction was monitored daily during construction events. Wildlife use at the site during construction was minimal.

On the first day of sediment delivery, Thursday March 21, 2013, Mike Perlmutter observed a pair of killdeer nesting in the northern portion of the site, where they had constructed a nest and had laid four eggs. Traffic cones were placed around a large area outside of the nest and the truck drivers were at first instructed to give a wide berth to the nesting, and then were instructed to avoid the area entirely by making deliveries to the southern part of the work area instead.

On Sunday March 24, 2013 Noreen Weeden reported that the killdeer nest was empty with no adults nearby and no eggs within the nest. Predation from Norway rats, feral cats, ravens, or other predators was suspected to be the cause of the nest failure. Sediment delivery to the former nesting area resumed on March 25, 2013.



Top: Killdeer observed March 21 by Mike Perlmutter.

Middle: Killdeer nest with eggs.

Bottom: Exclusion area marked by cones to protect killdeer nest.

Grading

A front end loader was used to spread the sediment across the site in a two to three foot layer that slopes gently towards the Bay. Minimal contouring was done other than gently sloping the edges, installation of a trail cut into the site and leading to the Bay, and installation of a gentle swale in the southern portion of the site. The sediments in this area have higher clay content, which may hold water longer and might support wetland vegetation.



Top: Edge contouring.

Middle: Constructing the path.

Bottom: Building the swale.

Erosion Control

As prescribed by the site's Storm Water Pollution Plan, straw wattle placement and hydromulch application were used to stabilize imported sediment and prevent it from eroding into the adjacent wetlands and bay waters. These are conservative measures, typical for construction projects that call for hydroseeding along with the hydromulch. In this case, the hydromulch was used only as a prescribed stabilizer, not as a medium to carry hydroseed, which would not have fared well applied mid-summer without irrigation.

The gentle slopes and hard sediment conditions likely would have obviated the need for hydromulch, which would not have been applied had it not been required by the permit. This approach could save money on future projects with similar conditions. This would also keep excess material that could facilitate weed invasion off-site.

A row of straw wattles were installed around the perimeter of the fill area. These serve as a physical barrier against sediment movement, containing it within the work area. The wattles were secondarily useful in demarcating the limits of the work area, although the work area was expanded during the sediment delivery, requiring additional labor and material costs to move and reinstall wattles further out.

Conwed Fibers® Hydro Mulch® 1000 with TriFlo™ was applied to the surface of the imported sediment after grading as a further measure to stabilize sediment and prevent it from eroding off-site.



Top: Wattles placed along the edge of the work area. Sediment was generally kept ten feet from the wattles before grading.

Bottom: Applying hydromulch.

Left inset: Conwed Fibers® Hydro Mulch® 1000 with TriFlo™ package.

Weed Abatement

Placement of sediment covered weeds growing in the work area. Weeds in parts of the southern portions of the work area were also bladed down with the front end loader to improve access to those areas by the sediment delivery trucks.

The typical weeds in these areas were *Brassica nigra* (black mustard), *Foeniculum vulgare* (fennel), *Heterotheca grandiflora* (telegraph weed), *Glebionis coronaria* garland daisy, and various species of European annual grasses.

It is hoped that the two to three feet of sediment placed over the existing grade will smother the existing weed seedbank and prevent those buried weed seeds from germinating. The imported sediment is expected to be largely weed-free, as it has been buried for hundreds to thousands of years and therefore should not have been exposed to invasive plant propagules prior to delivery on site.

Additionally the weeds in northern area just outside where the sediment was placed were bladed down with the front end loader and other weedy edge areas in the southern portion of the site were mowed down by contractors from Literacy for Environmental Justice. This will reduce the amount of weed seeds getting into the newly placed sediments in this area.



Top: Front end loader blading weeds outside the northern restoration area.

Bottom: The northern area cleared of weeds (mostly radish, fennel, telegraph weed, and exotic annual grasses).

Soil textures

Each sediment source varied in texture. The Hanson material had the highest clay content, followed by the Central Subway material. The Transbay material was notably sandier than the other two sediment sources.

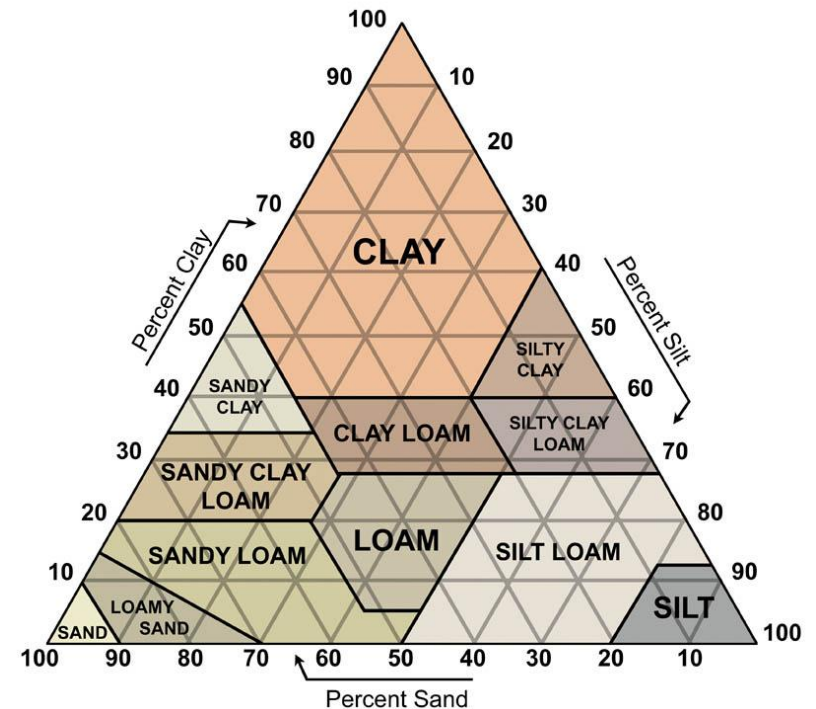
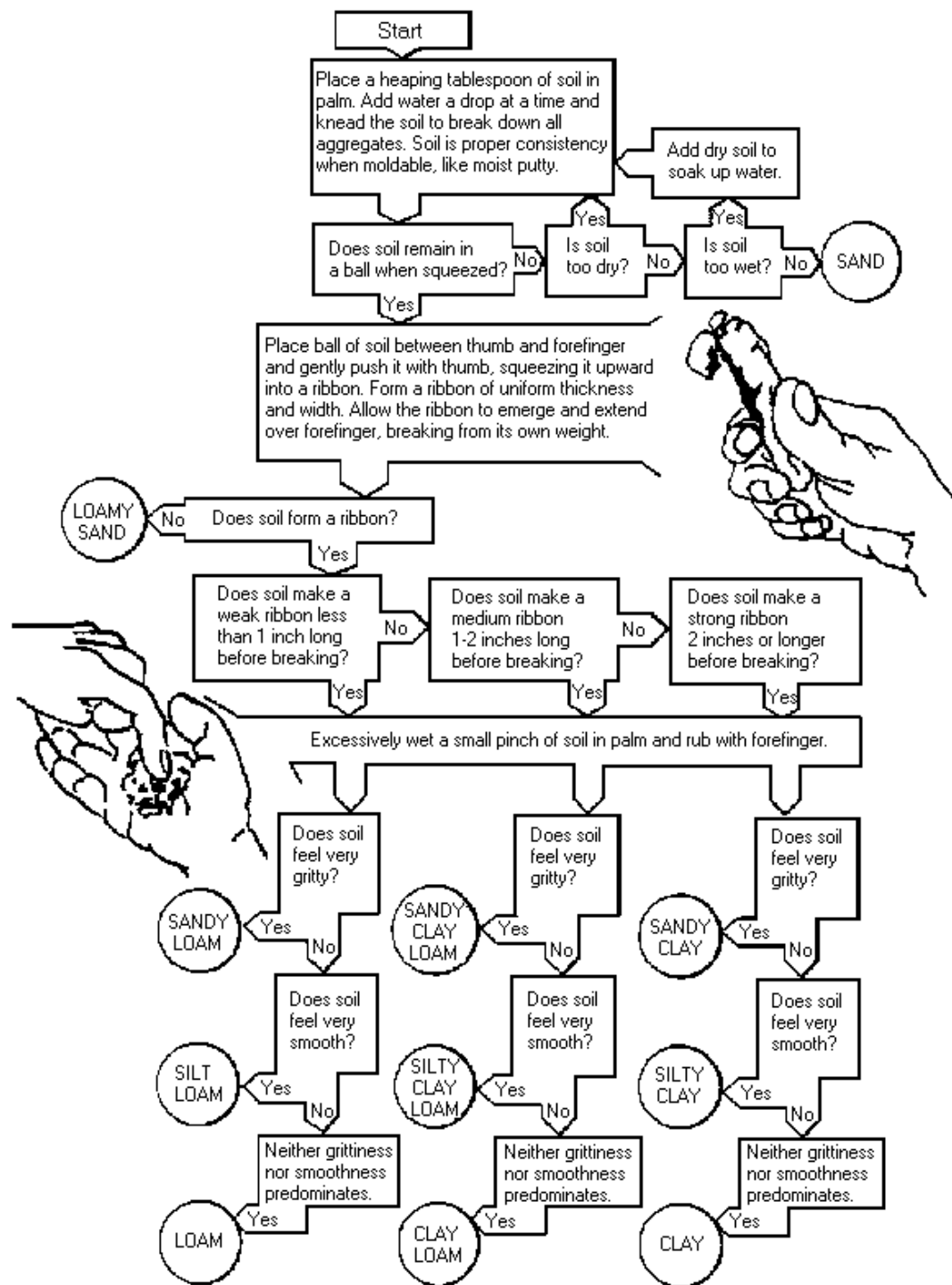
These materials were mixed to varying degrees during sediment delivery and grading. The resulting sediment textures across the site were assessed by on site by feel.

Subsequently soil samples were mixed thoroughly with water in jars and allowed to settle for 24 hours. During the settling time the materials stratified into layers based on particle size. Heavy dense particles such as pebbles dropped to the bottom of the jars first, then sand, followed by silt and then clay. After the samples settled they were photographed to visually document soil textural composition in different parts of the site.



Left: Transbay sediment mixed with water and allowed to settle in a glass jar.

Top to bottom: Hanson, Central Subway, and Transbay Terminal sediments, each with quarter for scale.



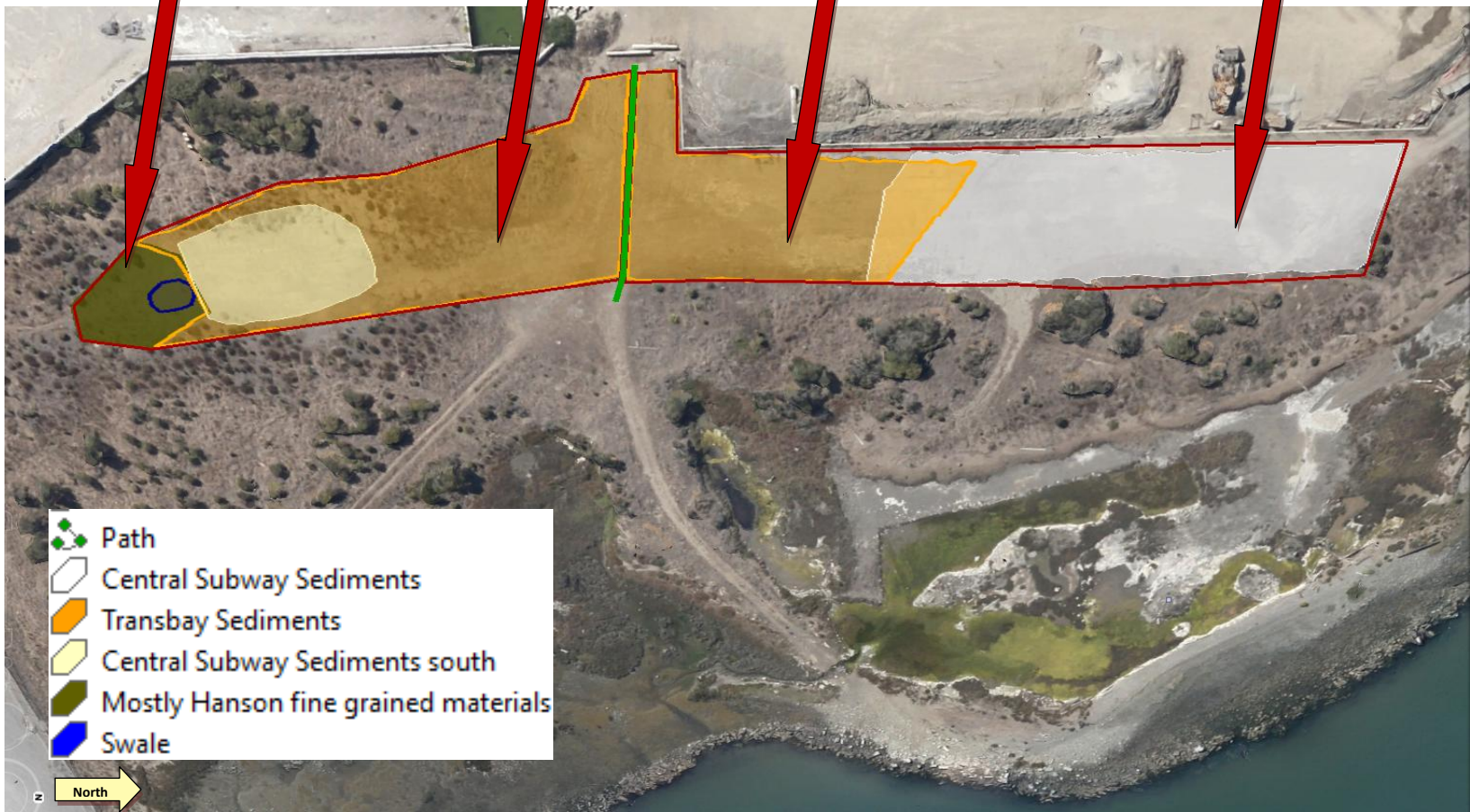
Assessing soil textural composition.

Left: the texture by feel test.

Above: diagram of soil textural classifications and their composition.



Map of Pier 94 showing approximate placement of different sediments of varying sources and qualities. Sediments were mixed somewhat during grading.



Soil samples from the north portion of the site

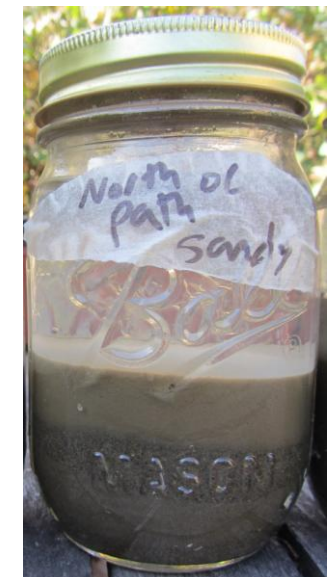
The soils in the northernmost area are sandy clay loam, with an estimated 80% sand content, 15-20% fines, and, 1-5% gravel.



The soils in the mid northern area are a sandy clay loam, with an estimated 85% sand content, 15% fines, and a small percentage of gravel.

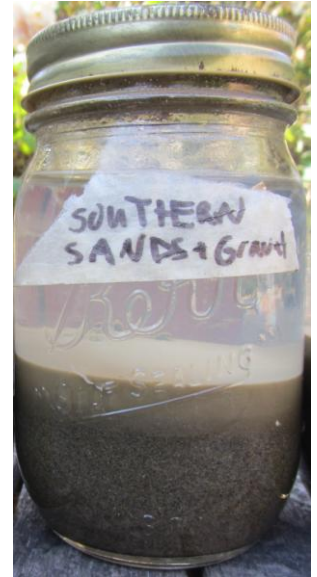


The soils just north of the path are a loamy sand, with an estimated 70% sand content and 30% fines.



Soil samples from the south portion of the site

The soils just south of the path are loamy sand, with an estimated 75% sand content, and 25% fines.



The soils in the southernmost area are sandy clay or sandy clay loam mostly fines, with some sands and gravel.



Plant propagation lists

Native plants will be seeded and planted into the site to establish a mix of native bunchgrass prairies, shrublands, and seasonal wetlands. Vegetation enhancement is aimed to increase vegetation cover and species richness. Increased shrub cover, and food availability from seeds and insects in the grasslands will improve habitat for local passerines, as well as marsh wildlife seeking shelter during high water events.

Golden Gate Audubon Society is contracting with Literacy for Environmental Justice to grow plants for the site to be planted in winters of 2013-2014 and 2014-2015 (with a few additional plants for 2015-2016). Literacy for Environmental Justice operate a nearby native plant nursery and have grown native plants for restoration projects throughout southeast San Francisco. They typically grow plants from propagules collected in southeast San Francisco which preserves the local genetics of local native plant populations.

Pacific Coast Seed was contracted to supply native plant seeds, which were delivered in November 2013. Seeds were ordered from San Francisco Bay Area stocks.

Species selection for plant and seed requests was developed from recommendations made by Peter Baye. These recommendations prescribed different plant species mixes, planting, and seeding rates based on soil substrate, which unfortunately was unknown when plant orders were due (March 2013), as sediment had yet to be delivered to the site. These recommendations were refined in conversations between myself and Peter - resulting in some species additions and deletions (such as coyote bush – which is predicted to colonize on its own) to the species lists. Additional modifications were needed to compensate some species that could not be provided by our suppliers. Substitutions were made in those cases. Additional substitutions have since been suggested by Literacy for Environmental Justice to compensate for some propagation shortfalls. Revisions to the plant palette will be reviewed as needed.

Propagation lists are provided on the subsequent three pages.

Year 1 Plant order from Literacy from Environmental Justice. To be planted winter 2013-2014					
Species	Common name	Container Size and Type	# of plants requested	Price per plant	Cost
<i>Achillea millefolium</i>	yarrow	stubbie	20	\$1.75	\$35.00
<i>Aesculus californica</i>	California buckeye	15 gal	9	Donated by LEJ. Each plant valued at \$50.	\$0.00
<i>Anaphalis margaritacea</i>	pearly everlasting	stubbie	70	\$1.75	\$122.50
<i>Artemisia californica</i>	California sage	stubbie	70	\$1.75	\$122.50
<i>Artemisia douglasiana</i>	mugwort	D16	375	\$4.00	\$1,500.00
<i>Danthonia californica</i>	California oat grass	stubbie	50	\$1.75	\$87.50
<i>Elymus glaucus</i>	blue wild rye	stubbie	135	\$1.75	\$236.25
<i>Elymus triticoides</i>	creeping wildrye, alkali wildrye	salvaged plug	300	\$3.00	\$900.00
<i>Eriogonum latifolium</i>	coast buckwheat	stubbie	70	\$1.75	\$122.50
<i>Eschscholzia californica</i>	California poppy	stubbie	45	\$1.75	\$78.75
<i>Festuca idahoensis</i>	Idahoe fescue	stubbie	150	\$1.75	\$262.50
<i>Festuca rubra</i>	red fescue	stubbie	150	\$1.75	\$262.50
<i>Hordeum brachyantherum</i>	meadow barley	stubbie	350	\$1.75	\$612.50
<i>Iris douglasiana</i>	Douglas iris	stubbie	80	\$1.75	\$140.00
<i>Lupinus albifrons</i>	silver bush lupine	D16	70	\$4.00	\$280.00
<i>Lupinus arboreus</i>	yellow bush lupine	D16	25	\$4.00	\$100.00
<i>Quercus agrifolia</i>	coast live oak	15 gal	9	Donated by LEJ. Each plant valued at \$50.	\$0.00
<i>Scrophularia californica</i>	California bee plant	D16	65	\$4.00	\$260.00
<i>Sisyrinchium bellum</i>	blue eyed grass	plugs	100	\$1.00	\$100.00
<i>Stipa pulchra</i>	purple needle grass	stubbie	250	\$1.75	\$437.50
<i>Symphyotrichum chilense</i>	common aster	stubbie	200	\$1.75	\$350.00
Totals			2,593		\$6,010.00

Year 2-3 Plant request: to be planted winters 2014-2015 and 2015-2016							
Species	Common name	Container Size and Type	# of plants requested	Price per plant	Cost	Notes from Patrick Rump, LEJ Director and Nursery Manager	Planting Year
<i>Carex barbarae</i>	basket sedge, whiteroot	D16	350	\$4.00	\$1,400.00	Need to find parent population	2
<i>Carex praegracilis</i>	meadow sedge, field sedge	D16	350	\$4.00	\$1,400.00	Need to find parent population	2
<i>Castilleja exserta</i>	Indian paintbrush	D16	60	\$4.00	\$240.00	Possibly this or a different paintbrush	2
<i>Ceanothus thyrsiflorus</i>	coast lilac	D40	15	\$7.00	\$105.00		2
<i>Chlorogalum pomeridianum</i>	soap root	stubbie	45	\$1.75	\$78.75		2
<i>Elymus x multiflorus</i>	giant creeping wildrye	stubbie	600	\$1.75	\$1,050.00		2
<i>Heliotropium curassavicum</i>	wild heliotrope	stubbie	200	\$1.75	\$350.00		2
<i>Iva axillaris</i>	poverty weed	stubbie	25	\$1.75	\$43.75		2
<i>Juncus effusus</i>	common rush	D16	15	\$4.00	\$60.00		2
<i>Juncus patens</i>	blue rush	D16	15	\$4.00	\$60.00		2
<i>Koeleria macrantha</i>	June grass	stubbie	100	\$1.75	\$175.00		2
<i>Lomatium caruifolium</i>	caraway leaved lomatium	stubbie	50	\$1.75	\$87.50	Yes or another <i>Lomatium</i> is possible	2
<i>Lotus scoparius</i>	deer weed	stubbie	55	\$1.75	\$96.25	Need to find parent population	2
<i>Phacelia californica</i>	California phacelia	D16	60	\$4.00	\$240.00		2
<i>Ranunculus californica</i>	California buttercup	stubbie	30	\$1.75	\$52.50		2
<i>Salix</i>	willow					Water dependent	2
<i>Dichelostemma congestum (or capitatum?)</i>	blue dicks	stubbie	70	\$1.75	\$122.50	needs 2-3 years	3
<i>Prunus ilicifolia</i>	holly leaf cherry	D40	13	\$7.00	\$91.00	needs 1-2 years	3
<i>Triteleia laxa</i>	Ithuriel's spear	stubbie	40	\$1.75	\$70.00	needs 3 years	3
Totals			2,093		\$5,722.25		

Seed order for Pacific Coast Seed. Seeds to be applied with rains in early winter 2013-2014.					
Species	Common name	Live seed per pound	Strike Price per pound	Pounds requested	Price for requested pounds
<i>Amsinckia menziesii subsp. intermedia</i>	Menzies' fiddleneck	230,000	\$145.00	2	\$290.00
<i>Bromus carinatus</i>	California brome	76,000	\$10.00	6.5	\$65.00
<i>Calandrinia ciliata</i>	red maids	1,600,000	\$80.00	0.2	\$16.00
<i>Centromadia pungens</i>	spikeweed	1,100,000	\$750.00	0.1	\$75.00
<i>Clarkia rubicunda</i>	farewell to spring	1,300,000	\$110.00	0.3	\$33.00
<i>Lasthenia californica</i>	California goldfields	4,000,000	a	0.2	\$24.00
<i>Layia platyglossa</i>	tidy tips	500,000	\$75.00	0.2	\$15.00
<i>Lotus purshianus</i>	Spanish clover	101,000	\$85.00	0.2	\$17.00
<i>Lupinus bicolor</i>	dwarf lupine	100,000	\$45.00	3.5	\$157.50
<i>Lupinus nanus</i>	sky lupine	45,000	\$50.00	3.2	\$160.00
<i>Trifolium fucatum</i>	bull clover	90,000	\$85.00	0.2	\$17.00
<i>Trifolium gracilentum</i>	pinpoint clover	400,000	\$60.00	0.2	\$12.00
<i>Trifolium wildenovii</i>	tomcat clover	400,000	\$50.00	2.5	\$125.00
Totals				19.30	\$1,006.50

Planting plan

Plants will be installed with the help of volunteers during the winter months, when rain provides natural irrigation. Golden Gate Audubon holds a monthly volunteer program at Pier 94 every first Saturday of the month. New plantings are watered with water carried out to the site on the day of planting. In the event that rains do not coincide with these monthly planting dates, supplemental watering may be necessary to help establish new outplants. Golden Gate Audubon Society is considering the feasibility of watering plants from rainwater impounded nearby in an open concrete box.

The first planting occurred November 2, 2013. Over about two hours, fourteen people planted two hundred meadow barley plants into the swale area in the southern portion of the site. This area is rockier and has more clay than much of the other areas on site and therefore is more challenging to dig and plant into. Large mattocks worked well to dig planting holes. Other tools such as hand picks, dibbles, and rock bars will be used in softer planting conditions.

Seeding plan

Seeds will be applied throughout the site by Literacy for Environmental Justice. Seeding will be hand-sown on a day preceding predicted rains. An attempt will be made to cover seeds with soil to prevent predation by birds and other wildlife and also to prevent loss to winds blowing seeds off-site. Seeding is planned for to coincide with rains in early winter 2013-2014.



Top: Volunteers planting the swale on November 2, 2013.

Bottom: *Bromus carinatus* seeds.



Top: Volunteer group November 2, 2013. Photo by Lee Karney.

Bottom: First planting (200 meadow barley plants) in the new swale November 2, 2013.

Photo Points

Photo points were established by Mike Perlmutter and Noreen Weeden on April 9, 2012 prior to upland enhancement activities at Pier 94. Photos from points 1-5 were taken during and after construction activities during the summer of 2013. Post grading photos taken on June 21, 2013 are presented below pre-enhancement photos from April 9, 2012 to demonstrate visual changes to the site.

Subsequent photos will be taken from points 1-5 during and after restoration in order to visually show changes over time at the site. Points 6-8 do not capture much of the site affected by restoration activities and were therefore abandoned. Photos should be taken annually in April-May to coincide with vegetation sampling, and during any significant restoration action occurring at the site.

Map of Photopoint Locations



Photopoint 1 located at the edge of the site at the northwest fence corner, 220° bearing.



Photopoint 2A, Located 140° bearing and 19.5 meters from Photopoint 1. Photo angle 185° .



Photopoint 2B at 297°.



Photopoint 3 at corner of the fence by the site entrance. Photo bearing at 60°.



Photopoint 4, fence corner. Photo at 145°.



Photopoint 4, fence corner. Photo at 38° bearing.



Photopoint 5, 23 meters at 95° from Photopoint 4. Photot at 180°.



Photo 5B at 35°.



Discussion

Major on the ground advances have occurred at the Pier 94 upland habitat enhancement project in 2013. Sediment donations were secured and delivered and now cover the site with a new surface clean of weeds and ready for the introduction of native plants. Native plantings commenced in November and will continue through the winter and spring with the help of monthly volunteer programs that will install approximately 2,500 plants. Additional native plants will be seeded in to add native vegetation in this first year of revegetation efforts. Controlling invasive plants on and around the site will be a key component of establishing native plant communities, which could easily be outcompeted by colonizing invasive plants that are well established in the area.

These efforts are aimed at transforming the site into a robust native plant community that will be the basis for an oasis of native wildlife habitat within a highly urbanized and industrialized portion of San Francisco. Enhancement of the upland habitats adjacent to Pier 94's wetland and beach habitat provides wildlife habitat connectivity along a gradient that rises up from the bay shore. Such connectivity is important to marsh wildlife that may need to seek shelter on higher ground during flooding from extreme high tides and/or storm surges. And in the event of sea level rise, such habitat connectivity allows shoreline habitat to retreat back and up to higher elevations – a key conservation concept in San Francisco Bay climate change adaptation planning.

The changes on the ground at Pier 94 have come about through the hard work, creativity, dedication, and persistence of a small staff at Golden Gate Audubon Society. With a modest budget and the help of diverse partners, Golden Gate Audubon has developed plans, obtained permits, and secured the in-kind donations and grant funding required to realize this project. Golden Gate Audubon is demonstrating a new approach to habitat restoration and enhancement. Careful documentation and monitoring should ensue to allow for adaptive management on site, and for the broader communication of the successes and challenges of these restoration techniques. Hopefully restoration at Pier 94 will continue successfully and can serve as a model for conservation work throughout San Francisco Bay.