DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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AND THE
COUNTY OF SAN MATEO

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1257–D SHEET 2 OF 2

SUMMARY	UNITS	ENGINEERING CHARACTER					PHYSICAL CHARACTER		
PREDOMINANT CHARACTER		EXPANSIVITY	CUT-SLOPE STABILITY	PERMEABILITY	EXCAVATABILITY	CHARACTER OF MATERIAL AS FILL	TEXTURE OF SURFICIAL MANTLE	PHYSICAL PROPERTIES OF BEDROCK	GEOLOGIC MAP UNITS
General composition and description of each engineering characteristic; see specific columns for details		Capability of bedrock and surficial mantle to swell significantly under light loads when wetted, expressed in terms related to UBC expansion index.	Estimated stability of 2:1 cut slopes 30 feet high in moderately weathered bedrock and 6 feet high in surficial mantle. Stability of bedrock is reported as average stability assuming random structural orientations, for conditions of adverse structural orientation, and for favorable structural orientation.	Permeability is estimated in four classes for three idealized cases: fresh bedrock at depth; shallow, moderately weathered bedrock; and saturated surficial mantle.	The estimated effectiveness in surficial mantle and weathered and fresh bedrock of a Case 580 or equivalent backhoe digging a 2-foot-wide trench, a Caterpillar D8 or equivalent crawler tractor with one tooth ripping on an open surface, or the probable necessity of heavier ripping or blasting.	The estimated presence, after excavation, handling, and compaction, of more than 1/3 clay or highly plastic clay or of more than 5 percent oversize rock fragments in fill derived from surficial mantle and moderately weathered and fresh bedrock.	Texture of surficial mantle likely to form from bedrock of unit by weathering, described as clayey or sandy (more or less than 1/4-1/3 clay), and ignoring the effects of downslope movement. Presence of a clayey subsoil (B horizon) reported for gentle slopes where known.	Description of basic geologic character of bedrock, from which most of the engineering characteristics are inferred, based largely on field observation.	Units on the geologic map (Brabb and Pampeyan, 1972a, with revised nomenclature of Brabb and Pampeyan, 1981) included in each materials unit
Sandstone and siltstone. Most bedrock and mantle unexpansive, some of each expansive. Cut-slope stability of bedrock moderate (approaching high), of mantle low. Permeability of bedrock and mantle largely low. Almost all can be trenched. Fill generally lacks clay and oversize fragments, but some is clayey.	A	Most bedrock unexpansive, some claystone beds and some clayey surficial mantle severely expansive.	Moderate (approaching high) average stability in bedrock. Moderate where structure is adverse, except low in clayey third of unit. High (approaching moderate) where structure is favorable. Low in mantle.	Intergranular permeability moderate to low, locally very low, at depth. In shallow bedrock, class unchanged by opening of fractures. Low in surficial mantle, except moderate where clayey subsoil lacking.	Surficial mantle and bedrock can be trenched, most of it with ease; local hard beds may require ripping or even blasting.	Generally lacks clay and oversize fragments, some clayey fill. In surficial mantle, some clayey fill, clay may be highly plastic. In moderately weathered and fresh material, some clayey fill, clay may be highly plastic; local hard blocks as large as 5 feet in diameter.	Clayey to sandy, subsoil generally clayey.	Composition: largely sandstone, siltstone, and claystone; sandstone medium to very fine grained and commonly silty, clayey, or conglomeratic; ratio of sandstone to siltstone and claystone probably less than 2:1; local conglomerate lenses, volcanic ash beds, and cemented shell-breccia beds. Hardness: firm to locally soft; sandstone soft and friable where weathered, ash beds friable, shell horizons and some conglomerate cemented and hard. Fracture: spacing moderate to very wide in sandstone, close in weathered clayey rock. Bedding: sandstone beds 5 to 30 ft thick, generally indistinct, locally distinct, commonly lenticular. Siltstone and claystone beds thin to very thick, commonly laminated; conglomerate beds as much as 4 ft thick; ash and shell beds as much as 5 or 6 ft thick. Stratigraphic thickness: 5,000 ft.	Merced Formation
Shale. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock and mantle low. Permeability largely very low at depth, low in shallow rock and mantle. Weathered bedrock and most fresh bedrock can be trenched, all can be ripped. Fill generally lacks oversize fragments, much is clayey.	B	Bedrock and surficial mantle generally unexpansive, but significantly expansive locally.	Low average stability in bedrock. Low where structure is adverse. Low to moderate where structure is favorable. Low in mantle.	Very low at depth, except low intergranular permeability in local interbedded sandstone. Low in shallow rock due to opening of fractures (limited by free clay). Low in surficial mantle.	Surficial mantle can be trenched with ease. Weathered bedrock can be trenched, much of it with ease. Most fresh bedrock can be trenched with difficulty and all can be ripped.	Generally lacks oversize fragments, but much clayey fill. In surficial mantle, largely clayey fill. In moderately weathered bedrock, clayey fill. In fresh bedrock, generally no clay or oversize fragments.	Generally clayey.	Composition: shale and some mudstone, few interbeds of sandstone. Hardness: soft to firm. Fracture: close spacing in weathered rock. Bedding: shale laminated; close to very close parting. Stratigraphic thickness: 6007?–800 ft.	Twohar Shale Member of San Lorenzo Formation; shale in Butano Sandstone
Mudstone. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock moderate (approaching low), of mantle low. Permeability largely very low at depth, largely low in shallow rock and mantle. Weathered bedrock and most fresh bedrock can be trenched, all can be ripped. Fill generally lacks oversize fragments, but much is clayey.	C	Bedrock and surficial mantle generally unexpansive, but significantly expansive locally.	Moderate (approaching low) average stability in bedrock. Low where structure is adverse. Moderate where structure is favorable. Low in mantle.	Very low at depth, low intergranular permeability in some interbedded sandstone. Low in shallow rock due to opening of fractures (limited by free clay). Low in surficial mantle, locally moderate(?).	Surficial mantle can be trenched with ease. Weathered bedrock can be trenched, much of it with ease. Most fresh bedrock can be trenched with difficulty and all can be ripped.	Generally lacks oversize fragments, but much clayey fill. In surficial mantle, largely clayey fill. In moderately weathered bedrock, clayey fill. In fresh bedrock, generally no clay or oversize fragments.	Generally clayey.	Composition: mudstone, siltstone, some shale, and minor sandstone. Hardness: firm to soft. Fracture: spacing where weathered very close to close, locally moderate; moderate to wide where fresh. Bedding: generally absent, locally laminated; some close to very close parallel parting. Stratigraphic thickness: 500 to 1,800 ft.	Lobitos Mudstone Member of Purisima Formation; Lambert Shale and San Lorenzo Formation, undivided; San Lorenzo Formation, undivided; Rices Mudstone Member of San Lorenzo Formation
Conglomerate and sandstone. Most bedrock and mantle unexpansive, but some of each expansive. Cut-slope stability of bedrock high, of mantle largely moderate, some low. Permeability in bedrock largely low, ranging from very low to moderate. In mantle largely moderate, some low to very low. Most bedrock can be trenched, all can be ripped. Fill generally lacks clay and oversize fragments, but some is clayey.	D	Most bedrock unexpansive, some claystone significantly expansive, some clayey surficial mantle severely expansive.	High average stability in bedrock. Moderate where structure is adverse. High where structure is favorable. Moderate average stability in mantle, low where mantle is clayey.	At depth, very low and low intergranular permeability in clayey and clay-poor bedrock, respectively; may be moderate locally. In shallow bedrock, minor increase in extent of low and moderate permeabilities by opening of fractures. Moderate in sandy surficial mantle, low to very low in clayey mantle.	Most surficial mantle can be trenched with ease, some clayey mantle may be sticky when wet and difficult to trench when dry. Most weathered and fresh rock can be trenched, much of it with difficulty, and all can be ripped.	Generally lacks clay and oversize fragments, but some highly plastic clay. In surficial mantle, some clayey fill, clay may be highly plastic. In moderately weathered and fresh bedrock, some clayey fill.	Largely sandy and some clayey, generally clayey subsoil on gentle slopes.	Composition: predominantly conglomerate, lesser sandstone, siltstone, and claystone; conglomerate of cobbles with poorly sorted sandstone or siltstone matrix, locally with boulders as large as several feet in diameter; sandstone fine to coarse grained. Hardness: firm to soft, conglomerate clasts hard. Fracture: none evident in conglomerate, close to moderate spacing in other rock types. Bedding: distinct to indistinct lenticular beds commonly several feet thick, ranging medium to very thick (307 ft). Stratigraphic thickness: 2,200 ft.	Santa Clara Formation
Clayey sandstone. Some bedrock and most mantle expansive. Cut-slope stability of bedrock moderate, of mantle very low. Permeability largely very low in bedrock and mantle. Most weathered and some fresh bedrock can be trenched, all can be ripped. Fill generally lacks clay and oversize fragments, but some is clayey.	E	Bedrock generally unexpansive, but some is significantly expansive, clayey mantle expansive.	Moderate average stability in bedrock. Low where structure is adverse. Moderate where structure is favorable. Very low in mantle.	At depth, very low intergranular permeability, low or moderate(?) in clay-poor sandstones. In shallow bedrock, class unchanged by opening of fractures. In surficial mantle, generally very low, locally low; moderate where mantle is sandy.	Surficial mantle can be trenched, most may be sticky when wet and difficult to trench when dry. Most weathered and some fresh bedrock can be trenched and all can be ripped.	Generally lacks clay and oversize fragments, but some highly plastic clay. In surficial mantle, generally clay fill, much clay may be highly plastic. In moderately weathered and fresh bedrock, generally no clay or oversize fragments.	Generally clayey, locally sandy.	Composition: fine-grained sandstone, siltstone, locally much silty mudstone, minor amounts of medium- to coarse-grained sandstone and porcellaneous shale and mudstone; clay or ash matrix in most fine-grained sandstone and siltstone, commonly none in medium- to coarse-grained sandstone. Hardness: firm where fresh, firm to soft where weathered; porcellaneous rock firm to hard. Fracture: spacing moderate to very wide in fine-grained sandstone where fresh, very close to moderate where weathered, and close in porcellaneous rock. Bedding: in fine-grained sandstone commonly absent to indistinct, local distinct beds medium to very thick; in other rock types thin to medium. Stratigraphic thickness: 250 to 2,150 ft (Tunitas Sandstone Member 250 to 400 ft, other units much thicker).	Tunitas Sandstone Member of Purisima Formation; Tahana Member of Purisima Formation; Purisima Formation, undivided; unnamed sandstone of Miocene age near Woodside
Sandstone. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock very high, of mantle largely moderate. Permeability of bedrock largely low to moderate, of mantle largely moderate. Most weathered and some fresh bedrock can be trenched, all can be ripped. Fill generally lacks clay and oversize fragments.	F	Bedrock and surficial mantle generally unexpansive, local clayey mantle significantly expansive.	Very high average stability in bedrock, both where structure is adverse and favorable. Moderate average stability in mantle, low where clayey subsoil present.	Very low to high intergranular permeability at depth, depending on presence of cement and grain size and sorting. In shallow bedrock, minor increase in extent of low and moderate permeabilities by opening of fractures. In surficial mantle, largely moderate, low to very low where clayey subsoil present.	Most surficial mantle can be trenched with ease. Most weathered and some fresh bedrock can be trenched, much with ease, and all bedrock can be ripped.	Generally lacks clay and oversize fragments. In surficial mantle, generally no clay or oversize fragments. In moderately weathered and fresh bedrock, local oversize fragments north of Pescadero Creek.	Sandy, clayey subsoil variably present.	Composition: very fine to coarse-grained sandstone, variably sorted, concretions as large as 1 ft in diameter. Hardness: firm to locally soft and friable where weathered, probably firm where fresh, concretions hard. Fracture: spacing where weathered very close to moderately wide. Bedding: absent to indistinct, very thick beds. Stratigraphic thickness: 150 to 450 ft.	San Gregorio Sandstone Member of Purisima Formation; Santa Margarita Sandstone
Sandstone and shale. Much bedrock and mantle expansive. Cut-slope stability of bedrock moderate, of mantle low (ranging from moderate to very low). Permeability low to very low at depth, low in shallow bedrock, moderate to very low in mantle. Much weathered bedrock can be trenched, all can be ripped; most fresh bedrock can be ripped, some may require heavy ripping or blasting. Fill generally lacks oversize fragments, but some is clayey.	G	Clayey surficial mantle and much clayey bedrock expansive.	Moderate average stability in bedrock, both where structure is adverse and favorable. Low average stability in mantle, very low where mantle is clayey, moderate where sandy.	Low intergranular permeability at depth in sandstone, very low where cemented, very low in clayey rock. In shallow bedrock, clayey rock low (limited by free clay), but sandstone class unchanged, due to opening of fractures. In surficial mantle, largely very low to low where mantle is clayey, moderate where sandy.	Sandy surficial mantle can be trenched with ease, clayey mantle may be sticky when wet and difficult to trench when dry. Much weathered bedrock can be trenched, except for some sandstone, and all can be ripped. Much fresh clayey bedrock can be trenched with difficulty, most fresh bedrock can be ripped, some cemented sandstone may require heavy ripping or blasting.	Generally lacks oversize fragments, but some highly plastic clay. In surficial mantle, some clayey fill, much clay may be highly plastic. In moderately weathered bedrock, some clayey fill, clay may be highly plastic. In fresh bedrock, some clayey fill, clay may be highly plastic; local oversize fragments as much as 1 to 3 feet across.	Sandy to clayey depending on local bedrock, local clayey subsoil.	Composition: sandstone with variably abundant interbeds of mudstone, siltstone, and shale; sandstone commonly medium to very coarse grained and poorly sorted, but with no clay matrix; in places, carbonate cement in thicker sandstone beds; clayey rock locally abundant. Hardness: sandstone firm where fresh, hard where cemented, firm to soft and friable where weathered; clayey interbeds firm to soft. Fracture: spacing commonly moderate to wide in sandstone, close to very close in weathered clayey interbeds. Bedding: distinct; sandstone beds thin to very thick (30 ft), commonly more than 10 ft thick, clayey interbeds thin to very thick. Stratigraphic thickness: 2,500 ft.	Butano(?) Sandstone
Serpentine with gouge and hard blocks. Bedrock and mantle largely unexpansive, some of each expansive. Cut-slope stability of bedrock moderate (ranging from high to very low), of mantle moderate to low, some very low. Permeability very low at depth; largely low in shallow bedrock, some very low; largely moderate to low in mantle, some very low. Most bedrock can be trenched, some requires ripping, and blocks may require blasting. Most fill lacks clay, but some is clayey; oversize fragments are common.	H	Gouge and clayey surficial mantle expansive.	Moderate average stability in bedrock, including high average stability in sheared serpentinite and very low average stability in gouge borders. In sheared serpentinite, moderate where structure is adverse, high where structure is favorable. Moderate to low average stability in mantle, very low in clayey mantle.	Very low at depth. In shallow bedrock, generally low to locally moderate due to opening of fractures in gouge borders. Moderate in surficial mantle, except low to very low where mantle is clayey.	Surficial mantle can be trenched, clayey mantle may be sticky when wet and difficult to trench when dry. Most gouge can be trenched, some with difficulty, but may be sticky when wet and difficult to trench when dry. Sheared serpentine can be trenched, most with difficulty where fresh; some fractured ultramafic rock can be trenched, all can be ripped. Large hard blocks may require blasting.	Much fill lacks clay, some is clayey and highly plastic; oversize fragments common. In clayey surficial mantle and gouge, clayey fill that may be highly plastic. In sheared serpentinite, common oversize fragments as much as 10 feet or more in diameter. In unsheared, fractured ultramafic rock, oversize fragments common.	Generally thin and rocky, locally clayey (probably in association with gouge).	Composition: sheared serpentinite containing blocks of serpentinite, ultramafic rock, schist, rodingite, and silica-carbonate rock, and locally masses 100 ft or more in diameter of fractured ultramafic rock; borders of clayey gouge. Hardness: sheared serpentinite firm to soft, fractured ultramafic rock hard to firm, blocks hard; gouge soft to firm. Fracture: spacing of shear planes very close to close; spacing of fractures in ultramafic masses moderate to wide, hard blocks a few inches to tens of feet in diameter, commonly less than 10 ft. Bedding: shear planes define a very close to close, commonly parallel, parting. Stratigraphic thickness: much of unit probably stratiform and 100 to 200 ft thick, locally may extend thousands of feet deep.	Serpentine
Gouge and sheared shale with hard blocks and sandstone. Much of the bedrock and mantle expansive. Cut-slope stability of bedrock moderate (ranging from very low to very high), of mantle low, ranging from very low to moderate. Permeability very low at depth; mostly low, some very low, in shallow bedrock; moderate to very low in mantle. Most weathered and some fresh bedrock can be trenched; much fresh bedrock can be ripped, but much requires heavy ripping or blasting. Much fill lacks clay and oversize fragments, but some is clayey and some contains oversize fragments.	I	Gouge, much severely sheared shale, and much clayey surficial mantle expansive.	Moderate average stability in bedrock; ranges from very low in gouge and severely sheared shale (1/4 of unit) to very high in fractured sandstone (1/2 of unit). Moderate where sandstone is adverse. Moderate where structure is favorable. Low average stability in mantle; ranges from very low in expansive clayey mantle to moderate in sandy mantle.	Very low at depth. In shallow bedrock, gouge very low, but sandstone low to locally moderate, and some less severely sheared shale low (limited by free clay), due to opening of fractures. Low to very low in clayey surficial mantle, moderate where sandy.	Sandy surficial mantle can be trenched with ease, clayey mantle may be sticky when wet and difficult to trench when dry. Gouge and severely sheared shale can be trenched, easily where weathered, some with difficulty where fresh, and may be sticky when wet and difficult to trench when dry. Most other bedrock can be trenched where weathered, largely with difficulty, some fresh bedrock can be trenched with difficulty and much can be ripped, and most fresh unbedded sandstone requires heavy ripping or blasting. Large hard blocks in sheared matrix or on ground surface may require blasting.	Much fill lacks clay and oversize fragments, some is clayey and highly plastic, some contains oversize fragments. In surficial mantle, some clayey fill, clay may be highly plastic. In gouge and severely sheared shale, clayey fill, clay may be highly plastic; many oversize fragments. In moderately weathered bedrock and sandstone, generally no clay or oversize fragments. In fractured sandstone, fill like that of unit P.	Clayey on sheared shale and gouge, sandy on sandstone.	Composition: graywacke-type sandstone, gouge, and variably sheared shale and siltstone containing blocks of sandstone, greenstone, chert, and other Franciscan rocks. Hardness: gouge and severely sheared shale soft to firm, shale firm to hard, sandstone hard where fresh and hard to firm where weathered, blocks hard. Fracture: approximately one-fourth of unit is gouge and severely sheared shale in which spacing of shear planes is less than 1/4 in., and blocks cover tens of feet in diameter; remainder of unit is moderately sheared shale and siltstone with shear spacing of 1/4–1 in., which contains discontinuous bodies of closely fractured sandstone; approximately half is closely fractured sandstone. Bedding: shear planes define very close to moderately spaced, crudely parallel parting through sheared half of unit; rare distinct bedding planes in sandstone. Stratigraphic thickness: hundreds of feet.	Sheared rocks of Franciscan assemblage
Porcelaneous shale and mudstone. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock high, of mantle low. Permeability largely very low at depth, largely low in shallow bedrock, moderate to low in mantle. Weathered bedrock and some fresh bedrock can be trenched, all can be ripped. Fill generally lacks clay and oversize fragments.	J	Bedrock and surficial mantle generally unexpansive, but significantly expansive locally where bedrock is not siliceous.	High average stability in bedrock. Moderate to high where fracture is adverse, moderate where bedding is adverse. Very high where structure is favorable. Low average stability in mantle; ranges from moderate in sandy mantle to low in clayey mantle.	At depth, largely very low, except low intergranular permeability in interbedded sandstone. In shallow rock, low to locally moderate due to opening of fractures. In surficial mantle, moderate to low.	Surficial mantle can be trenched with ease, weathered bedrock can be trenched, some fresh bedrock can be trenched with difficulty, and all can be ripped.	Generally lacks clay and oversize fragments.	Sandy to clayey.	Composition: porcelaneous shale and mudstone, some chert, some nonsiliceous mudstone, local sandstone. Hardness: typically hard to firm and brittle, chert hard, nonsiliceous mudstone firm to soft, sandstone firm to hard. Fracture: spacing very close to close, locally moderate. Bedding: absent to distinct; medium to very thick beds, chert and some porcelaneous rock laminated; very close to local moderately spaced parallel parting in places. Stratigraphic thickness: 400 to 5,000 ft.	Pomponio Mudstone Member of Purisima Formation; Santa Cruz Mudstone; Lambert Shale
Basaltic volcanic rock. Bedrock unexpansive, most mantle expansive. Cut-slope stability of bedrock very high, of mantle very low. Permeability very low at depth, low to moderate in shallow bedrock, very low to low in mantle. Most weathered bedrock can be trenched, all weathered bedrock and most fresh bedrock can be ripped. Fill generally lacks clay and oversize fragments, but some is clayey.	K	Bedrock unexpansive, most clayey surficial mantle expansive.	Very high average stability in bedrock. High where structure is adverse. Very high where structure is favorable. Very low in mantle.	At depth, very low to low intergranular and fracture permeability. In shallow bedrock, low to moderate fracture and intergranular permeability. In surficial mantle and decomposed basalt, generally low to very low.	Surficial mantle can be trenched, may be sticky when wet and difficult to trench when dry. Most weathered bedrock can be trenched, some with difficulty, and all can be ripped. Probably all fresh bedrock can be ripped.	Generally lacks clay and oversize fragments, but some highly plastic clay and oversize fragments. In surficial mantle and decomposed basalt, generally clayey fill, and clay may be highly plastic; oversize fragments in some places. In moderately weathered and fresh bedrock, oversize fragments in some places.	Generally clayey. Decomposed basalt locally tens of feet deep.	Composition: chiefly fine-grained basaltic rock; flow breccia of 1- to 12-in. blocks with glass or calcite matrix, dense to vesicular flows, pillow lavas with 2- to 5-ft pillows in glass or tuff matrix, agglomerate, less abundant tuff and medium- to coarse-grained intrusive rocks, minor amounts of sandstone and mudstone; in places weathered to clayey, decomposed basalt to depths of tens of feet. Hardness: fresh crystalline rock hard, glass and tuff probably firm; weathered rock generally firm to soft; glass and tuff more easily weathered; decomposed basalt firm to soft, commonly with hard, spheroidal weathering cores of small to large size. Fracture: spacing close to moderate, locally wide. Bedding: indistinct to locally distinct, much rock unbedded. Stratigraphic thickness: variable, 60 to 4,000 ft.	Page Mill Basalt; Mindego Basalt and related volcanic rocks; unnamed volcanic rocks west of Pescadero
Basaltic volcanic rock. Bedrock unexpansive, much mantle expansive. Cut-slope stability of bedrock very high, of mantle low to very low. Permeability very low at depth, largely low in shallow bedrock, low to very low in mantle. Most weathered bedrock can be trenched, all can be ripped; much fresh bedrock can be ripped, some may require heavy ripping or blasting. Fill generally lacks clay and oversize fragments, but some is clayey and some contains oversize fragments.	L	Bedrock unexpansive, much clayey surficial mantle expansive.	Very high average stability in bedrock. High where structure is adverse. Very high where structure is favorable. Low to very low in mantle.	Very low at depth. In shallow bedrock, low to locally moderate due to opening of fractures. In surficial mantle, generally low to very low.	Surficial mantle can be trenched, much may be sticky when wet and difficult to trench when dry. Most weathered bedrock can be trenched, some with difficulty, and all can be ripped. Much fresh bedrock can be ripped, some may require heavy ripping or blasting.	Generally lacks clay and oversize fragments, but some highly plastic clay and oversize fragments. In surficial mantle, generally clayey fill, and clay may be highly plastic. In moderately weathered bedrock, generally no clay or oversize fragments. In fresh bedrock, oversize fragments common.	Generally clayey.	Composition: altered basaltic volcanic rock as flows, pillow lava, breccia, tuff breccia, and tuff in unknown proportions, minor amounts of intrusive rock, and a few chert and limestone bodies. Hardness: fresh rock generally hard, weathered rock firm to hard, but locally soft. Fracture: spacing close to locally moderate in weathered rock; in fresh rock probably moderate to wide, locally very wide. Bedding: indistinct to absent. Stratigraphic thickness: variable, tens of feet to possibly 5,000 ft.	Greenstone of Franciscan assemblage
Sandstone and shale. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock moderate (approaching high), of mantle low. Permeability of bedrock and mantle largely low. Most weathered and some fresh bedrock can be trenched, most of remainder can be ripped, some fresh bedrock may require heavy ripping or blasting. Much fill lacks clay and oversize fragments, but some is clayey and some contains oversize fragments.	M	Bedrock and clayey surficial mantle generally unexpansive, but significantly expansive locally.	Moderate (approaching high) average stability in bedrock. Low where fracture is adverse, very low where bedding is adverse. Very high where structure is favorable. Generally low in mantle.	At depth, low intergranular permeability in sandstone, very low where cemented and in clayey rock. In shallow bedrock, sandstone class unchanged, but clayey rock low (limited by free clay), due to opening of fractures. In surficial mantle, low to moderate.	Surficial mantle can be trenched with ease, most weathered bedrock can be trenched. Some fresh bedrock can be trenched with difficulty, most can be ripped, some may require heavy ripping or blasting.	Much fill lacks clay and oversize fragments, some is clayey, oversize fragments present in some places. In surficial mantle, generally clayey fill. In moderately weathered bedrock, much clayey fill, oversize fragments in some places. In fresh bedrock, oversize fragments in some places.	Most clayey, some sandy.	Composition: interbedded sandstone and mudstone with minor amounts of shale; sandstone commonly very fine to fine grained, but medium to very thick beds coarser. Hardness: hard to firm where fresh, hard to soft where weathered. Fracture: spacing close to wide; generally close in thin to medium sandstone beds and moderate to wide in thicker beds; in mudstone close to moderate where fresh, very close where weathered. Bedding: distinct, commonly very thin to thin, some medium; medium to very thick sandstone beds with minor amounts of shale form a few sequences 25 to 100 ft thick. Stratigraphic thickness: more than 2,500 ft.	Butano Sandstone west of Skyliondа
Sandstone and shale. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock moderate (approaching high), of mantle low. Permeability largely very low at depth, largely low in shallow bedrock and mantle. Most weathered bedrock can be trenched, all bedrock can be ripped. Much fill lacks clay and oversize fragments, but some is clayey and some contains oversize fragments.	N	Bedrock and surficial mantle generally unexpansive, some mantle and local bedrock significantly expansive.	Moderate (approaching high) average stability in bedrock. Low where fracture is adverse, very low where bedding is adverse. Very high where structure is favorable. Low in mantle.	At depth, very low to locally low intergranular permeability. In shallow bedrock, low to locally moderate due to opening of fractures. In surficial mantle low, except moderate where sandy.	Surficial mantle can be trenched with ease; most weathered bedrock can be trenched, some with difficulty. All fresh bedrock can be ripped.	Much fill lacks clay and oversize fragments, some is clayey and some contains oversize fragments. In surficial mantle, generally clayey fill. In moderately weathered bedrock, some clayey fill. In fresh bedrock, some oversize fragments.	Clayey to locally sandy.	Composition: rhythmically interbedded sandstone and shale, conglomerate of cobbles and boulders (some as much as 5 ft in diameter) near middle of section, calcite cement common in fresh rock. Hardness: sandstone hard where fresh, firm where weathered; shale firm to hard where fresh, firm to soft where weathered; fresh conglomerate clasts hard, weathered boulders and some cobbles firm to soft; other cobbles hard. Fracture: spacing very close to moderate, locally wider, close in weathered shale. Bedding: distinct, rhythmic sandstone beds, thin to medium, locally thick; very close, imperfect bedding-plane parting in shale. Stratigraphic thickness: 3,800 ft; conglomerate 160 ft.	Unnamed sandstone, shale, and conglomerate of Paleocene age near Point San Pedro
Sandstone and some sheared shale with gouge and hard blocks. Most bedrock and mantle expansive, some of each unexpansive. Cut-slope stability of bedrock moderate (approaching high), some very low; of mantle moderate, some very low. Permeability very low at depth; largely low (ranging from very low to moderate) in shallow bedrock; largely moderate (some extending to very low) in mantle. Most weathered bedrock can be trenched; much fresh bedrock can be ripped, but much requires heavy ripping or blasting. Much fill lacks clay and oversize fragments, but some is clayey and some contains oversize fragments.	P	Bedrock and surficial mantle generally unexpansive; gouge, severely sheared shale, and clayey surficial mantle expansive.	Moderate (approaching high) average stability in bedrock, despite very low in sheared shale (1/10 of unit). Moderate approaching high where structure is adverse. Very high where structure is favorable, very low in sheared shale. Moderate average stability in mantle, very low in clayey tenth of unit.	Very low at depth. In shallow bedrock, gouge and severely sheared shale very low, but moderately weathered sandstone and shale low to locally moderate; due to opening of fractures. Moderate in sandy surficial mantle, low to very low in clayey mantle.	Sandy surficial mantle can be trenched with ease, clayey mantle may be sticky when wet and difficult to trench when dry. Most weathered sandstone and shale can be trenched, largely with difficulty; fresh sandstone and shale can be ripped where bedding or well-developed shear surfaces are closer than 3 feet, elsewhere requires heavy ripping or blasting. Gouge and severely sheared shale can be trenched, easily where weathered, some with difficulty where fresh; may be sticky when wet and difficult to trench when dry.	Much fill lacks clay and oversize fragments, some is clayey and some contains oversize fragments. In surficial mantle, generally no clay or oversize fragments, except clayey over gouge and sheared shale, clay may be highly plastic. In moderately weathered sandstone, generally no clay or oversize fragments. In fresh sandstone, some oversize fragments. In gouge and sheared shale, clayey fill, may be highly plastic; many oversize fragments.	Generally sandy; clayey over gouge and severely sheared shale.	Composition: sandstone and approximately 1/5 interbedded siltstone and shale in sequences locally 10 to several hundred ft thick; local pebble and cobble conglomerate; some variably sheared siltstone, shale, and gouge; gouge and severely sheared shale and siltstone constitute approximately 1/10 of the unit, and occur in zones less than 500 ft wide, commonly less than 100 ft wide. Hardness: hard where fresh, firm to locally soft where weathered, conglomerate clasts hard to firm, gouge and severely sheared shale soft to firm. Fracture: spacing close, locally moderate, in most rock; some rock variably sheared; gouge and severely sheared rock with shear spacing less than 1/4 in. constitutes approximately 1/10 of the unit. Bedding: absent in some sandstone; much distinct, thin to very thick (25 ft) bedding in sandstone sequences and in similar sandstone beds in siltstone and shale sequences that reach several hundred feet in thickness; local conglomerate layers and lenses 1 to 700 ft thick; shear planes define very close to moderately spaced parallel parting in severely sheared tenth of unit. Stratigraphic thickness: thousands of feet.	Sandstone of Franciscan assemblage; Conglomerate of Franciscan assemblage; Franciscan assemblage undivided
Sandstone and shale. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock high, of mantle moderate. Permeability low to very low at depth, largely low in shallow bedrock, largely moderate in mantle. Most weathered and some bedrock can be trenched, most of remainder can be ripped, some fresh bedrock may require heavy ripping or blasting. Fill generally lacks clay and oversize fragments.	Q	Bedrock and surficial mantle largely unexpansive, but significantly expansive locally.	High average stability in bedrock. Moderate where fracture is adverse, low where bedding is adverse. Very high where structure is favorable. Generally moderate in mantle.	Low intergranular permeability at depth in sandstone, very low where cemented and in clayey rock. In shallow bedrock, sandstone class unchanged, but clayey bedrock low (limited by free clay), due to opening of fractures. Moderate in most surficial mantle; locally low to very low.	Surficial mantle can be trenched with ease. Most weathered bedrock can be trenched, some with difficulty, thick to very thick sandstone beds can be ripped. Most fresh, thin- to medium-bedded sandstone and shale can be trenched with difficulty; most fresh bedrock can be ripped, some hard, very thick sandstone beds may require heavy ripping or blasting.	Generally lacks clay and oversize fragments. In surficial mantle, local clayey fill. In moderately weathered bedrock, generally no clay or oversize fragments. In fresh bedrock, local oversize fragments.	Largely sandy, local clayey subsoil.	Composition: sandstone, mudstone, and shale; sandstone fine to medium grained, moderately to well sorted, carbonate cement common in thicker beds. Hardness: hard to firm where fresh, firm to soft where weathered. Fracture: spacing ranges from close to very wide (6 ft), commonly moderate to wide; close to very close in weathered clayey rock. Bedding: distinct sandstone beds medium to very thick (tens of feet), commonly 1 to 10 ft; sequences of clayey rock thin to very thick (10 ft). Stratigraphic thickness: variable, from a few feet to 3,000 ft or more.	Vaqueros Sandstone; Butano Sandstone between Pilarcitos and San Andreas faults
Sandstone and minor shale. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock high, of mantle moderate. Permeability largely low in bedrock, largely moderate in mantle. Most fresh and weathered bedrock requires ripping, some fresh bedrock may require heavy ripping or blasting. Fill generally lacks clay and oversize fragments, but some contains oversize fragments.	R	Bedrock and surficial mantle largely unexpansive, but significantly expansive locally.	High average stability in bedrock. Moderate (approaching high) where fracture is adverse, low where bedding is adverse. Very high where structure is favorable. Moderate in mantle.	At depth, low to locally moderate(?) intergranular permeability in sandstone, very low where cemented and in clayey rock. In shallow bedrock, sandstone class unchanged, but clayey rocks low (limited by free clay), due to opening of fractures. In surficial mantle, moderate to locally low.	Surficial mantle can be trenched with ease. Most weathered bedrock can be trenched, locally, most fresh and weathered bedrock can be ripped. Hard, very thick sandstone beds with wide to very wide fracture spacing may require heavy ripping or blasting.	Generally lacks clay and oversize fragments, but oversize fragments in some places. In surficial mantle and moderately weathered bedrock, generally no clay, but some oversize fragments. In fresh bedrock, some oversize fragments.	Largely sandy, local clayey subsoil.	Composition: sandstone and less than 10 percent mudstone and shale; sandstone very fine to very coarse grained, some thicker beds carbonate cemented; local conglomerate of pebbles, cobbles, and boulders as much as several feet in diameter; clayey rock in sequences locally as thick as 200 ft. Hardness: sandstone firm to hard where fresh, hard where cemented, firm to soft and friable where weathered; conglomerate clasts hard; clayey rock firm to soft. Fracture: spacing moderate to very wide, locally close; in weathered clayey rock close to very close. Bedding: medium to very thick (30 ft), distinct to locally indistinct. Stratigraphic thickness: 500 ft near Half Moon Bay, 9,000 ft at Butano Ridge.	Lompico Sandstone; Butano Sandstone near Butano Ridge
Sandstone, conglomerate, mudstone and shale. Bedrock and mantle largely unexpansive. Cut-slope stability of bedrock high, of mantle largely low. Permeability very low at depth, largely low in shallow bedrock, moderate to low in mantle. Some weathered bedrock can be trenched, most of remainder can be ripped, some rock may require heavy ripping or blasting. Fill generally lacks clay, some contains oversize