Figure 4.13
Width-to-depth ratio plotted against drainage area

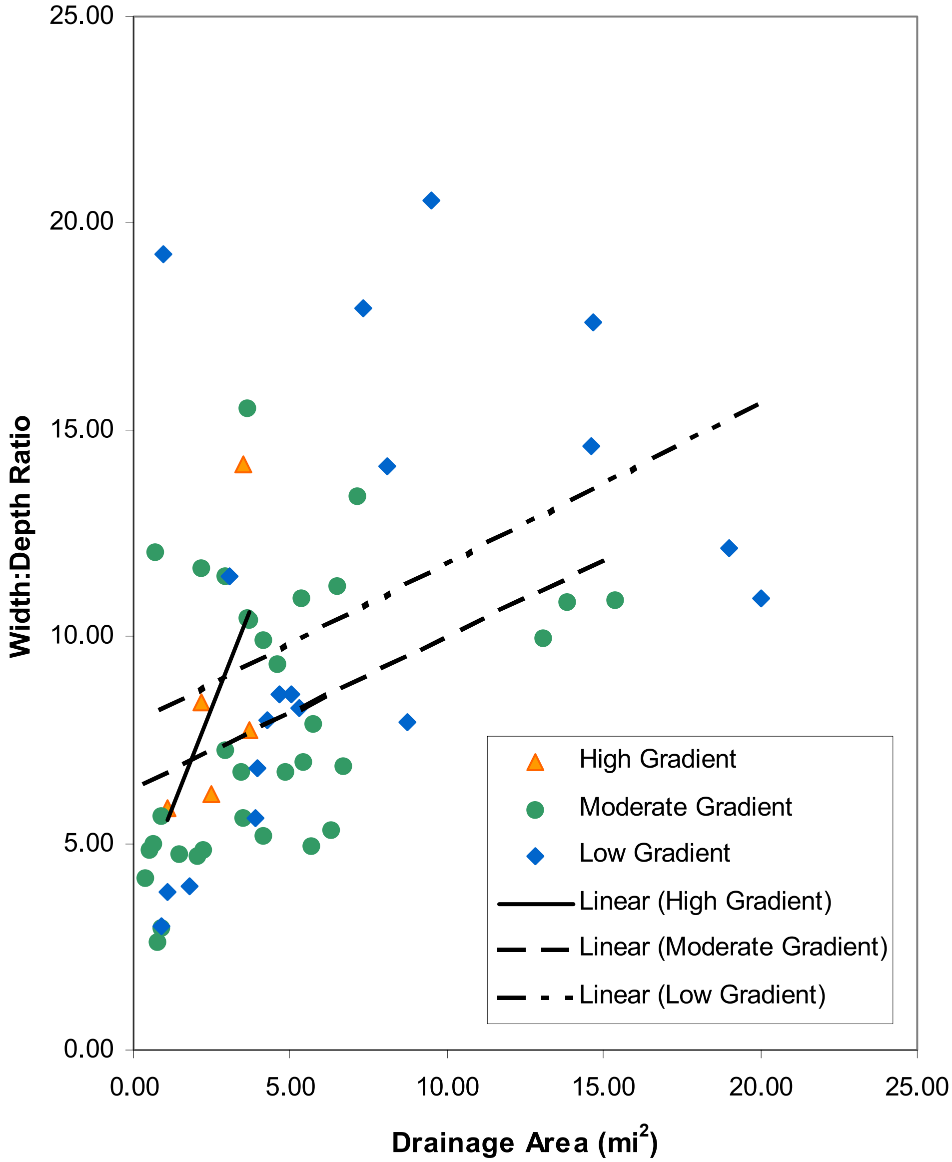
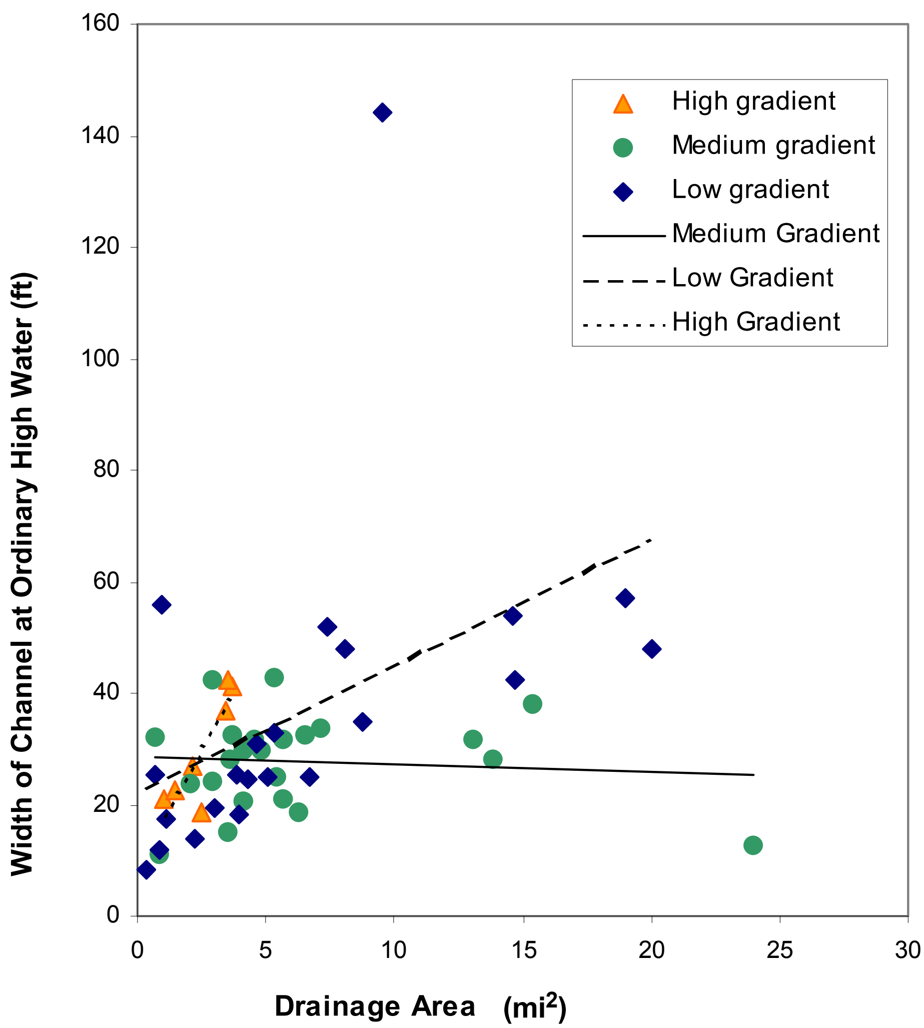


Figure 4.14
Width of channel at ordinary high water plotted against drainage area



Thus, the high gradient streams are set up as transport mechanisms for the materials that are fed to them from their adjacent hillslopes. Additionally, they transport water and sediment/debris on two very different levels. First, high gradient streams maintain an "average" or annual level that transports daily average precipitation and the smaller amounts of sediment moved with water. Secondly, episodic, large scale processes move large amounts of water and earth in mudflow/debris-flow events. Both mechanisms serve to transport water and sediment to the Medium and Low gradient subclasses. High gradient streams have distinct morphological characteristics that allow them to function in this manner. These features include:

Characteristics of High Gradient Stream Reaches

1. Intact longitudinal (*i.e.,* channel slope) profile and gradients > 6%,
2. Large numbers of residual pools (*e.g.,.* an average of 10 pools per reference site) and
3. Channel roughness features including boulder size D-84's (*e.g.,* 3 feet on average), and larger particles (*e.g.,* 8 inches on average) embedded in coarse grained material (*i.e.,* 5 inches on average).

The function of the high gradient systems to transport sediment to the medium and low gradient systems can be highly altered or interrupted by engineered structures such as debris basins (see photograph in Figure 4.15).

Figure 4.15
Photograph of Santa Monica Creek debris basin

Medium gradient Channels on Dissected and Undissected Debris Flow and Alluvial Fan Surfaces

Stream channels within the medium or medium gradient dissected debris flow/ alluvial fan surfaces also are dominated by bedrock and sandy-skeletal materials with large amounts of boulders and stones. The type of soil material (sandy loam to loamy sand) that generally comprises the channel banks in the Medium gradient subclass, coupled with a diminished longitudinal (*i.e.* channel slope) gradient, allows the medium gradient channels to be mobile and to move laterally, except where they are confined vertically and/or laterally by natural features such as bedrock, stones/boulders, or engineered features such as hardened banks and channels, rip-rap, *etc.*

Width-to-depth ratios for the medium gradient channels range from 4 to approximately 15, with a mean of 7.91 (Appendices B and C). These ratios are not statistically different from those of the High gradient subclass. However, when plotting width-to-depth ratios of the channel against source areas, we find the trend line for the Medium gradient subclass to have a distinctly different slope than the plot for the High gradient subclass. It has roughly the same as the slope for the Low gradient subclass (Figure 4.13). The intercept of the *y* axis suggests that the medium gradient channels may have a slightly lower width-to-depth ratio at a given drainage area, relative to the low gradient channels. The plot of drainage area versus channel width at OHW better indicates the narrower channel widths versus drainage area within the medium gradient channels relative to either the low or high gradient systems (Figure 4.14). These data indicate the (1) tendency of the narrow channels within the Medium gradient subclass to dissect the alluvial fan and debris flow geomorphic surfaces, and (2) relative lateral constraints of these channels by narrow canyon walls and/or large boulders composing the channel banks.

Within the medium gradient channels the D-84 size class ranges from 31 mm to 1057 mm (1.2 to 41.6 inches), with a mean of 322 mm (12.7 inches) (Appendices B and C). The larger size class (D-84's) in these channels is roughly one third the average in the high gradient channels and twice the average of those within the low gradient channels. These data support the observations of mudflow derived cobbles, stones, and boulders that provide roughness, determine channel geometry, and constrain lateral migration of these channels. Thus, roughness features such as large woody debris will not be as important in determining channel geometry as it is farther downstream within the low-gradient reaches. The plot of watershed area that drains to the specific channel location versus the D-84 size class, shows a trend line that is intermediate between the high gradient and relatively unconfined low gradient channel systems (Figure 4.10).

Thus, the medium gradient streams function to receive sediment and debris from their adjacent hillslopes and the high gradient systems, and to selectively export specific size fractions to the low gradient systems. Additionally, medium gradient systems transport water and sediment/debris on two very different levels. First, medium gradient streams maintain "average" or annual water levels that transport daily average precipitation and the smaller amounts of sediment moved with that water. Secondly, episodic, large scale processes move large amounts of debris in mudflow/debris-flow events (see photograph in Figure 4.3). Both mechanisms serve to transport water and earth material to the Low gradient subclass. Medium gradient streams have distinct morphological characteristics that allow them to function in this manner. These features include:

Characteristics of Medium Gradient Stream Reaches

1. Intact longitudinal profile and gradients between 2 and 6%,
2. Moderate numbers of residual pools (*e.g.,* an average of 5 pools per reference site) with an increase in pool size relative to the high gradient system,
3. Channel roughness features that include boulder and stone sized D-84's (*e.g.,* 12 inches on average), and moderate size particles (*e.g.,* 3 inches on average) embedded in finer grained material (*i.e.,* <1 inch on average), and
4. Narrow width-to-depth ratios relative to drainage area.

Low gradient Channels on Coastal Plain Surfaces

Stream channels within the Low gradient subclass are not completely dominated by coarse skeletal material. They display more fine textured material within the channel bed. The change in slope from the medium and high gradient surfaces to a low gradient surface is the mechanism that facilitates the accumulation of the finer sized material within the streambeds of the coastal plain surface (see photograph in Figure 4.4).

Width-to-depth ratios for the low gradient channels range from 3 to approximately 21 with a mean of 10.69 (Appendices B and C). These ratios are generally greater (*i.e.* stream channels are wider) than those within the High and Medium gradient subclasses, and are likely a reflection of the ability of the low gradient channels to move (meander) laterally and thus display sinuosity. When plotting width-to-depth ratio of the channel against the source area, we find the trend line for the Low gradient subclass to have a distinctly different slope than the plot for the High gradient subclass, but statistically the same as the slope for the Medium gradient subclass (Figure 4.13). The plot of drainage area verses channel width at OHW better illustrates the greater channel widths versus drainage area within the low gradient channels relative to the medium gradient systems (Figure 4.14). These data indicate that the channels within the

Low gradient subclass have the potential to move laterally on the landscape except where there are anthropogenic constraints (*i.e.,* concrete, rip-rap, *etc.*). Although the medium reaches are generally incised, so is Arroyo Burro in its lower reach. However, much of that incision is due to the active faulting and crustal shortening in all but the Carpinteria and Goleta basins, where basins are sinking and stream channels are becoming less steep. In areas of sea cliff retreat and, therefore, resultant shortening of streams, channel gradients can be increased at the coast.

The low gradient streams seldom are naturally constrained, however, some reaches are anthropogenically constrained (*e.g.* engineered hardened banks, concrete trapezoids). The D-84 size class ranges from 24 mm to 472 mm (1 to 18.6 inches) with a mean of 164 mm (6.5 inches), within the low gradient channels (Appendices B and C). The size of the D-84's indicates that there is no lag of debris flow derived cobbles, stones, and boulders. However, a critical point for the low gradient section is that the coarser fraction bed materials (*i.e.* those fractions equal to or less than approximately 322 mm in size, the medium gradient D-84 size) still get transported, but are then buried in the low gradient streambed by finer materials. Therefore, low gradient channels must be able to accommodate all sediment size fractions from 300 mm to clay size fractions. The plot of watershed area that drains to the specific channel location, verses D-84 size class, reflects a trend for the smallest D-84 sizes found in channels fed by the largest drainage areas (Figure 4.10). This trend is opposite of what is found in the high gradient channel systems. Additionally, the small particle sizes within the Low gradient channel systems have a great deal to do with the biogeochemical functioning of intact Low gradient stream ecosystems in the SCSBC Region.

Thus, the low gradient streams are organized to receive sediment and debris from the medium and high gradient systems, and to selectively retain specific sediment size fractions. The material within the low gradient systems reflects the transport and deposition of sediment/debris on two very different levels. First, low gradient streams maintain "average" or annual water levels that transport daily average precipitation and the smaller amounts of sediment moved with water. Secondly, low gradient streams maintain episodic, large scale processes that move large amounts of debris in mudflow/debris-flow events. Both mechanisms serve to transport water and earth material to the Low gradient subclass. Low gradient streams have distinct morphological characteristics that allow them to function in this manner. These features include:

Characteristics of Low Gradient Stream Reaches

1. Intact longitudinal profile and low gradients < 2%,
2. Fewer numbers of residual pools (*e.g.,* an average of only 2 pools per reference site) but a large increase in pool size relative to the medium and high gradient systems (*e.g.,* 3,940 ft^2 average for the low gradient channels, compared to < 250 ft^2 average for high and medium gradient channels),
3. Diminished channel roughness features (*i.e.,* sand and gravel size D-84's, 6 inches on average), and finer sized particles (*e.g.,* < 2 inches on average) embedded in fine grained material (*i.e.,* <0.2 inches on average), and
4. Moderate width-to-depth ratios relative to drainage area.

The ability for the low gradient channels to migrate laterally and to retain sediment is important in the SCSBC region. Where intact, these low gradient systems can (1) engage their floodplains, (2) provide increased substrate for plant communities and faunal support habitat, (3) provide increased area for contact with water, (4) provide increased time of contact between water and soil/sediment, and (5) facilitate biogeochemical processing of nutrients, organic matter, and contaminants. Where low gradient channels are not intact (*e.g.,* hardened, entrenched, altered channel geometry, *etc.*), the previously mentioned functions are usually lost due to (1) the minimization or elimination of area of contact with water, (2) diminished or eliminated time of contact between water and soils/sediment, and (3) impacts to riparian plant communities (see photograph in Figure 4.16).

Figure 4.16
Photograph of concrete trapezoidal channel on low gradient coastal plain surface - Lower Mission Creek

4.8 Soils and Biogeochemistry

4.8.1 Introduction and Background

There are a variety of definitions of "soil" within the literature that reflect many different perspectives on soil material and its functioning. Common pedalogic (*i.e.*, related to the science of soil genesis or formation) definitions consider soil to be a natural entity of unconsolidated or poorly consolidated materials at the earth's surface that are a mixture of mineral and organic solids, and liquids and gases. Soils are created as a function of biogeochemical and physical weathering processes acting on geologic materials through time, modified by climate and topographic relief. Because soils develop partly as a result of biogeochemical processes, they frequently possess morphological indicators that reflect the chemical and physical processes within them (Buol *et al.,* 1989, Birkeland 1984).

The biogeochemical and physical processes that occur in soils can result in zones of accumulations, losses, or alterations of various organic and/or mineral materials. These zones are manifest in distinct horizontal layers called "horizons". Many soil horizons are easily discernable upon examination of an adequate vertical section of soil due to changes in color, texture and/or structure. A vertical section of soil with its component horizons is referred to as the soil profile. It is the type and arrangement of soil horizons that reflect the history of the soil and the processes that have occurred within the soil. Thus, the overall soil morphology allows for the classification of the soil, and facilitates the interpretation of the biogeochemical and physical processes that have occurred within the soil (Buol *et al.* 1989). Soil biogeochemical processes and their morphological indicators are a function of oxidation-reduction (*i.e.,* redox) regimes within the soil. Because soil redox regimes are directly related to soil water and oxygen dynamics, morphological indicators within the soil provide valuable information on soil hydrology and aeration to an informed soil observer.

4.8.2 Soil Components and Function

Soils are composed of two general compartments, each with two different components. The general compartments in all soil are solids and voids (also called pore space). Solid components of the soil consist in varying ratios of mineral (inorganic) and organic materials of various size, shape, and composition. Pore space, by definition, is space available for fluids (*e.g.*, liquids and gases). Different compartments and components of a soil usually exist in a mixed, locally homogeneous condition that facilitates the physical and biogeochemical interactions between them. The combination of particles and voids is commonly referred to as the soil matrix (Brewer 1975). The importance of these components, the interactions between them, and the implications for riverine ecosystems in the SCSBC region (*i.e.*, larger scale ecosystems) are discussed below.

Soil Minerals

The mineral component of the soil consists of particles of rock and minerals that have been weathered from the geologic materials specific to the area or region. Thus, soil particles may reflect the physical (size, color) and chemical (mineralogical composition, resistance to weathering) characteristics of the geologic material (parent material) from which they were weathered. There are many examples of this relationship in the SCSBC region. The weathering of larger rock into much smaller particles results in large increases in surface area of the soil mineral fraction. The size distribution of the mineral grains within the soil is a critically important physical property that affects the (1) movement of water into and through the soil, (2) retention of water within the soil, (3) soil temperature, (4) retention and availability of nutrients, (5) soil flora and fauna, and (6) soil tilth (*i.e.*, ease of management for agriculture) (Birkland 1984, Brady 1984). The size distribution of the soil particles is termed "soil texture", and is divided into three main textural classes based upon particle size: sand (0.05 to 2 mm / 0.002 to 0.079 inches), silt (0.002 to 0.05 mm / 0.000079 to 0.002 inches), and clay (< 0.002 mm / <0.000079 inches) (USDA 1993). Nine additional soil textural classes are recognized based upon varying percentages of sand, silt, and clay within the soil sample (Appendix E.1). Soil particles often are organized into larger aggregates, called peds, which can have a variety of sizes and shapes. Organic acids, root exudates, secondary oxides of iron (Fe) and manganese (Mn), silica, and carbonates all can serve as cementing agents that bind the individual particles into larger aggregates. This organization is referred to as soil structure, and the degree and strength of this organization plays critically important roles in (1) plant growth (*i.e.,* rooting depth, aeration), (2) surface and shallow subsurface hydrology, (3) erosion, (4) structural habitat for soil biota, and (5) the structural integrity of the soil (Brady 1984, Buol *et al.* 1989).

Minerals within the soil are divided into primary and secondary mineral components. Primary minerals are formed with the cooling of molten rock (*e.g.*, quartz, feldspar) and in metamorphic environments with higher temperature and pressures. Secondary minerals (*e.g.*, clays) are formed by the weathering of primary minerals at low temperatures and pressures that are common to surface (*i.e.*, soil) environments (Jackson 1964, Soil Science Society of America 1977). Physical and chemical weathering of primary and secondary minerals is a significant source of many macro- and micronutrients required by soil biota. The secondary mineral component is the dominant contribution to the nutrient pool, and is usually found in the fine silt and clay size fractions (Killham 1995).

Reactions at the soil mineral surface–water interface are proportional to surface area. Thus, the smallest size fractions are the most important in terms of soil chemical reactions due to the large surface area contributed by large numbers of extremely small mineral particles (Stumm and Morgan 1981, Sposito 1989). Very fine clay particles can be less than 0.2 micrometers (0.0002 m / 0.0000079 inches) and have surface areas on the order of 800 m^2g^{-1} (Hillel 1982). Thus, the surface area of one gram of fine clay can exceed the surface area in one gram of coarse sand by at least 1000 fold (Brady 1984). Additionally, some clays have high cation exchange capacity (CEC) (*i.e.,* the ability of positively charged ions to reversibly complex with the surface of clay minerals as well as some organic structures) and "assimilative capacity." The ability of clay to sorb (*i.e.,* reversibly complex) and exchange charged particles with the aqueous environment can play important roles in water quality through the inhibition of contaminant movement (Drever 1988). Cation exchange and the assimilative properties of clays are due to a molecular geometry and crystal lattice structure that facilitates the retention of cations (*i.e.,* positively charged ions, metals, ammonium, *etc.*) and larger positively charged compounds as a result of net negative charges within the crystal lattice of the clay. Thus, some clays can have large reserves of plant nutrients, metals, enzymes, and acidity (*i.e.,* Al^{+3} on the exchange complex, and H^+ associated with compounds on the exchange complex). Although bacteria are generally anionic (negatively charged) and motile (mobile), they are closely associated with, and frequently adsorbed (*i.e.*, temporarily and reversibly adhered) to the surface of soil particles. Adsorption to soil particle surfaces can occur by different mechanisms, but is generally a result of ion exchange (Killham 1995). Clay and fine silt size particles play integral roles in the (1) movement of water into and through the soil, (2) retention and availability of water within the soil, (3) soil temperature, (4) retention and availability of nutrients, (5) soil flora and fauna dynamics, (6) soil tilth, and (7) water quality (Brady 1984, Drever 1988).

Therefore, finer textured soils are capable of performing specific biogeochemical work within their environments. This is important in understanding the Low gradient Riverine ecosystem functions in SCSBC. It is the Low gradient subclass, which has the preponderance of fine textured soil relative to the High and Medium gradient subclasses. Fine textured soils are a component of the biogeochemical "engine" that can augment water quality by contributing to biogeochemical functions articulated in the HGM protocol as Cycling of Elements and Compounds, and Removal of Imported Elements and Compounds.

Soil Organic Matter

There are two broad classifications of soil type and they are determined by the amount of organic matter within the soil. Soils that contain from 12% to 20% organic carbon by weight, dependent upon clay content, are classified as organic soils (Histosols). Soils that do not meet organic carbon criteria are classified as mineral soils (USDA-NRCS 1999). Organic soils are rare and minimal in areal extent. However, they can play critically important roles in the landscape due to their physical properties that allow them to hold large amounts of water, as well as due to biogeochemical processes that are driven by the high organic carbon content within them. In the SCSBC region, Histosols are associated with riverine and coastal wetland systems. Although the areal extent of Histosols is minimal within the SCSBC region, they are worth mentioning due to the importance of their physical properties and biogeochemical processes. The general biogeochemical and physical processes associated with soil organic matter are summarized below.

Soil organic matter consists of plant, animal, and microbial components, residues, and by-products at various stages of decay or synthesis. The importance of the soil organic component in physical and biogeochemical processes cannot be overstated. Well-drained mineral soils typically can have organic matter contents of only two to six percent, but the influence of organic carbon on soil biogeochemical processes can be significant relative to the low percentages of organic matter found within many soils. Soil organic matter can have profound effects on soil physical and chemical processes and is the dominant reservoir of nutrients for soil microbial populations (Atlas & Bartha 1987, Killham 1995). Soil organic matter has a large cation exchange capacity and, therefore, plays a role in the retention of bacteria and microorganisms. Intact soil profiles within Riverine ecosystems can contribute to improvement in water quality as a function of higher organic carbon content. Thus, soil organic matter is one of the components within an intact soil profile, which can augment water quality by specific biogeochemical functions such as Cycling of Elements and Compounds, Removal of Imported Elements and Compounds, and Organic Matter Transport. Soil organic matter also contributes to the hydrologic functions of Surface and Subsurface Water Storage and Exchange, and Landscape Hydrologic Connections within the SCSBC Riverine ecosystems.

Microbial populations play integral roles in virtually all soil chemical reactions, and some specialized communities interact with plant roots to create an environment that supplies nutrients conducive to plant growth and vigor. Additionally, some microbial populations (*e.g.*, bacteria) can exceed 1,000,000,000 individuals in a single gram of soil (Brady 1984) under favorable conditions. There are many different bacterial transformations of compounds that occur in nature. Soil bacteria play dominant and critically important roles in biological conversion and transformation of contaminants and toxic organic compounds in surface and groundwater (Higgins & Burns 1975, Matsumura & Krishna Murti 1982). The transformation of carbon-based compounds (*e.g.* some pesticides and herbicides) by microbial communities associated with soil organic carbon is another important function of an intact soil profile. Microbial transformations of compounds within the soil contribute to the HGM biogeochemical functions of Cycling of Elements and Compounds, and Removal of Imported Elements and Compounds.

Although bacteria are present in the greatest numbers within the soil, plant roots constitute the overwhelming majority of the soil biomass (Paul & Clark 1989). Plant roots have profound effects on soil physical properties (*e.g.*, size and strength of soil structure), microbial populations and dynamics, moisture retention, and biogeochemical processes. Additionally, the zone of soil immediately adjacent to the root is the most biologically and biogeochemically active area within the soil (Curl & Truelove 1986).

The amount and type of organic residues can vary widely among soils. Some soil organic residues can break down easily (*e.g.,* sugars, amino acids, some organic acids, *etc.*), while others are more resilient (*e.g.*, lignin, cellulose, humin, *etc.*) (Paul & Clark 1989, Killham 1995). Thus, the quantity of soil organic matter is a function of the rate of decomposition verses the rate of primary productivity and other inputs of organic material. The quantity and quality of soil organic matter also is a function of landscape position, soil texture, climate, and management practices (Jenny 1961, Birkland 1984). In the SCSBC region, landscape position and management play a critical role in determining the amount of soil organic matter present within an intact soil profile.

The largest contributor to soil organic carbon is plant residues (Paul & Clark 1989). The association of organic carbon and microbial populations with plant roots occurs in a thin zone called the rhizosphere. The rhizosphere is commonly thought of as the zone of soil that is immediate to the root or is influenced by root exudates. Thus, this zone typically is higher in microbial populations and organic compounds as compared with the rest of the soil matrix (Cambell & Rovira 1973). Due to the association of microorganisms and organic matter with plant and animal activity (particularly the rhizosphere), soil organic matter content and microbial populations tend to be highest within the soil surface horizon and decrease with depth (Verhoef & De Goeda 1985, Paul & Clark 1989). Although the greatest accumulations of organic carbon are found near the soil surface, total soil reservoirs of carbon exceed amounts within the atmosphere by nearly three fold (Bolin *et al.* 1979, Paul & Clark 1989). Soil organic carbon reserves typically exceed the amount of carbon in the standing biomass including forest and grassland (Whittaker 1975). Only the oceanic carbonate fraction and fossil fuel reserves have a greater carbon reservoir than soil and sediments (Bolin *et al.* 1979). Processes affecting soil organic matter can have implications that range from local carbon export and water quality, to global carbon balance. Intact (vegetated) riparian buffers and soil profiles within the SCSBC riverine ecosystems work in conjunction to increase the biogeochemical functioning of these ecosystems by contributing to the physical condition and chemical processes within the soil. Thus, soil organic matter in an intact soil profile is important to ecosystem functions recognized by the HGM protocol, including the biogeochemical functions of Cycling of Elements and Compounds, Retention of Imported Elements and Compounds, and Organic Matter Export in riverine ecosystems in SCSBC.

Chemical effects of soil organic matter can include (1) increased weathering rates of mineral particles due to the activity of organic acids (*e.g.*, fulvic and humic acids), (2) increased microbial activity or populations due to nutrient sources, particularly carbon, nitrogen, and phosphorus, (3) changes in redox regime due to organic carbon being the source of electrons consumed in reduction reactions, (4) increased CEC and sorption/chelation of metals due to the colloidal nature and surface activity of the some organic fractions, (5) partitioning of some organic compounds such as pesticides and herbicides within the organic matter, (6) increased time of travel for some contaminants, (7) decreased pH as a result of root exudates and/or organic acid synthesis, and (8) changes in water quality (Brady 1984, Drever 1988, Sposito 1989).

Physical effects of soil organic matter can include: (1) increased water holding capacity, (2) decreased soil bulk density, (3) increased soil structure, (4) increased soil aeration, (5) darker soil color, and (6) increased potential rooting depth. The ability of organic constituents to play a major role in the aggregation of soil mineral particles leads to increased soil structure that directly contributes to the physical properties mentioned previously and their positive effects on soil and plant interaction (Tisdale & Oades 1982). Darker soil colors are not a direct function of aggregation and structure, but occur as a result of dark brown and black colors associated with various types of organic acids and humic materials (Aiken *et al.* 1985). Thus, the chemical and physical effects of soil organic matter contribute to the biogeochemical functions performed by intact soil profiles in the SCSBC region. This is why, in later portions of the *Draft Guidebook*, we have focused on "Intact Soil Profiles" as being an important HGM variable for biogeochemical functions within Riverine ecosystems in the SCSBC Region.

Soil Water Soil water content is a function of climate, soil texture, organic matter content, structure, and management practices. Soil water is present within the voids (pore space) of the soil and, in conjunction with the elements and compounds in solution, is commonly referred to as the soil solution.

Soil water affects biological parameters such as (1) macro- and micro-faunal habitat, (2) microbial activity, (3) the accumulation and distribution of organic matter, and (4) the type and distribution of plant communities (Brady 1984, Killham 1995). Soil water content affects chemical parameters such as: (1) the type and amount of soluble compounds and elements (*e.g.,* nutrients such as nitrate (NO_3^-) and phosphate (PO_4^-) and redoxi-sensitive metals such as iron (Fe^{+2}) and manganese (Mn^+)) within the soil solution, (2) soil pH, (3) soil atmosphere, and (4) osmotic potential (*i.e.*, a pressure or energy gradient for water, created by the unequal concentration of salts in a soil or biological environment) (Drever 1988, Killham 1995).

When all pore space is completely filled with water, the soil is "saturated" by definition. The distribution of particle size (texture) within the soil, allows water to be held at different energies, or tension (*e.g.*, matric potential). Scientists recognize three general types of soil water in relation to texture and matric potential (1) water contained in the larger pores under low tension and easily removed from the soil profile by gravity (gravitational water), (2) water held at moderate tension, and moves or is held by capillary action (capillary water), and (3) water present in the smallest of pores (micro pores) or as a thin film on clays or colloidal particles (hygroscopic water), and very difficult to remove (*i.e.*, held at high tension) (Brady 1984). Thus, in finer textured soil water is held with greater energy (tension) providing longer contact time between water and mineral and organic components. Longer contact time between water and soil mineral and organic components facilitates the biogeochemical and hydrologic functioning of the riverine ecosystem. Additionally, in finer textured soils, water is held within the smaller pores and, therefore, is in contact with the most reactive components of the soil (*e.g.*, clays, colloids, and/or organic compounds).

Soils that are saturated at a frequency and duration sufficient to produce specific morphological features (*i.e.*, redoximorphic features) within the upper part of the soil horizon are referred to as hydric soils. These soils are frequently associated with wetland ecosystems and perform specific biogeochemical functions. Importantly, there are two general types of saturation associated with the soil system (1) episaturation, which indicates a discontinuous saturation (*i.e.,* unsaturated layers or horizons) below the upper boundary of saturation and within the upper two meters of the soil profile, and (2) endosaturation, which indicates continuous saturation in all layers below the upper boundary of saturation, to depths of two meters or more (SSSA 1997). Both types of saturation can play major roles in the creation of hydric soils and their associated biogeochemical processes that contribute to water quality. Hydric soils are frequently finer textured relative to the surrounding non-hydric soils in similar landscape positions. Thus, intact soil profiles with fine textured soil contribute biogeochemical functions of Cycling of Elements and Compounds, and Removal of Imported Elements and Compounds, as well as the hydrologic functions of Surface and Subsurface Water Storage and Exchange, and Landscape Hydrologic Connections. Nearly all water that reaches streams, rivers, and oceans has flowed through, or over, soil. Thus, intact soil profiles within the riverine ecosystems of SCSBC have chemical and physical properties that play large roles in water quality dynamics. These biogeochemical and hydrologic functions indicate the importance of intact riverine ecosystems, especially within the Low gradient subclass.

Soil Atmosphere

The dominant gases found in the earth's atmosphere are the dominant gases within the soil atmosphere (*e.g.,* CO_2, N_2, O_2,) (Paul & Clark 1989). However the amount and distribution of water within the soil pore space can have large effects on the gaseous composition within the soil atmosphere and the soil solution (Killham 1995). Additionally, (1) soil temperature, (2) the chemical composition of the soil solution, (3) microbial activity, (4) the partial pressure of gases within the soil atmosphere, and (5) the type of plant communities at the soil surface all can interact to affect the solubility of gases in the soil solution (Paul & Clark 1989).

Oxygen content is of particular interest in soil-water interactions. The dominant microbial components of soil are the heterotrophs, that is, organisms that utilize reduced carbon as an energy source and use O_2 as a terminal electron acceptor. In the absence of O_2, anaerobic soil organisms can obtain energy from inorganic compounds and use oxidized elemental species (*e.g.*, iron (Fe^{+3}), manganese (Mn^{+4}), nitrate (NO_3^-), and sulfate (SO_4^{-2}) as terminal electron acceptors. These specific biogeochemical reactions are important processes that affect nutrient dynamics, elemental cycling, and water quality in wetland and riverine systems. Changes from aerobic (*i.e.,* in the presence of oxygen) to anaerobic (*i.e.*, in the absence of oxygen) metabolism have been shown to occur at O_2 concentrations of less than one percent of the soil atmosphere. Additionally, the overall aeration of the soil is sometimes not considered as important as the aeration status interior to soil aggregates (Harris 1981). Thus, there can be anaerobic microsites and anaerobic processes to scale within an aerated soil matrix, and vice versa.

Changes in the aeration status of the soil can produce profound changes in the redox regime of the system. Soils typically will display prominent morphological indicators when conditions are strongly reducing or are alternately reduced and oxidized. Soil matrix color often is the most obvious morphological indicator, and it can reflect strongly reducing soil environments by the presence of grayish (*i.e.*, gleyed) colors that may be greenish gray, bluish gray, dark gray, *etc.* These colors denote the reduction and/or removal of iron from the system and are referred to as redoximorphic depletions (USDA 1996). Alternating conditions of oxidation-reduction frequently can be distinguished by the presence of small reddish or orange 'blotches' on the face(s) of soil aggregates, mineral material, roots, and/or root channels. These blotches occur as a result of reducing conditions that bring iron (Fe) and/or manganese (Mn) into solution, and alternating oxidizing conditions that cause the metals to precipitate upon/within soil aggregates and/or roots or root channels (*i.e.*, oxidized rhizospheres). These features are referred to as redoximorphic concentrations (USDA 1996). Thus, redoximorphic features can provide insight to the soil redox regime (*i.e.,* soil water and O_2 dynamics) and biogeochemical functions such as Cycling of Elements and Compounds, and hydrologic functions such as Surface and Subsurface Water Storage and Exchange, and Landscape Hydrologic Connections. Although high organic matter content in some wet soils can mask redoximorphic features that may be present, drying and then examining the soil material will often reveal the presence of redoximorphic indicators.

4.8.3 Soils Within the Reference Domain by Subclass

Within the SCSBC reference domain, soil profile conditions (*i.e.,* intact soil horizons) strongly affect soil moisture, hydraulic, thermal, and redox regimes, and support pedogenic (*i.e.,* soil forming) processes. Intact soil horizons are necessary for wetland hydrology and associated biogeochemical processes within riverine ecosystems within the reference domain, especially riverine systems on the low gradient coastal plain surfaces. In addition, pore space within mineral soil horizons provides subsurface storage of water and increased contact time between water and soil substrates. The soil profile provides substrates for, and strongly influences, biogeochemical processes that immobilize, transform, cycle, and store elements and compounds. Additionally, the soil profile provides substrate for establishment and maintenance of plant communities and faunal support habitat. Off-site effects of intact soil horizons include diminished water runoff, diminished element and nutrient export, diminished sediment transport to adjacent and down gradient areas, and augmented water quality. Soils within the reference domain vary among the High, Medium and Low gradient subclasses as a function of landform, elevation, topographic gradient, and geologic substrate.

Soils of the High Gradient Santa Ynez Mountain Front Surfaces

Soil Genesis

Soil formation on the steep gradient mountain front is a function of climate and organisms (Jenny 1961) weathering sandstone and shale parent materials over time, and modified by topography. Although all five factors of soil formation contribute to the type and degree of soils formation, relief and landscape position are dominant factors with respect to soil formation on the steep mountain front surfaces of the Santa Ynez. Soils on steep slopes have rapid runoff, significant erosion, and minimal contact time between water and soil minerals. Thus, weathering proceeds slowly and the soil materials strongly reflect the characteristics of the parent material. Because “soil material is lost through erosion nearly as fast as it forms through weathering of the parent sandstone and shale” on the steep slopes of the Santa Ynez, profiles are generally young in age, shallow, poorly developed, and contain large amounts of coarse fragments (Shipman *et al.* 1972). The Maymen soil is an example of profile development on steep slopes. “These soils are only 10 to 20 inches deep” and dependent upon vegetation cover, have “only one to three inches darkened by organic matter” (Shipman *et al.* 1981). In the High gradient mountain front subclass there are many areas that have exposed bedrock, or have soils that are too eroded and/or thin to be classified as soil.

Soil Drainage

The 0 and 1 order stream channels on the steep mountain front surfaces have low sinuosity and thus directly and rapidly convey materials removed by erosion and/or slope failures and debris flows. Thus, stream channels on the steep mountain front surfaces are dominated by shallow to thick deposits of poorly sorted, coarse-textured soils that are young in age, low in organic carbon, dominated by boulders, stones, and cobbles, and generally show little to no profile development. In areas where the riparian soils have been stable for an extended time, a weak A horizon has developed. Weak granular structure, or massive structure (due to lack of significant rooting activity, low clay content, and/or young age) often characterize the high gradient riverine soil profiles. These soils have a preponderance of macro pores (larger pores) and often are well drained to excessively drained due to pore size and high hydraulic conductivity (*i.e.,* the ability of water to move at a rapid rate through porous media (*e.g.,* soil). These soils do not remain saturated or wet for long periods, thus minimizing contact time between water and soil components and diminishing microbial activity and associated biogeochemical reactions.

Adjacent to the riverine assessment area, soils will exhibit a range of drainage conditions dependent upon the nature and texture of the parent geologic material, and the interstratification of the alluvial and colluvial deposits. Those soils formed in the Tertiary marine sandstone are well drained, while those soils formed in Tertiary marine shale are poorly drained. Soils formed within alluvium and colluvium that is interstratified with components of both formations will exhibit drainage intermediate between the sandy and fine textured Tertiary materials.

No fine textured soils were observed within the riparian areas adjacent to the streams within the High gradient Santa Ynez mountain front subclass. Additionally, none of the soils observed within the riparian corridors in the High gradient subclass met the technical criteria for hydric soils (Corps of Engineers 1987, NTCHS 1997). Streambed materials within the High gradient subclass were combinations of bedrock and sandy-skeletal materials with little, to no fine textured materials within the bed or riparian areas (Figure 4.11). The Natural Resource Conservation Service (NRCS) frequently has included the high gradient streams and riparian areas within the dominant upland soil map unit or has mapped the drainages as generic "Orthents" (*i.e.*, young and/or poorly developed soils) at the suborder level of soil taxonomy (1:24,000 mapping scale).

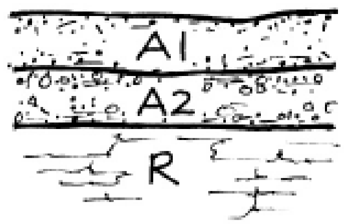
Range of Variation in Soil Profiles Within the Subclass

The NRCS has mapped nine different soil associations consisting of 18 different soil series on gently sloping to extremely steep surfaces of the Santa Ynez foothills and mountains (Shipman *et al.* 1981). These soil types range in texture from loamy sands to clay, and are weathered from marine sandstone and shale with small areas of igneous rock. This soil distribution makes up approximately 80% of the Santa Barbara County, California, South Coastal Part soil survey area. These soil associations are found at elevations between 50 and 4,700 ft (Shipman *et al.* 1981). Some of the representative profiles from the High gradient subclass are illustrated in Figure 4.17. Within the riverine ecosystem, riparian soils showed little variation and are dominantly sandy skeletal (*i.e.*, sandy soil matrix with > 35% stones, cobbles, and gravel) and well drained.

Figure 4.17 Representative soil profiles within the High gradient subclass

Gaviota Series
Example of somewhat excessive drained soils on uplands

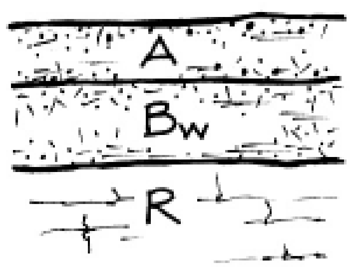
Slope: 9-75% Elevation: 150-1500 feet above mean sea level



PROFILE	TEXTURE	MUNSELL COLOR
A1	sandy loam	dark brown, 10YR 4/3
A2	gravelly sandy loam	dark brown, 10YR 4/3
R	shattered sandstone	light yellowish brown

Maymen Series
Example of well drained soils on mountains (Santa Ynez)

Slope: 5-100% Elevation: 150-15001000-4700 feet above mean sea level



PROFILE	TEXTURE	MUNSELL COLOR
A	sandy loam	dark brown, 7.5YR 3/2
Bw	loam	light brown, 10YR 4/4
R	coarse and med. grained fractured sandsone	yellowish brown to reddish brown

Orthents Suborder
Example of young, poorly developed soils on steep and very steep terrace escarpments

Slope: 50-75% Elevation: variable

PROFILE	TEXTURE	MUNSELL COLOR
C or A/C	stony fine sandy loam*	wide range, moist color values and chroma generally >3/3

Perturbation and Disturbance

Natural perturbations of soils in the High gradient subclass are primarily fire, erosion, and mass movement or failure related to fire-rain cycles and/or seismic activity. Fire can affect soil physical and biogeochemical properties by destroying surface vegetation, root biomass, and oxidizing soil organic carbon. Destruction of soil biomass on slopes can (1) increase erosion hazard, (2) increase the potential for mass movement or failure of soils/slopes, (3) diminish the moisture holding capacity of the soil, (4) impact infiltration rates, (5) impact soil structure, and (7) increase surface runoff, all of which play a major role in riverine ecosystem processes.

Mass movement or failure of slopes can affect soil physical and biogeochemical properties by (1) mixing soil horizons and materials, (2) removing or burying surface vegetation, (3) destroying soil structure, (4) altering soil drainage patterns, including rates of infiltration and subsurface flow, and (5) depending upon moisture content, can drastically alter soil pore size distribution (*i.e.*, can change the size, shape, and total volume of soil voids).

Anthropogenic perturbations to soil within the High gradient subclass are primarily clearing and grading operations related to roads and development. Clearing and grading operations can affect soil physical and biogeochemical properties by (1) removing or burying topsoil with increased organic content, (2) removing or burying surface vegetation, and (3) causing soil compaction that increases erosion hazard, diminishes infiltration rates, and increases surface runoff due to destruction of soil structure and alteration of the pore size distribution.

Soils of the Medium Gradient Dissected and Undissected Debris Flow and Alluvial Fan Surfaces

Soil Genesis

Soil formation on the medium gradient debris flow and alluvial fan surfaces is influenced by all five soil-forming factors, with no one factor dominating. The diminished topographic gradient (*i.e.* channel slopes of 2 – 6%) allows more contact time between water and the mineral soil, facilitating weathering, soil profile development, and vegetative cover. Additionally, less soil material is removed by erosion and/or slope failure compared to the High gradient subclass. Although the soils on the medium gradient surfaces are generally intermediate in age and better developed relative to soil on the Santa Ynez mountain front, materials within and adjacent to the drainages tend to be poorly sorted, coarse-textured soils that are dominated by large coarse fragments, and generally show little profile development. However, in some areas adjacent to the stream channel, a thin, weakly developed A horizon is present over the underlying parent material. The parent material in these locations is generally unsorted debris originating on the steep slopes of the Santa Ynez mountain front geomorphic surface, or exposed, weathered bedrock.

There is an increase in the presence and extent of soil that meets the technical criteria for hydric soils, as well as an increase in finer textured soils, within the medium gradient surface. Eighteen percent of the soil observations within the riparian areas were hydric soils as compared with zero percent observed within the High gradient Santa Ynez mountain front subclass. Twelve percent of the soil observations within the riparian areas of the debris flow and alluvial fan surfaces consisted of a loamy (non-skeletal) or finer particle size class. Some terraces within the Medium gradient subclass have older, well-developed soils such as the Milpitas-Positas-Concepcion association. These soils exhibit strong profile development and organic carbon accumulation (Shipman *et al.* 1981).

Soil Drainage

Stream channels within the medium gradient dissected and undissected debris flow/alluvial fan surfaces are also dominated by bedrock and sandy-skeletal material. Only four percent of the observations within the channel bed were found to have a fine earth particle size class of loamy (non-skeletal) or finer material (Figure 4.11). The type of soil material that generally comprises the channel banks in the Medium gradient subclass (sandy loam to loamy sand), coupled with a diminished longitudinal (*i.e.* channel slope) gradient, allows medium gradient channels to be mobile. For example, they move laterally, except where they are confined vertically and/or laterally by anthropogenic activity, bedrock, or extremely large boulders. The NRCS has (1) included the medium gradient streams and associated riparian areas within the dominant upland mapping unit, (2) mapped the drainages as a generic “Orthents” at the suborder level of soil taxonomy, (3) mapped the drainages as a Cortina stony loamy sand (Figure 4.18), or (4) mapped the drainages as an Elder sandy loam (Figure 4.17) with inclusions of Riverwash (see photograph in Figure 4.19) at the 1:24,000 mapping scale. Weak granular or sub angular blocky structure, and/or massive structure (due to lack of significant rooting activity, low clay content, and/or young age) often characterize the medium gradient riverine soil profiles. These riparian soils have a preponderance of larger pores and often are excessively drained due to high hydraulic conductivity. Most of these soils do not remain saturated or wet for long periods, minimizing contact time between water and soil components.

Adjacent to riverine HGM assessment areas, soils will exhibit a range of drainage conditions dependent upon the nature and texture of the parent geologic material, and the inter-stratification of the alluvial and colluvial deposits. Those soils formed in the Tertiary marine sandstone are well drained, while those soils formed in Tertiary marine shale are poorly drained. Soils formed within alluvium and colluvium that are interstratified with components of both formations will exhibit drainage intermediate between the sandy and fine textured Tertiary material.

Range of Variation

The NRCS has mapped three different soil associations consisting of seven different soil series on nearly level to moderately sloping (*i.e.,* 1% to 9% slopes) alluvial fans, terraces, and coastal valleys (Shipman *et al.* 1981). These soils range in texture from sandy loams to silty clay loams, and are weathered in alluvium derived from sedimentary rock. This soil distribution makes up approximately seven to 13% of the Santa Barbara County, California, South Coastal Part soil survey area (Shipman *et al.* 1981). Soil associations within this subclass include some soils mapped on the gently sloping to extremely steep foothills and mountains and overlap within the High gradient subclass. These soil associations are found at elevations between 20 and 4,700 ft (Shipman *et al.* 1981). Some of the representative profiles from the Medium gradient subclass are illustrated in Figure 4.18.

Within the Medium gradient subclass, riparian soils exhibit slightly more variability than those within the High gradient subclass. Riparian soils are dominantly sandy skeletal and well-drained debris flow materials, but textures ranged from sandy skeletal to loamy (non skeletal). Soil drainage was dominantly well-drained, with small areas of poorly drained soils. Additionally, small areas of hydric soils are present within the Medium gradient subclass riparian areas.

Perturbation and Disturbance

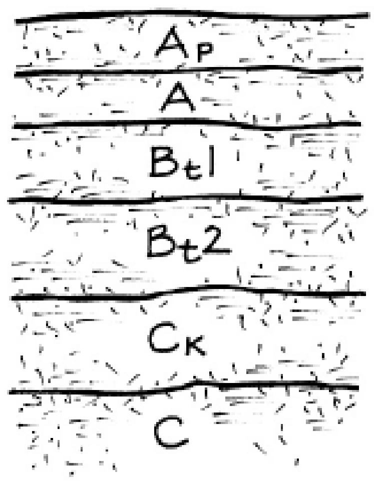
Natural perturbations of soils in the Medium gradient dissected alluvial fan and debris flow subclass are primarily fire, erosion, and mass movement or failure on the steeper channel slopes. Slope failure and mass movement are frequently related to fire-rain cycles and/or seismic activity.

Fire can affect soil physical and biogeochemical properties by destroying surface vegetation, root biomass, and oxidizing soil organic carbon. Destruction of soil biomass on slopes can (1) increase erosion hazard, (2) increase the potential for mass movement or failure of soils/slopes, (3) diminish the moisture holding capacity of the soil, (4) impact infiltration rates, (5) impact soil structure, and (6) increase surface runoff.

Figure 4.18
Representative soil profiles within the Medium gradient subclass

Botella Series
Example of well drained soils on alluvial fans and in small valleys

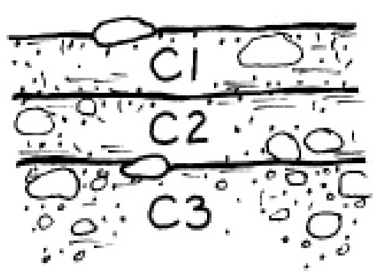
Slope: 0-9%   Elevation: 20-800 feet above mean sea level



PROFILE	TEXTURE	MUNSELL COLOR
	silty clay loam	black, 10YR 2/1
	silty clay loam	black, 10YR 2/1
	silty clay loam	black, 10YR 2/1
	silty clay loam	black, 10YR 2/1, anddark yellowish brown 10YR 3/4
	silty clay loam	very dark grey, 10YR 3/2 dark brown, 10YR 3/3
	silty clay loam	very dark greyish brown, 10/ 2/2

Cortina Series
Example of somewhat excessive drained soils on alluvial fans adjacent to stream channels

Slope: 2-9%   Elevation: 100-400 feet above mean sea level



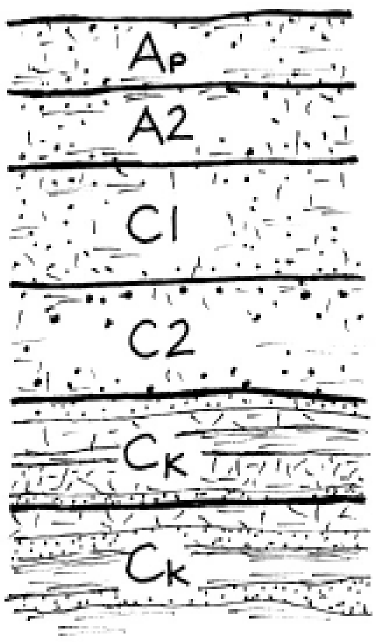
PROFILE	TEXTURE	MUNSELL COLOR
	stony loamy sand	dark brown, 10YR 4/3
	stony loamy sand	very dark brown, 10YR 2/2
	loamy sand with gravel cobbles and stone	dark yellowish brown 10YR 4/4

Figure 4.18
Representative soil profiles within the Medium gradient subclass(cont.)

Eldar Series
Example of soils on alluvial fans and narrow valleys

Slope: 0-9% Elevation: 30-400 feet above mean sea level

PROFILE

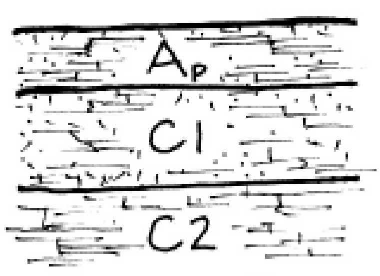


TEXTURE	MUNSELL COLOR
sandy loam	very dark grayish brown, 10YR 3/2
sandy loam	very dark grayish brown, 10YR 3/2
fine sandy loam	dark yellowish brown, 10YR 4/4
coarse loamy sand	dark reddish brown, 5YR 3/3
interstratified loam carbonate cementation	variable colors
interstratified silty clay loam and loamy sand, carbonate cementation	variable colors

Santa Lucia Series
Example of well drained soils on footprints and mountains

Slope: 9-75% Elevation: 100-1000 feet above mean sea level

PROFILE

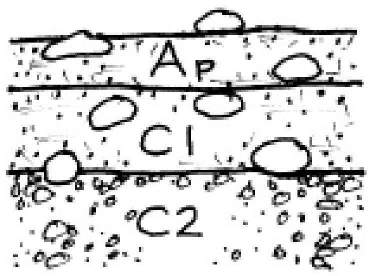


TEXTURE	MUNSELL COLOR
shaly clay loam	very dark grayish, 10YR 3/1
shaly clay loam	very dark grayish brown, 10YR 3/1
Monterey shale	white to light gray

Figure 4.18
Representative soil profiles within the Medium gradient subclass(cont)

Soboba Series
Example of excessively drained soils in long, narrow valleys

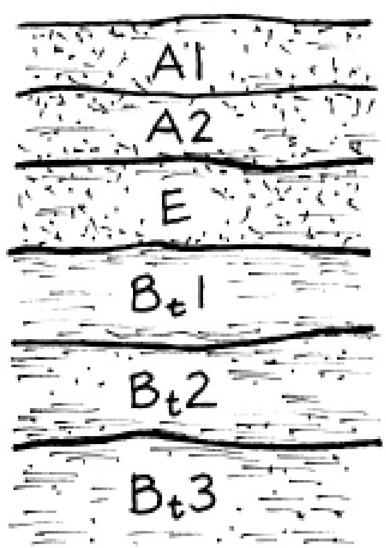
Slope: 2-9%   Elevation: 50-400 feet above mean sea level



PROFILE	TEXTURE	MUNSELL COLOR
	stony coarse sandy loam	dark brown, 10YR 4/3
	stony coarse loamy sand	dark brown, 10YR 4/3
	very gravelly sand	yellowish brown, 10YR 5/4

Tierra Series
Example of moderately well drained soils on dissected terraces and low rolling hills

Slope: 9-50%   Elevation: 100-1600 feet above mean sea level



PROFILE	TEXTURE	MUNSELL COLOR
	sandy loam	very dark grayish brown, 10YR 3/2
	sandy loam	very dark grayish brown, 10YR 3/2
	sandy loam	dark grayish brown, 10YR 4/2
	clay	dark grayish brown, 10YR 3/2 to yellowish brown 10YR 5/6
	sandy clay	yellowish brown, 10YR 5/6
	sandy clay	yellowish red, 5year 5/6-5/8, and gray, 10YR 6/1, and reddish brown, 5YR 5/4

Figure 4.19
Photograph of "Riverwash" riparian soil within the Medium gradient subclass - Cañada del Coho Creek

Mass movement or failure of slopes can affect soil physical and biogeochemical properties by (1) mixing soil horizons and materials, (2) removing or burying surface vegetation, (3) destroying soil structure, (4) altering soil drainage patterns, including rates of infiltration and subsurface flow. Depending upon the soil moisture content, mass movement/slope failure can drastically alter soil pore size distribution (*i.e.,* can change the size, shape, and total volume of soil voids). Anthropogenic perturbations to soil within the Medium gradient subclass are primarily clearing and grading operations related to development, the creation of impervious surfaces related to development and flood control, and activities associated with agriculture and grazing.

Clearing and grading operations can affect soil physical and biogeochemical properties by (1) removing or burying organic rich topsoil, (2) removing or burying surface vegetation, and (3) causing soil compaction that increases erosion hazard, diminishes infiltration rates, and increases surface runoff due to destruction of soil structure and alteration of the pore size distribution. Activities related to agriculture and grazing (tillage and traffic) can affect soil physical and biogeochemical properties by disturbance and compaction of the soil surface horizon. Tillage and/or grazing can result in (1) oxidation and loss of soil organic carbon, (2) diminished soil structure, (3) decreased infiltration rates, (4) increased erosion hazard, (5) decreased soil water storage capacity, and (6) decreased soil aeration.

Low Gradient Coastal Plain Surfaces

Soil Genesis

Soil formation on the Low gradient coastal plain surface subclass is generally a function of all five soil forming factors (Jenny 1961). However, on this surface, topography (nearly level surfaces), microorganisms (increased organic carbon contents), and time play a more major role than in the steeper, moisture starved, and younger, High and Medium gradient subclasses. Soils on the low gradient coastal plain surface subclasses generally are more advanced in age than the soils found in the Santa Ynez mountain front or debris flow/alluvial fan surfaces.

The low gradient surface has the least topographic gradient of the High, Medium and Low gradient subclasses and soils on this surface have the most contact time between water and soil components. Increased contact time between water and soil will facilitate (1) mineral weathering, (2) soil profile development, (3) microbial activity, (4) organic carbon accumulation, (5) vegetative cover, and (6) changes in water chemistry. Thus, when compared to the sandy skeletal soils that are characteristic of the riparian areas in the High and Medium gradient subclasses, the finer textured soils in low gradient landscape positions have higher organic carbon content, cation exchange and assimilative capacity, and therefore have a more profound influence on water chemistry and, thus, water quality.

Soil associations such as the Milpitas-Concepcion, and the Concepcion-Botella are found on the low gradient coastal surfaces. The Milpitas-Concepcion soils are considered “old soils” with “extremely abrupt and highly contrasting soil change” as a result of long-term soil formation. The Botella soil has “formed on alluvium from sedimentary rock”, yet has high organic carbon concentrations to depths of up to three ft (Shipman *et al.* 1981).

Soil Drainage Properties
Stream channels within the Low gradient subclass are not completely dominated by coarse skeletal material. The change in slope from the medium and high gradient surfaces to a low gradient surface has allowed for the accumulation of finer sized material within the streambeds of the Coastal Plain Surface. Riparian soils within the Low gradient subclass exhibit the greatest range in texture and structure within the reference domain. Textures range from sandy to clay, and structure ranges from massive to moderate sub angular blocky. Forty-one percent of the soil observations within the stream riparian areas of the coastal plain surface had a particle size class of loamy (non-skeletal) or finer. The type of soil materials that generally comprises the channel banks in the Low gradient subclass (sand to clay, with minimal large boulders or stones), coupled with a diminished longitudinal gradient, allows the low gradient channels to be mobile and move laterally, except where they are confined vertically and/or laterally by engineered hardened structures (*e.g.* riprap, concrete channel walls, *etc.*). Additionally, 32% of the riparian soils observations met the technical criteria for hydric soils, as opposed to 18% within the

Medium gradient subclass and zero percent within the High gradient mountain front subclass (Figure 4.20). However, finer textured soils that occur within the Low gradient coastal surface subclass are rare, given past and current land uses. Where they occur, they exhibit increased profile development, structure, and organic carbon accumulation. Thus, when compared to the sandy skeletal soils that are characteristic of the High and Medium gradient subclasses, the finer textured soils in low gradient landscape positions have higher cation exchange and assimilative capacities. Large areas of alluvial and colluvial materials of Quaternary age overlie Miocene marine shale (*i.e.,* Monterey and Rincon units) within the Low gradient subclass. Thus, the drainage class of soils found on the low gradient coastal surface ranges from very poorly drained to well drained, dependent upon whether the soil formed in coarse Quaternary materials or fine textured marine shale.

Variation within the subclass

The NRCS has mapped three different soil associations consisting of seven different soil series on the nearly level coastal plains, terraces, and coastal valleys. Several unnamed soils have been mapped and classified as "Aquepts" (*i.e.*, poorly drained soils intermediate in age and/or profile development) at the suborder level of taxonomy (Shipman *et al.* 1981). These soils range in texture from sandy loam to silty clay loam, and are weathered in deep alluvium derived from sedimentary rock. This soil distribution makes up between 7 to 13% of the Santa Barbara County, California, South Coastal Part soil survey area (Shipman *et al.* 1981). Soil associations within the Low gradient subclass include overlap of some soils mapped on the gently sloping to steep terraces and small valleys, and are found at elevations between sea level and 800 ft (Shipman *et al.* 1981). Representative profiles from the Low gradient subclass are illustrated in Figure 4.21.

Within the SCSBC reference domain, the largest range in variability of riparian soils is found within the low gradient riverine ecosystems. Riparian soils were dominantly loamy skeletal and well drained, but textures ranged from sandy skeletal to clay, and soil drainage ranged from very poorly drained to well drained. Additionally, there is an increase in the number of observations of hydric soils within the low gradient riparian areas when compared to the high and medium gradient systems (Fig 4.20).

Perturbation and Disturbance

Natural perturbations of soils in the low gradient coastal surface are primarily fire, erosion, flooding, and seismic activity. However, less soil material is removed by erosion, and almost none is moved by slope failure(s) compared to the medium and high gradient surfaces.