2 Concepts

A *few basic concepts form the foundation for drainage systems that preserve and restore the hydrologic cycle. Once these basic concepts are understood, the ingenuity of designers, planners and builders can be applied to invent specific techniques for the special requirements of any site.*

The concepts spring from an integrated, comprehensive approach to stormwater management, considering each site's unique position within a larger watershed, and each smaller watershed within a site.

The application of these concepts consistently within a site will create a stormwater management approach that minimizes impervious area, reduces direct connections between impervious areas and the stormdrain system, and mimics natural systems while being economical, aesthetically pleasing, and technically sound.

Concepts

2.1 Every site is in a watershed. Rain falls on every site. What happens to the rain depends on the site's place in the larger watershed, and on the smaller watersheds within the site. From where does water enter the site? To where does it go? Understanding that a site has a position in the larger context is essential to stormwater management.

2.2 Start at the source. What happens immediately after a drop of rain hits the ground? Rather than convey stormwater away for treatment at the end of a pipe, water quality is most easily and economically achieved if stormwater management starts at the point that water contacts the earth.

2.3 Think small. For decades planners, engineers and builders have been trained to think big– to design systems that will handle peak flows from the biggest storms. Yet a significant amount of pollutants and flow-induced impacts to streams are in the early rains and small storms. Designing systems to accommodate the big storm is still essential for protection of life and property, but small-scale techniques, applied consistently over an entire watershed, can have a big impact — both improving stormwater quality and reducing overall runoff volume.

2.4 Keep it simple. A wide variety of simple and effective strategies can be employed to achieve stormwater quality goals. Designed for the small storms, these simple strategies often use natural methods and materials, and sometimes require a different kind of engineering or maintenance than conventional modern drainage systems. By employing an array of a few simple techniques throughout a site, improved stormwater management can be achieved economically with modest maintenance requirements, and can often be cost-effectively integrated into larger, flood control-type facilities.

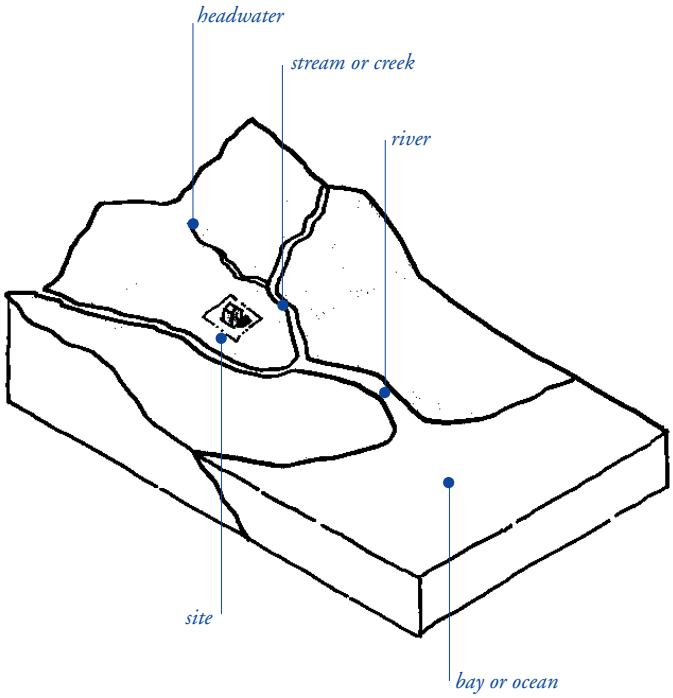
2.5 Integrate the solutions. Providing stormwater management facilities is not a problem – it's an opportunity. By integrating solutions into the overall site plan, stormwater facilities can provide recreational, aesthetic, habitat, *and* water quality benefits.

Concepts

2.1

Every site is in a watershed

Once a single drop of rain reaches the earth, its journey is determined by the watershed in which it lands. A watershed is defined by the U.S. Environmental Protection Agency as "the geographic region within which water drains into a particular river, stream, or body of water." [8]



A small puddle in an uneven field reflects a tiny, localized watershed. At a neighborhood scale, gradual changes in elevation, or man-made artifacts like roadways or railroad embankments may define watersheds. Regionally, a range of mountain ridges may create a watershed that is drained by a network of small streams and creeks, each of which forms a tributary to larger water bodies, forming larger watersheds, all of which ultimately empty into a lake, bay or ocean.

No matter where you are in a watershed, or at what scale of watershed you are working, what you do on any particular site always has effects on the overall hyrologic system. By understanding that every site has a relationship to its adjoining watersheds, by investigating the soil and hydrologic conditions of the site, and by appreciating the micro-watersheds within each site, designers can best achieve the overall objective: restoration and preservation of the natural hydrologic system.

Concepts

2.2

Start at the source

***W**hen a single drop of rain lands, it is carried by gravity and soil physics downward into the soil.*

If the soil is covered with an impervious material, such as rooftops, concrete, or asphalt, the single drop of rain flows along whatever surface it encounters, moving downhill, joining with other drops of rain to create runoff.

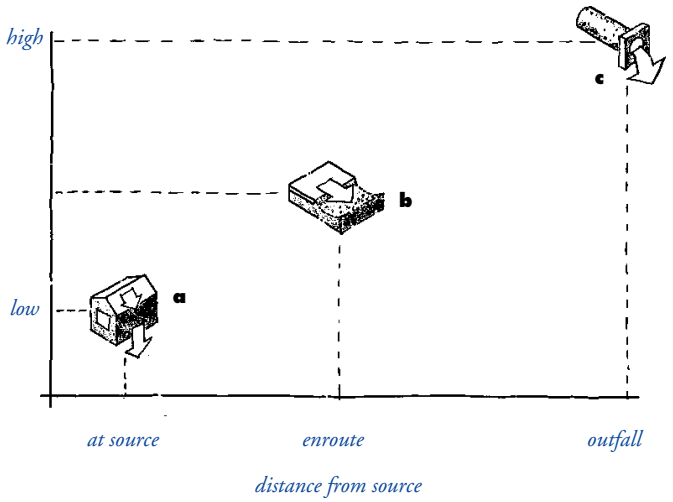
If this runoff is collected in pipes and conveyed long distances before treatment many opportunities for improved water quality are lost. "End of pipe" strategies, such as large retention ponds, can be important components of an overall stormwater management system, but are more complex and costly than strategies that start at the source.

Small collection strategies, located at the point where runoff initially meets the ground, repeated consistently over an entire project, will usually yield the greatest water quality improvements for the least cost.

Source control is cheapest

If runoff is infiltrated or detained at its source (a) the least costs are incurred and maintenance is minimal. If runoff is carried some distance and treated enroute (b), costs and maintenance demands rise. If runoff is carried directly to the outfall (c), cost for treatment controls are highest and most maintenance intensive.

The most economical, simplest stormwater management opportunities for water quality are at the source of the runoff.



Concepts
2.3

Think small

***S**mall storms add up. Because of their frequency, small storms, meaning storm sizes that recur once every two years or more frequently, produce the vast majority of total runoff over time. In the Bay Area, small storms account for eighty percent of total annual rainfall.*

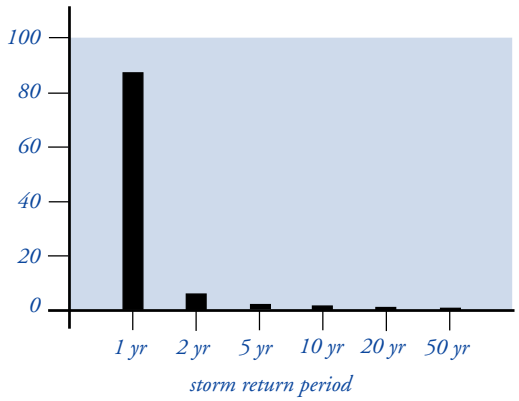
By targeting these small storms, rainfall can be managed for water quality through relatively small water quality systems. In this way, managing frequent small storms can address a large part of the pollution problem.

In the past, stormwater management has focused almost exclusively on flood protection. In the same way that a freeway designed for rush hour traffic can easily handle the traffic on a quiet weekend morning, stormwater systems that can accommodate flood flows are more than adequate to convey more frequent small storms. So, in designing only for flood protection, designers have been able to neglect the small storm and its impacts.

With an awareness of the importance of small storms for water quality protection designers now consider small storms, because of their frequency and cumulative impacts, as well as the infrequent large rainfall event.

Small storms add up

Rainfall is distributed between relatively infrequent large storms and more frequent small storms. For example, in the Bay Area, approximately eighty percent of the total annual rainfall is produced by the accumulated contribution of the many small storms, the size that recurs every two-years or less (two-year recurrence interval). These small storms typically produce between 0.5 to 1.25 inches of rain, depending on microclimate. By comparison, all of the larger storms combined (five, ten, twenty and fifty year intervals) typically produce less than twenty percent of the total annual rainfall.



Concepts

2.4 *Keep it simple*

The techniques illustrated in this document were purposefully kept simple. Being simple, they are easy to understand. They are also relatively easy and inexpensive to design, build and maintain.

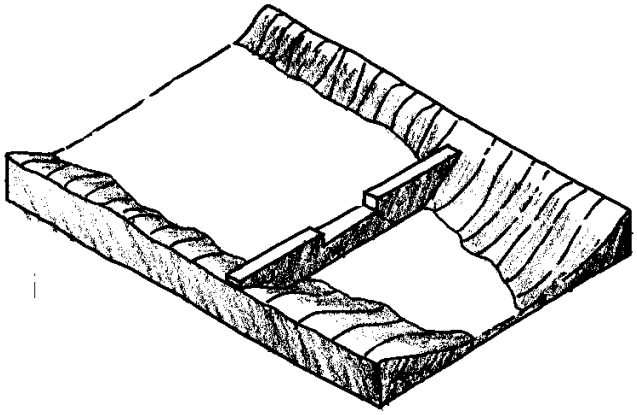
To address the many diverse sites found in the Bay Area, this document illustrates a wide variety of techniques, applicable to different soils, sites, and conditions. It is not intended that all *the techniques illustrated here will be appropriate for each project, but instead, that planners, landscape architects, and engineers select and adapt those few that are most suited to a particular site.*

A simple gravel strip, a concave instead of convex planting area, an infiltration basin at the end of a downspout — all of these are simple, but effective strategies for integrating stormwater management into a site plan.

The best stormwater management system will rely on a few simple techniques, applied consistently over an entire project or site.

Simple but effective

Because most stormwater management has generally been focused on complex, large systems, small, simple solutions may appear at first glance less effective. Yet simple solutions can be just as effective, and must undergo the same rigorous engineering analysis as more complex approaches. The difference is that the simple systems generally use lower technology materials and rely on natural materials integrated with the landscape, rather than mechanical or man-made processes, to manage stormwater.



Concepts

2.5

Integrate the solutions

The stormwater management system can become an organizing element for site planning and design. Infiltration devices, drainage swales, and retention areas can be integrated into a site plan to improve aesthetics and provide recreational resources.

For example, a landscaped area, if slightly concave or depressed, can also serve as a temporary detention basin. Drainage swales can be landscaped with attractive riparian species. Pathways can follow these swales, creating attractive greenbelts that reflect natural landforms. A sandy area can serve as a children's playground in the dry season, but become a shallow infiltration basin in the winter rains.

Home buyers and business tenants consistently indicate a preference for water features. A network of small ephemeral pools and swales, treated carefully with attractive planting and maintenance, can satisfy this desire for a relationship to water and give developments a competitive advantage.

An integrated site plan will generally yield a series of smaller stormwater management facilities rather than one large basin at the end of a traditional conveyance system. This integrated approach not only reduces cost while achieving environmental goals, but it also maximizes land values, improves marketability, adds aesthetic interest, and provides increased recreational opportunities.

Design out the hazard, design in the people

Often environmentally sound stormwater management facilities, such as retention basins, are fenced or hidden from view. This approach to stormwater management not only adds significant "opportunity costs" through lost building sites or recreational potential, but also sends a symbolic message that stormwater is hazardous.

There are legitimate concerns for safety and liability, but they can usually be mitigated through simple design strategies such as shallow basin depths and gently sloping sides. By designing out the hazards and designing in the people, most drainage features can be integrated into the site plan to mimic the natural hydrologic cycle, add aesthetics, and increase recreational value.