

# A Appendices

*The following pages provide supplementary information for those seeking more detail on residential site planning and design guidance for stormwater quality.*

*The appendices were adapted from a variety of technical sources drawn from throughout the United States.*

## Appendices

**A.1 Glossary.** Relevant terms and acronyms used in the text and common to stormwater management issues.

**A.2 Bibliography.** A listing of relevant documents on site planning and design for stormwater management. These documents address a wide range of approaches to current practice, including engineering, environmental science, landscape architecture, planning, horticulture, real estate marketing and development.

**A.3 Footnotes.** References for information cited in the text.

**Access streets** The lowest order street in the hierarchy of streets, it conducts traffic between individual dwelling units and higher order streets (such as collector and subcollector streets). Access streets convey the lowest traffic volume, and are prime candidates for reduced street widths.

**Alternative modes of transportation** Modes of transportation other than the single passenger automobile, such as transit, bicycling, carpooling, and walking.

**Alternative surfaces** Pavement types other than conventional asphalt or concrete. Examples include porous pavement and pavers.

**Amenity** Something that increases material or physical comfort.

**Aquifer** The underground layer of rock or soil in which groundwater resides. Aquifers are replenished or recharged by surface water percolating through soil. Wells are drilled into aquifers to extract water for human use.

**Arterial street** A street that provides a direct route for long-distance travel within the region and also to different parts of the city. Traffic on an arterial street is given preference at intersections, and some access control may be considered in order to maintain capacity to carry high volumes of traffic.

**Average daily traffic (ADT)** The average total number of vehicles that traverse a road or highway on a typical day. Often used to classify and design roadway systems.

**Best Management Practice** A method, activity, maintenance procedure, or other management practice for reducing the amount of pollution entering a water body. The term originated from the rules & regulations developed pursuant to the federal Clean Water Act (40 CFR 1 30).

**Bioretention** A technique that uses parking lot islands, planting strips, or swales to collect and filter urban stormwater, that includes grass and sand filters, loamy soils, mulch, shallow ponding and native trees and shrubs.

**Buffer** A zone created or sustained adjacent to a shoreline, wetland or stream where development is restricted or prohibited

to minimize the negative effects of land development on animals and plants and their habitats.

**Building footprint** Commonly used term to describe the ground area that a building covers.

**Catchment** The smallest watershed management unit, defined as the area of a development site to its first intersection with a stream, usually as a pipe or open channel outfall.

**Check dam** (a) A log or gabion structure placed perpendicular to a stream to enhance aquatic habitat. (b) An earthen or log structure, used in grass swales to reduce water velocities, promote sediment deposition, and enhance infiltration.

**Cluster Development** A development pattern for residential, commercial, industrial, institutional, or combination of uses, in which the uses are grouped or “clustered,” through a density transfer, rather than spread evenly throughout the parcel as in conventional lot-by-lot development. A local jurisdiction’s Critical Area Program may authorize such development by permitting smaller lot sizes if a specified portion of the land is kept in permanent open space to provide natural habitat or open space uses through public or private dedication.

**Collector street** Acts as the primary traffic route within a residential or commercial area.

**Constructed wetland** An artificial wetland system designed to mitigate the impacts of urban runoff.

**Contamination.** The impairment of water quality by waste to a degree that creates a hazard to public health through poisoning or through the spread of disease.

**Cul-de-sac** A circular section located at the end of an access street that permits vehicles to turn around.

**Curbs** A concrete barrier on the margin of a road or street that is used to direct stormwater runoff to an inlet, protect pavement edges, and protect lawns and sidewalks from encroachment by vehicles.

**Density** The average number of families, persons, or housing units per unit of land, usually density is expressed “per acre”.

**Design storm** A rainfall event of specified size, intensity, and return frequency (e.g., a storm that occurs only once every 2 years) that is used to calculate runoff volume and peak discharge rate.

**Detention** The temporary storage of storm runoff which is used to control discharge rates sufficiently to provide gravity settling of pollutants.

**Detention time** The amount of time water actually is present in a basin. Theoretical detention time for a runoff event is the average time parcels of water reside in the basin over the period of release from the basin.

**Drainage basin (see Watershed)** A land area bounded by high points, which drains all surface water into a single stream or other body of water.

**Effective Impervious Surface** The portion of impervious surface that generates stormwater runoff which must be managed or directed to a stormwater conveyance system, rather than infiltrating into the ground.

**Ephemeral stream** A stream or waterway that holds water only for a few hours or days, and dries up shortly after rain storms.

**Erosion** The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road, building, or timber cutting.

**Evapotranspiration** The loss of surface water into the atmosphere, through plants and evaporation.

**Excess parking** Parking spaces that are constructed over and above the number required or predicted based on the parking demand ratio for a particular land use or activity

**Excess stormwater runoff** Any increase in stormwater resulting from: an increase in the imperviousness of a site, including all additions to buildings, roads, and parking lots; changes in

permeability caused by compaction during construction or modifications in contours, including the filling or drainage of small depression areas; the alteration of drainageways, or regrading of slopes; the destruction of forest; or the installation of collection systems to intercept street flows or to replace swales or other drainageways.

**Filter fabric** Textile of relatively small mesh or pore size that is used to (a) allow water to pass through while keeping sediment out (permeable), or (b) prevent both runoff and sediment from passing through (impermeable).

**Filter strips** A vegetated area that treats sheetflow and/or interflow to remove sediment and other pollutants. Used to treat shallow concentrated stormflows over very short contributing distances in urban areas.

**First flush** The delivery of a disproportionately large load of pollutants during the early part of storms due to the rapid runoff of accumulated pollutants. The first flush of runoff has been defined several ways (e.g., one-half inch per impervious acre).

**Forebay** An extra storage space provided near an inlet of a wet pond or constructed wetland to trap incoming sediments before they accumulate in the pond.

**Grassed channel** A long, open, and grassed channel used to convey stormwater runoff to a downstream point. It is designed to filter out pollutants during water quality storms, and also convey large storm events.

**Green space** The proportion of open space in a cluster development that is retained in an undisturbed vegetative condition.

**Groundwater** Water stored underground that fills the spaces between soil particles or rock fractures. A zone underground with enough water to withdraw and use for drinking water or other purposes is called an aquifer.

**Habitat** The specific area or environment in which a particular type of plant or animal lives. An organism’s habitat must provide all of the basic requirements for life and should be free of harmful contaminants.

**Hammerhead** A “T” shaped turnaround option for lightly traveled residential streets. Creates less impervious cover compared to a circular cul-de-sac.

**Headwater stream** A term for the smaller first and second order tributary streams in a drainage network.

**Heat island effect** The increase in ambient temperatures generated by heat radiating from paved surfaces exposed to sunlight.

**Hydrology** The science of the behavior of water in the atmosphere (air), on the surface of the earth, and underground.

**Impermeable** Not able to be infiltrated by water.

**Impervious surface** Any surface which cannot be effectively (easily) penetrated by water. Examples include pavement, buildings, compacted soils, and rock outcrops.

**Imperviousness** The percentage of impervious cover within a development site or watershed.

**Infill** Developing vacant parcels or redeveloping existing property to achieve higher density in urban areas as an alternative to development in outlying rural areas.

**Infiltration** The downward entry of water into the surface of the soil, as contrasted with percolation which is movement of water through soil layers.

**Infiltration basin** A concave vegetated surface (e.g., pond, swale) designed to hold water so that it can gradually infiltrate into the soil.

**Interconnected streets** Street system that allows traffic to circulate within neighborhoods instead of creating cul-de-sacs and dead end streets that result in disconnected residential areas. A grid pattern of blocks is a typical example.

**Nonpoint source pollution** Pollution that enters water from dispersed and uncontrolled sources, such as rainfall or snowmelt moving over and through the ground rather than single, identifiable sources. A nonpoint source is any source of water pollution that does not meet the legal definition of point source in section

502(14) of the Clean Water Act (e.g., forest practices, agricultural practices, on site sewage disposal, automobiles, and recreational boats). While individual sources may seem insignificant, they may contribute pathogens, suspended solids, and toxicants which result in significant cumulative effects.

**Non-renewable resources** Resources that are not naturally regenerated or renewed.

**Nonstructural control** A practice that does not require construction of a facility to control urban runoff.

**NPDES** National Pollutant Discharge Elimination System, a provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by EPA, a state, or another delegated agency.

**Open space** A portion of a cluster development that is set aside for public or private use and is not developed with homes. The space may be used for active or passive recreation, or may be reserved to protect or buffer natural areas (see also green space)

**Perennial streams** A stream channel that has running water throughout the year.

**Performance criteria** Technical standards that govern the development process that are based on meeting general objectives for design, rather than prescribing rigid, uniform and detailed design requirements.

**Permeable** A type of soil or other material that allows passage of water or other liquid.

**Permeable surfaces** Areas characterized by materials that allow stormwater to infiltrate the underlying soils (e.g., soil covered or vegetated areas)

**Pervious** A soil or material that has the specific quality of allowing the passage of water or other liquid.

**Point Source Pollution** A source of pollutants from a single point of conveyance, such as a pipe. For example, the discharge from a sewage treatment plant or a factory is a point source.

**Pollutants** A chemical or other additive that adversely alters the

physical, chemical, or biological properties of the environment.

**Porous pavement** Asphalt or concrete paving material consisting of a coarse mixture cemented together with sufficient interconnected voids to provide a high rate of permeability.

**Premium** An additional charge for real estate property with an amenity such as a water view or a view of wooded land.

**Receiving waters** Lakes, rivers, wetlands, and coastal waters that receive runoff.

**Recharge Area** A land area in which surface water infiltrates soil and reaches to the zone of saturation, such as where rainwater soaks through the earth to reach an aquifer.

**Recharge** Infiltration of surface water to groundwater.

**Retrofit** To provide or add new equipment, parts, or techniques unavailable at the time of original construction.

**Riparian Area** Habitat found along the bank of a natural and freshwater waterway, such as a river, stream, or creek, that provides for a high density, diversity, and productivity of plant and animal species.

**Runoff** Water from rain, melted snow, or agricultural or landscape irrigation that flows over the land surface.

**Runoff coefficient** The runoff coefficient determines the portion of rainfall that will run off the watershed. It is based on the permeability and water-holding capacity of the various surfaces in the watershed. The runoff coefficient value, expressed as *C*, can vary from close to zero to up to 1.0. A low *C* value indicates that most of the water is retained for a time on the site, as by soaking into the ground or forming puddles, whereas a high *C* value means that most of the rain runs off rapidly.

**Setback** A zone designated to protect sensitive areas from negative impacts associated with development.

**Shared parking** A parking strategy designed to reduce the total number of parking spaces needed within an area, by allowing adjacent users to share parking areas during non competing hours of operation (e.g., a shared lot for a theater and an office

building).

**Sheetflow** A flow condition during a storm where the depth of stormwater runoff is very shallow in depth and spread uniformly over the land surface. This sheet flow quickly changes into concentrated channel flow within several hundred feet.

**Steep slope** An area of a development site that is too steep to (a) safely build on or (b) has a high potential for severe soil erosion during construction.

**Stormwater conveyance** A system of gutters, pipes, or ditches used to carry stormwater from surrounding land areas to constructed or natural drainage systems.

**Stormwater runoff** Rain that flows off the surface of the land without entering the soil.

**Structural control** A practice that involves design and construction of a facility to mitigate the adverse impact of urban runoff, and often requires maintenance.

**Subdivision** The process (and the result) of dividing a parcel of raw land into smaller buildable sites, streets, open spaces, and public areas, and the designation of utilities and other improvements. Critical Area regulations govern the density and design of new subdivisions.

**Subwatershed** A watershed management unit whose boundaries are typically defined as all of the land draining to the point where two second order streams combine together to form a third order stream. A subwatershed may be a few square miles in area, and are the key geographic unit for urban stream classification and watershed-based zoning.

**Surface water** Water on the surface of the land that has not infiltrated the soil including streams, lakes, rivers, and ponds.

**Swale** An open drainage channel that has been explicitly designed to detain or infiltrate the entire runoff volume associated with a water quality storm event.

**Trip generation rate** A statistic that indicates the number of vehicular trips that are taken from an average dwelling unit in a

particular land use category on a typical day. For example, studies have shown that one single family home generates about 10 trips per day.

**Unbuildable lands** The portions of a development site where structures cannot be located for physical or environmental reasons (e.g., easements, open water, steep slopes, floodplains, wetlands and stream buffers).

**Unit Pavers** Concrete grid and modular pavement whose spaces are filled with pervious materials such as sod, sand, or gravel.

**Water table** The upper surface of groundwater or the level below which the soil is saturated with water. The water table indicates the uppermost extent of ground water.

**Watershed (see Drainage basin)** The geographic region within which water drains into a particular river, stream or body of water. A watershed includes hill, lowlands, and the body of water into which the land drains. Watershed boundaries are defined by the ridges of separating watersheds.

**Wet pond** Pond for urban runoff management that is designed to detain urban runoff and always contains water.

**Zoning** A set of regulations and requirements which govern the use, placement, spacing, and size of land and buildings within a specific area (zone).

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- <sup>7</sup> Schueler, Tom. Site Planning for Urban Stream Protection, 1995, pp. 42-43.
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- <sup>11</sup> personal measurements by Tom Richman, 1996
- <sup>12</sup> Schueler, p. 148.
- <sup>13</sup> this discussion of traffic volumes and costs related to access streets is adapted from Schueler, p. 148.
- Recent household survey data indicates that the 10 vehicle per day per household rule-of-thumb overestimates actual vehicle trips, especially in neo-traditional neighborhoods where multiple modes of transportation are supported. This suggests that two-way "access streets" with shared central moving space may safely serve more than 50 residential units. Frank Spielberg, ITE Technical Review Committee, personal communication, 1996.
- <sup>14</sup> *ibid.* The term "headwater streets" has been popularized by Tom Schueler of the Center for Watershed Protection.
- <sup>15</sup> Schueler, p. 148.
- <sup>16</sup> Spielberg, Frank ITE Technical Review Committee, personal communication
- <sup>17</sup> City of Olympia, 1994, p. 92-94.
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- <sup>30</sup> Woodward-Clyde. *Parking lot BMP Manual*.
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- <sup>31</sup> Ferguson (1994), p. 53.
- <sup>32</sup> Florida Concrete Products Association, video.
- <sup>33</sup> California Department of Transportation, *Standard Specifications*, Sec. 39, 1995.
- <sup>34</sup> Ferguson, personal conversation based on 1996 site inspection.
- <sup>35</sup> Ramsey & Sleeper, *Architectural Graphic Standards*, p. 105.
- <sup>36</sup> *ibid.* and Ferguson, 1998, p. 54
- <sup>37</sup> Ferguson, 1994, p. 52.
- <sup>38</sup> *ibid.*
- <sup>39</sup> Ferguson, 1994.
- <sup>40</sup> City of Olympia, 1994, p. 30. In one of the few studies that actually measured impervious surface coverage, the City of Olympia (WA) found that the street and circulation network accounted for an average of 63 to 70% of total impervious coverage in a selection of eight single family and multifamily residential developments. Also see Schueler, Tom (1995), p. 19.
- <sup>41</sup> Santa Clara Valley Nonpoint Source Pollution Control Program, *Source Identification and Control Report*, 1996.
- <sup>42</sup> Headwaters Streets: Schueler (1995), ad passim. Institute for Transportation Engineering, *Traffic Engineering for Neo-Traditional Neighborhood Design*.
- <sup>43</sup> ITE, "Traffic Engineering for Neo-Traditional Neighborhood Design: an informational report," February 1994. This report "does not include Institute recommendations on the best course of action," and is a survey obtained from transportation engineering professionals and research. A technical committee of the ITE is currently considering neo-traditional street design standards for adoption by the ITE.
- <sup>44</sup> *ibid.*
- <sup>45</sup> Ferguson (1994), p. 18.
- <sup>46</sup> Ferguson (1994), p. 14
- <sup>47</sup> Harris, p. 48

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<sup>49</sup> Stormwater Pollution Prevention Plan. Construction of San Pedro Avenue Extension in the City of Pacifica. Prepared by Wilsey & Ham. August, 1995

<sup>50</sup> *ibid.*

<sup>51</sup> Santa Clara Valley Nonpoint Source Pollution Control Program. Duke, L.D. and Shannon, J.A. Best Management Practices for Industrial Storm Water Pollution Control. 1992.

<sup>52</sup> Santa Clara Valley Nonpoint Source Pollution Control Program, 1992 and Stormwater Pollution Prevention Plan, 1995.

<sup>53</sup> Stormwater Pollution Prevention Plan, 1995, and Industrial/Commercial Best Management Practice Handbook. California Storm Water Best Management Practice Handbooks. March 1993. Camp Dresser McKee for Stormwater Quality Task Force

<sup>54</sup> Stormwater Pollution Prevention Plan, 1995.

<sup>55</sup> City of Burlingame Storm Water Pollution Protection Standard Specifications.

<sup>56</sup> Environmental Protection Agency. *Economic Benefits of Run-off Controls*. (EPA 841-S-95-002), 1995.

<sup>57</sup> Liptan, Tom and Carmel Kinsella Brown, "A Cost Comparison of Conventional and Water Quality-Based Stormwater Designs," Urban Stormwater Management in the Southwest Conference, Long Beach, CA, 1998.