Guidelines for Riparian and Wetland Buffers

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1.0 Introduction

Riparian and wetland habitats provide numerous economic and ecological benefits to the human and natural environment in the form of flood control, erosion control, and protection of hydrological, biological, and water quality resources. The purpose of these Guidelines for Riparian and Wetlands Buffers (Guidelines) is to provide information about designing effective riparian buffers and identifying allowable land uses in a manner that is consistent with the Carlsbad Habitat Management Plan (HMP). The HMP does not include detailed information about designing buffers that effectively protect ecological function. This document was developed to supplement the HMP by providing recommendations and best practices that are consistent with local, state, and federal wetlands-related regulations.

Section 21.210.090 of the Carlsbad Municipal Code (Habitat Preservation and Management Regulations) authorizes the Planning Director to prepare a publish guidelines to assist in the implementation of the HMP. These guidelines have been developed using the most current technical research, scientific literature, and regulatory guidance available (TAIC 2007), including:

- Relevant standards in the Carlsbad HMP, including Measures to Minimize Impact on HMP Species and Mitigation Requirements (p. D-90); Additional Conservation Standards to be Applied to Properties in the Coastal Zone (p. D-114); and Adjacency Standards (p. F-16).
- Past regulatory practices that have occurred during the California Environmental Quality Act (CEQA) review process for development projects.
- *Carlsbad Watershed Management Plan* (Carlsbad Watershed Network, 2002).
- *Guidelines for Riparian and Wetland Buffers* - Modifications to the City of Carlsbad Habitat Management Plan proposed by the Carlsbad Watershed Network (2005).
- *Draft Proposed Model Ordinance for Stream Protection* (City of Los Angeles, 2007).
- *Resource Protection Ordinance* (County of San Diego).
- *Model Ordinances to Protect Local Resources* (Environmental Protection Agency, 2007).
- Article 39 of *The Practice of Watershed Protection* (Center for Watershed Protection, 2000).

- Heraty, M. 1993. *Riparian Buffer Programs: A Guide to Developing and Implementing a Riparian Buffer Program as an Urban Best Management Practice*. (M. Herary, Environmental Protection Agency, 1993).
- Schueler, T. 1995. *Site Planning for Urban Stream Protection*. (T. Schueler, Environmental Protection Agency, 1995).
- Wenger, S. 1999. *A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation* (S. Wenger, Office of Public Service and Outreach Institute of Ecology University of Georgia, 1999).

The target audience for these guidelines includes (1) City of Carlsbad Planning Department staff when reviewing projects for compliance with the HMP, (2) private developers during the project design phase, and (3) preserve managers when identifying resources protection, management, and restoration priorities for preserve lands within the City of Carlsbad's HMP.

1.1 Benefits of Riparian and Wetland Buffers

Well-designed riparian and wetlands buffers provide numerous benefits to the adjacent riparian/wetland habitats in the form of hydrological, biological, and water quality resource protection. Benefits include:

1. Restoring and maintaining the chemical, physical, and biological integrity of the aquatic resources.
2. Removing pollutants and excess nutrients delivered by urban stormwater.
3. Reducing erosion and sediment entering the stream (sediment filter).
4. Stream bank stabilization.
5. Providing infiltration of stormwater runoff.
6. Stream flow regulation.
7. Contributing the organic matter that is a source of food and energy for the aquatic ecosystem (nutrient input) – leaf litter.
8. Providing tree canopy to shade streams and promote desirable aquatic organisms (shading/thermo-regulation).
9. Providing wildlife habitat/structural diversity.
10. Providing wildlife migration corridors.
11. Providing flood protection/attenuation.
12. Furnishing scenic value and recreational opportunities.

1.2 Goals & Objectives

These Guidelines were developed with the following goals and objectives in mind.

Goals: *To protect and enhance aquatic, riparian, and wetland habitats, water quality, and ecological functions throughout the HMP lands within the City of Carlsbad.*

To provide guidance and recommendations for the design and use of riparian / wetland buffers within preserve areas to supplement the policies and standards set forth in the HMP.

Objectives:

1. Provide buffer design recommendations and variance procedures in order to facilitate HMP implementation in Carlsbad.
2. Identify allowable uses and land use restrictions for riparian/wetland buffer zones.
3. Develop generic and specific buffer management/land use guidelines corresponding to potential adjacent land uses to reduce or eliminate resulting edge effects.
4. Identify specific opportunities and constraints for buffer establishment on the watershed (stream-reach) level.

1.3 Definitions

Best Management Practices: Best Management Practices (BMPs) are measures taken to improve project design and performance to mitigate or ameliorate potential or anticipated adverse environmental impacts of project implementation and/or operation.

Buffer: For the purpose of this analysis, the "buffer" is defined as the area extending outward perpendicularly from the top of bank of a natural or constructed channel or watercourse. In cases where stream banks are present within the enclosed canopy of a riparian forest, the riparian buffer begins at the lateral edge of the riparian forest canopy. Riparian/wetland buffers consist of transitional and upland habitats (including all non-developed, native and non-native scrub, grassland, and non-riparian woodland habitats) as well as moderately disturbed and/or softscaped areas (e.g., utility ROWs, natural open space, landscaped parkland, etc.). Riparian/wetland buffers would not include frequently or regularly flooded areas but may include infrequently flooded terraces above the elevation of frequent or semi-frequent flooding.

Development Project: Use of a property, including grading, clearing and grubbing, construction, alteration of any magnitude or activities incidental thereto which requires a discretionary or ministerial permit, entitlement or approval issued under Titles 15, 18, 20, or 21 of the municipal code (Carlsbad Municipal Code 21.210.020).

Impaired Water Bodies: Those water bodies within Carlsbad's jurisdiction, or outside City boundaries but collecting storm water runoff from within the City, that are listed on the CWA 303d list as impaired water bodies.

Non-Tidal Wetlands: Non-tidal wetlands are ecosystems characterized by permanent or frequent inundation or soil saturation for extended periods of time which are not influenced by the natural ebb and flow of the ocean tide.

Riparian Habitat: Riparian habitats are transitional aquatic / terrestrial habitats that occur in close proximity to a permanent or seasonal source of surface waters and which support a dominance of riparian (vegetation) species. Riparian habitats in Carlsbad include riparian scrub (e.g., mulefat scrub, southern willow scrub, and baccharis/tamarisk scrub), riparian woodland (e.g., sycamore-alder riparian woodland), and riparian forest (e.g., southern coast live oak riparian forest).

Riparian Species: Riparian species are trees, shrubs, and other emergent vegetation that occur in close proximity to flowing water or which are dependent on an abundant supply of soil moisture from a nearby freshwater source. Riparian species are those species which are best adapted to tolerate prolonged or frequent soil saturation.

Riparian Zone: For the purpose of this analysis, the Riparian Zone[1] is defined as being the extent of the continuous canopy of riparian habitat, or, in the absence of closed canopy riparian habitat, the extent of all jurisdictional wetlands as defined by the Cowardin Wetland Classification System (Cowardin et al. 1979), within 100 feet of the tops of a natural or artificial stream bank including areas characterized by native or non-native herbaceous riparian vegetation.

Stream: A linear feature, through which water flows at least periodically, possessing a discrete bed, bank, and channel.

[1] For the purpose of monitoring compliance with these guidelines, the "riparian zone" will be permanently fixed upon adoption of the formal delineation and would not expand over time to include recruitment of additional riparian acreage within the initially established riparian buffer zones.

Tidal Waters: Tidal waters are estuarine coastal ecosystems influenced by the natural ebb and flow of the tide.

Wetlands: Areas that are inundated or saturated by surface or ground water at a frequency or duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. For purposes of the Carlsbad HMP, wetlands are those lands which contain one or more of the following naturally occurring wetland communities: southern coastal salt marsh, alkali marsh, freshwater marsh, freshwater, estuarine, and disturbed wetlands. Wetlands also include areas lacking wetland communities due to non-permitted filling of previously existing wetlands (IA Section 3.40; HMP Appendix A).

Within the Coastal Zone, wetlands are defined as "lands within the Coastal Zone, which may be covered periodically, or permanently with shallow water, and include saltwater marshes, freshwater marshes, open or closed brackish water marshes, swamps, mudflats, and fens. Wetlands shall include land where the water table is at, near, or above the land surface long enough to promote the formation of hydric soils or to support the growth of hydrophytes, and shall also include those types of wetlands where vegetation is lacking and soil is poorly developed or absent as a result of concentrations of salts or other substances in the substrate. A preponderance of hydric soils or a preponderance of wetland indicator species shall be considered presumptive evidence of wetland conditions" (HMP Section D 7-6).

Vernal Pools: Vernal pools are a highly restricted, unique wetland habitat type that contain high numbers of endangered, sensitive, and endemic plant and animal species. Vernal pools occur in several scattered locations throughout the City on marine terraces (HMP Appendix A).

2.0 Buffer Design Guidelines

The following section presents the guidelines for designing riparian/wetland buffers including appropriate buffer dimensions, landscaping requirements, and other applicable specifications.

2.1 HMP Area-Wide

The following design guidelines apply to the establishment of protective buffers for riparian and wetland habitats within the Carlsbad HMP area. See Section 2.2 for guidelines specific to the Coastal Zone, which supersede these guidelines in the Coastal Zone.

1. All riparian and wetland habitat types shall be protected by appropriate buffers.
2. Riparian buffers should be continuous along streams, especially along smaller headwater streams (Osborne and Kovacic 1993).
3. For the purpose of buffer design, jurisdictional wetlands and riparian habitats shall be delineated in accordance with applicable state and federal regulations (Title 14, Section 13577 of the California Code of Regulations; Section 1602 of the California Fish and Game Code; and Section 404 of the Clean Water Act) during a formal jurisdictional delineation survey, and appropriate buffers shall subsequently be designed in consultation with the CEQA lead agency.
4. Buffers shall be measured from the outer edge of the protected habitats as delineated during the formal jurisdictional delineation survey, and as defined below (see also definitions in Section 1.3).
    a. Riparian habitat - the outside edge of jurisdictional riparian canopy or dripline.
    b. Wetlands - the outside edge of jurisdictional wetland habitat.
    c. Streambed – for non-vegetated waters and/or ephemeral channels, the protected zone should be measured from the top of the stream bank.
5. Protective buffers shall be a minimum of 100 feet in width surrounding all non-estuarine wetlands and riparian habitats (see Section 2.2 below for buffer requirements in the Coastal Zone).
6. Within 200 feet of estuarine areas, land uses that would contribute to degraded water quality, changes in surface water or groundwater hydrology, or increased runoff, erosion, and sedimentation are prohibited (HMP p. D-95).

7. Planners should consider expanding the dimensions of the buffer surrounding special wetland and riparian resources based on “Additional Considerations” described in Section 3.0.

8. Buffers should be designed to accommodate the "build-out" condition of the stream or water body; i.e., the width, depth, and configuration projected to be the end result of upstream development, which shall be larger than the existing stream or water body under the current practice of continued addition of impervious surface to the watersheds, and due to the lag time required for the stream to respond to altered hydrology.

9. Buffers of at least 100 feet shall be maintained adjacent to occupied habitat of the following HMP-covered species (HMP Section D-6), unless a lesser buffer is approved by the wildlife agencies:

    a. Least Bell’s vireo (*Vireo bellii pusillus*)
    b. Southwestern willow flycatcher (*Empidonax trailii extimus*)
    c. Harbison’s dun skipper (*Euphyes vestries harbisonii*)

10. Although other City Zoning ordinances allow development within the 100-year floodplain, wetland and riparian buffers should ideally be expanded to encompass the entire 100-year floodplain surrounding a stream or wetland area to protect ecological function if the floodplain extends beyond 100 feet from the riparian or wetland habitat.

11. Roadways and other crossings of the buffers shall be avoided and minimized; crossings will be designed to minimize impacts to habitat to the maximum extent feasible and be constructed with wildlife crossings (culverts, underpasses, etc.) of suitable size and spacing to preserve documented wildlife movement routes through riparian/wetland habitat and adjacent buffers. In order to maximize their effectiveness, wildlife crossings should be designed to meet the most recent published recommended specifications (e.g., openness ratio) such as the Transportation Research Board's National Cooperative Highway Research Program’s (NCHRP’s) Wildlife Crossings Decision Guide (http://www.wildlifeandroads.org/decisionguide/1.cfm) and Wildlife Crossings Toolkit (http://www.wildlifecrossings.info/beta2.htm). Wildlife crossings will be subject to City Planning Director and City Engineering Department approval.

2.2 Coastal Zone

Within the Coastal Zone, protective buffers shall be a minimum of 50 feet in width surrounding riparian habitats and 100 feet in width surrounding jurisdictional wetlands.

Pursuant to Condition 7-11 of the HMP, the protective buffer for wetlands and riparian areas possessing an unvegetated bank or steep slope (>25%) shall be measured from the top of the bank or steep slope rather than the edge of habitat, unless there is at least 50 feet between the riparian or wetland area and the toe of the slope. If the toe of the slope is less than 50 feet from the wetland or riparian area, the buffer shall be measured from the top of the slope.

2.3 Standards Areas

Pursuant to Section D-3.C of the City of Carlsbad HMP *Preserve Components and Assembly – Standards Areas*, some areas within specific Local Facilities Management Zones (LFMZs), as identified in the HMP, are subject to zone-specific planning standards. Table 1 summarizes the planning standards related to riparian and wetlands buffers. These standards supersede the generic HMP planning area-wide design recommendations described above. Note that the "no net loss of wetlands" standard is not mentioned because it is a federal regulation that applies to all areas in Carlsbad, both inside and outside of the HMP.

Table 1. Zone-Specific Planning Requirements Related to Riparian and Wetlands Buffers for Development within HMP Standards Areas.

LFM Zone	Standards Area Riparian/Wetlands Buffer Requirements
1	Retain and manage natural habitats adjacent to lagoons in order to buffer wetland resources.
8	Maintain continuity between wetland and upland habitat.
14, 15, 20	Conserve all riparian habitats onsite; prohibit fill or development within existing floodplain (except for essential infrastructure). When conversion of agricultural lands to other uses is proposed, set back all development impacts at least 100 feet from existing wetland habitats and require habitat restoration or enhancement in the riparian and buffer areas.
21	Avoid impacts to the watersheds of vernal pools and oak riparian forest.
25	Conserve wetlands habitat and set back development at least 100 feet. Conserve and enhance riparian vegetation along Buena Vista Creek with 200-foot buffers supporting natural vegetation between wetland habitats and development. Use sensitive road design of any road or utility crossing of Buena Vista Creek. Prohibit fill or development within existing floodplain (except for essential infrastructure).

2.4 Three-Zone Buffer Design

1. Buffers shall consist of three discrete zones, a "Protection Zone", "Separation Zone", and "Transition Zone" (Figure 1). Each zone performs specific, necessary functions which must be considered when determining the appropriate width for each zone. Table 2 shows the characteristics and requirements for the Protection and Separation Zones. These zones shall be considered fixed parts of the buffer that will be included within the City's Preserve once adopted and recorded on the final site plans. The Transition Zone will be located outside the preserve area, but will nevertheless contribute to the protection of the wetland/riparian resource. The characteristics, applicable Adjacency Standards, and land use recommendations for this zone are also included in Table 2.

   Protection Zone (inner zone): extends a minimum of 50 ft, as measured from the outside of riparian habitat (or top of bank in unvegetated streams), and protects the physical and ecological integrity of the stream or wetland ecosystem.

   Separation Zone (middle zone): extends a minimum of 50 feet perpendicular to the watercourse starting at the outward edge of the inner zone depending upon stream order (greater width for higher order stream) and includes the boundary of the 100-year flood plain, if feasible. Within the Coastal Zone, a total minimum buffer width of 50 feet from riparian habitat is required, and therefore the riparian buffer may not include a Separation Zone.

   To protect ecological function, the width may be increased to include steep slopes, erodible soils, wetlands within or adjacent to the 100-year flood plain, USFWS-designated critical habitat, and habitat occupied by species listed by the state or federal government as threatened or endangered. If documented and approved by the City and Agencies, the width may be reduced as long as ecological function is not adversely affected. See Section 2.5 for guidance.

   Transition Zone (outer zone): Located outside of the protected habitat / City Preserve boundaries, but near enough to impact riparian/wetland habitat, and therefore functions as part of the wetlands buffer. Land use restrictions within this zone must comply with HMP Adjacency Standards (HMP p. F-16), and restricted use standards within 200 feet of estuarine habitat (HMP p. D-95). All other land uses, including no permanent structures, minimal impervious cover, and restricted landscape palette and irrigation, are recommendations.

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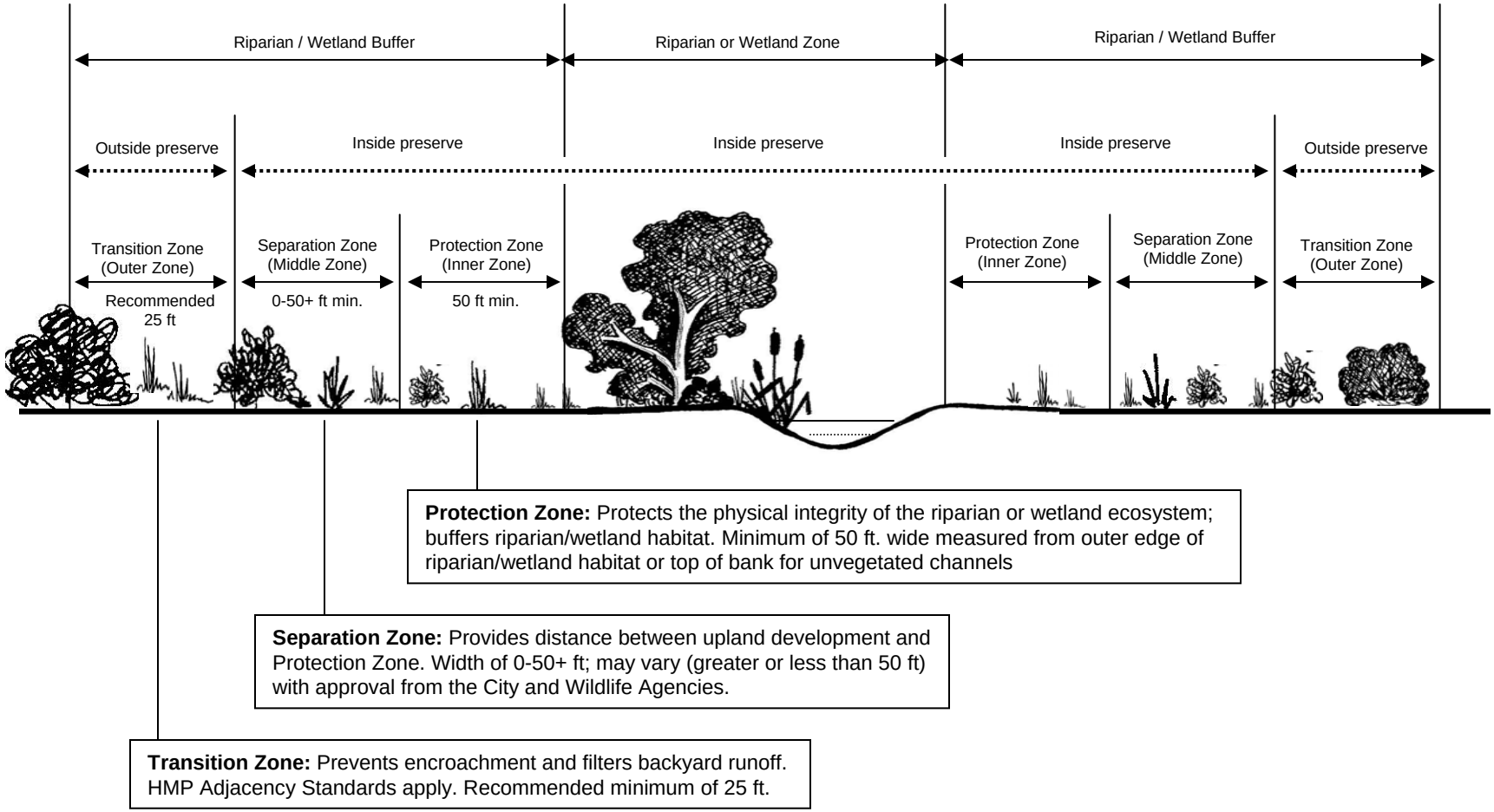

Figure 1. Protection, Separation, and Transition Zones

Table 2. Buffer Zone Requirements[1]

Characteristics	Protected Buffer (HMP Preserve)		HMP Adjacency Standards
	Protection Zone (Inner Zone)	Separation Zone (Middle Zone)	Transition Zone (Outer Zone)
Function	Protects the physical integrity of the stream or wetland ecosystem; buffers riparian habitat	Provides distance between upland development and protection zone	Prevents encroachment and filters backyard runoff
Width[2]	Minimum of 50 feet from the edge of riparian/wetland habitat	Minimum of 50 feet; may vary upon approval by City and Agencies[3]	Recommended 25 foot minimum setback to structures; may include restricted uses if adjacent to estuarine habitat
Landscaping / Vegetation	No alteration of native vegetation, if feasible. If disturbed, plant community must be restored to pre-development condition, or better.	No alteration of native vegetation, if feasible. If disturbed, plant community must be restored to pre-development condition, or better.	Native habitat encouraged but may be landscaped; limited irrigation; no invasives (HMP F-18 C). Additional recommendations: no permanent structures or septic systems.
Utilities and Stormwater Management Facilities	Delivery conduits with force dissipaters; erosion control drop structures; flood control facilities; water, sewer, and utility crossings. Access roads to these facilities permitted.	Facilities allowed in Protection Zone, in addition to off-line flow-through soft-bottom treatment wetlands and detention basins. Access roads to these facilities permitted.	Recommendation: BMPs allowed that treat up to 100 cubic feet/second.

[1] Source: Adapted from Stormwater Managers' Resource Center: Aquatic Buffers Fact Sheet and The Practice of Watershed Protection, Article 39. Zone 3 includes recommendations in addition to Adjacency Standards, as noted.

[2] Pursuant to the HMP, riparian habitat within the Coastal Zone requires a minimum buffer of 50 feet (rather than 100 feet); therefore there may not be a Separation Zone within the buffer. In addition, estuarine habitat requires restricted uses within 200 feet of the habitat edge. The 200 feet can be divided among the three zones as negotiated with the City and Wildlife Agencies; land uses within the outer zone (Transition Zone) must be consistent with the HMP (See Section 2.1, no. 6 of these guidelines).

[3] The Separation Zone may be greater or less than 50 feet (a) to preserve buffer function based on local conditions, and (b) with approval by the City and Agencies. See footnote 2 above regarding buffers adjacent to estuarine habitat.

2. The Protection and Separation Zones of the wetland and riparian buffers shall be individually identified on preserve area maps. Once established, the Protection and Separation Zones of an approved riparian/wetland buffer shall be incorporated into the City's HMP preserve.
3. The Protection and Separation Zones should be primarily managed for wildlife habitat, open space, and stormwater treatment, and should have no impervious surfaces or structures, except for paved access roads to stormwater facilities, erosion control drop structures, and flood control facilities.
4. If possible, Native vegetation within the Protection and Separation Zones shall not be altered. If disturbed, the area shall be (re)vegetated or landscaped with pre-development upland or upland / riparian transitional vegetation, consisting of native vegetation with species type and cover appropriate for site conditions within the buffer.
5. Parts of the Protection and Separation Zones where no pre-existing native riparian or upland vegetation was present prior to development, will be landscaped / vegetated with a temporary erosion control hydroseed mix consisting of native grasses and annual species. In addition, <5% non-native species will be allowed in these parts of the buffer, with no invasive exotic vegetation allowed.
6. Within the Transition Zone, non-invasive ornamental species such as turf grasses and non-invasive succulent groundcovers would be acceptable; however, native landscaping would be preferred.

2.5 Alternative Buffer Configurations

Applicants may request Alternative Buffer Configurations (ABCs) for specific projects to allow some reduction of buffer dimensions so long as the critical functions of the buffer and riparian systems are not impaired. A change (e.g., a reduction or increase) in buffer width could only occur in the Separation or Transition Zone; a change in the Protection Zone width is not allowed. Any proposed variation or deviation from the standard buffer configurations for a specific site shall require sufficient information to demonstrate that an alternative buffer design (i.e., buffer of lesser width) would be adequate to protect the functions and values of adjacent wetlands and/or riparian habitats. Such information may include, but is not limited to: geomorphic characteristics, including slope and erodibility of soils, wetland integrity, habitat quality within the buffer, adjacent land use, the size and type of the development, and any proposed mitigation that will also achieve the purposes of the buffer (see Section 3.0 for more information). Note that alternative buffer configurations may not be approved if the area drains to a Clean Water Act (CWA) 303d-listed impaired water body. The City of Carlsbad shall consult with California

Department of Fish and Game, U.S. Fish and Wildlife Service (and Coastal Commission staff for projects within the Coastal Zone) during the CEQA review process in making such buffer determinations.

Examples of Alternative Buffer Configurations may include the exclusion of a portion of the floodplain from the fixed buffer or the allowance of other encroachments into the ideal minimum fixed buffer. Reduced buffers shall not impact sensitive species or known wildlife movement corridors (which must be documented in the Biological Resources Technical Report), must not affect floodwater conveyance, and must not reduce other biological functions of the buffer. Section 3.0 should be consulted when making a determination regarding alternative buffer design.

Where feasible, encroachment within the riparian/wetland buffer zone should be mitigated by enlargement of the riparian/wetland buffer dimensions elsewhere on the parcel. For example, where the establishment of a 100 foot wide buffer is infeasible due to existing development, the surrounding riparian/wetland buffers should be widened to create a buffer averaging 100 feet in width (per 100 feet of channel length).

When considering a buffer reduction, land managers and local regulators should consider the health and functionality of the watershed in its entirety. Furthermore, for streams and rivers where the floodplain and stream corridor are confined and are no longer of sufficient width to protect the riparian or wetlands habitat, modifications of the buffer standards may be made such that the essential biological and hydrological functions of the buffer are carried out. This may require the installation of engineered swales, catchments, plantings, bioengineering bank retention measures, etc. However, whenever possible, bank stabilization hardscape and engineered flood control structures should be removed from the stream to allow for dynamic stream behavior, which will ultimately also reduce erosion, increase ground water recharge, and promote plant diversity in riparian or wetland vegetation communities.

3.0 Additional Considerations

When designing protective buffers, it is imperative to consider the physical and biological characteristics of the site. This section describes the most pertinent considerations that should be analyzed, including hydrogeomorphology, riparian and wetland habitat integrity, habitat quality, and adjacent land use. Table 3 provides a summary of these characteristics and how they tend to affect functionality of a buffer. For example, potential buffer areas with the following characteristics will tend to provide a good (high) buffer function: high soil/ground permeability, low surface erodibility, high habitat integrity, and/or low intensity adjacent land use. Areas with the characteristics of a low-functioning buffer may have to be larger to accommodate the same buffer function.

Table 3. Site Characteristics and Buffer Functionality

Characteristic	Buffer Functionality			Comments
	Low	Medium	High	
Soil/Ground Permeability	Low (e.g., permeability coefficient k <.001 cm/sec	Medium (e.g., 0.001 < k <0.01)	High (e.g., k> 0.1)	Surfaces with low permeability generate more runoff, leading to increased volume and velocity of peak flows down stream, which could cause greater erosion and sedimentation, and possibly changes in habitat.
Surface Erodibility	High	Medium	Low	Higher erodibility may lead to degradation of habitat and increased sedimentation. Surface erodibility may be affected by vegetative cover, soil texture and composition, and slope.
Habitat Integrity	Low	Medium	High	Lower integrity signifies higher impairment of the riparian system, and less capacity to function as a habitat buffer.
Habitat Quality	Low	Medium	High	Higher quality habitat is a higher priority for inclusion in the Protection and Separation Zones of the riparian buffer due to its value to wildlife. Higher quality habitat would be less likely to be approved for buffer reductions. Additionally, lower quality habitat may provide less buffer function, and may therefore, require additional enhancements.
Adjacent Land Use	High Intensity	Medium Intensity	Low Intensity	More intensive adjacent land uses may require higher functioning buffers around nearby wetland/riparian habitats (e.g., additional mitigation through BMPs and/or greater width).
Downstream Water Quality	High	Medium	Low	Low downstream water quality indicates that the current conditions are not providing adequate buffer function and therefore, restoration of the buffer may be recommended.

3.1 Site Hydrogeomorphology

Site hydrogeomorphology (geology, geomorphology, hydrology and soils) is important to consider when designing buffers for aquatic or wetlands resources protection. In order to design the most effective buffer configuration for proposed development projects, a qualified engineer should conduct relevant hydrologic and geotechnical tests to evaluate site geomorphology and perform a standard risk assessment.

Human-caused soil erosion, in excess of natural systems, can damage riparian and wetland habitats by carrying away native soil, and by causing bank cutting/destabilization, downstream flooding, and sedimentation. Eroded materials fill reservoirs, ponds, and drainage ditches, and silt up estuaries, which may result in detrimental changes to vegetation community structure, wildlife, and water quality. Several water bodies in Carlsbad are listed in the CWA 303(d) list as impaired for sediment by the USEPA and State of California. Therefore, it is important to assess the permeability (infiltration) and erodibility of soils when designing appropriate protective buffers for riparian and wetland habitats.

Permeability. High infiltrating soils retain more water locally and generate less runoff compared to lower infiltrating soils. Paving, armoring, or creation of other impermeable soils surfaces would result in a more rapid discharge of runoff and could potentially cause an increase in the volume of peak flows downstream, which could cause erosion, undercutting of stream banks and sedimentation. Resultant impacts to habitat could include degradation of adjacent woodland by destabilizing soil substrate, causing large trees to fall, and thereby reducing canopy cover. Another potential impact could be rapid succession of wetland or riparian habitat due to increased sedimentation (e.g., overgrowth of cattails in a pond or estuary, or changes from southern willow scrub to mulefat-dominated habitat).

Erodibility. Soil erodibility is affected by the amount and type of vegetative cover, soil characteristics (e.g., texture and structure), and slope. For example, the root system of woody perennials, such as sage brush, is able to bind and retain the soil much more effectively than shallow-rooted annuals or bare ground. Soils with coarser texture and a higher percentage of organic material tend to be less erodible than fine-grained, inorganic soils. Depending on soil type, more buffer along the tops of slopes may be needed to reduce human-caused erosion.

Potential project impacts to wetland resources both onsite and downstream should be considered when designing wetland buffers. It is recommended that riparian buffers be

wider than the minimum along streams or watercourses situated on soils rated as moderate to severely erodibile (as determined by the USDA), and that appropriate permanent erosion control measures be installed, which may include habitat restoration. In addition, development adjacent to or upstream from moderate to severely erodible soils may require additional measures to reduce the velocity of peak flows, and reduce erosion and sedimentation downstream.

3.2 Riparian/Wetland Habitat Condition

For the purpose of establishing functional buffers and ensuring the adaptive management of riparian/wetland buffer areas, it is first imperative to classify the integrity (condition of riparian/wetland system) and quality of the riparian areas that the buffers are designed to protect. Habitat integrity and quality may be used as indicators of overall habitat condition. Habitat with high integrity and/or quality, as described below, should be the greatest priority for protection and inclusion into the buffer design. Because areas of lower habitat quality tend to discharge runoff more rapidly, tend to remove fewer pollutants and contamination from stormwater runoff, and tend to be less capable of resisting erosion, buffers consisting of lower quality habitats may be considered less effective in protecting wetlands and riparian habitats. These areas may require wider buffer widths and/or additional enhancements (e.g., measures to reduce erosion and sedimentation or habitat restoration) to provide adequate protective function.

For the purpose of these guidelines, wetland, stream, and riparian integrity can be classified into the following three categories:

High Integrity: Non-incised natural (non-engineered) streams with continuous or nearly-continuous adjacent riparian vegetation including native riparian tree and shrub species.

Moderate Integrity: Moderately-incised natural (non-engineered) streams with limited native riparian vegetation adjacent to stream channel, unvegetated ephemeral and intermittent streams and washes, natural streams with low to moderate infestations of non-native species.

Low Integrity: Artificial (engineered) streams with limited riparian vegetation, natural streams with heavy infestation of non-native species, heavily incised natural streams with no native riparian vegetation.

Habitat quality within the buffers can be determined by assessing the presence or absence of federal or state listed species, HMP covered species or narrow endemic species;

diversity of native species; habitat function; ecological role of the wetland; potential for habitat enhancement or restoration; connectivity to other natural habitats; and hydrological function. Table 4 lists the factors and quality indicators to be used in determining habitat quality.

Table 4. Factors for Considering Riparian/Wetland Habitat Quality

Factors	Quality Indicators
Sensitive Species	Presence of federally- and/or state-listed endangered or threatened plant or animal species, or HMP covered species.
Flora and Faunal Diversity	Species richness of native plants and/or animals.
Habitat Function	Function as wetland habitat, including habitat for migratory birds, tidal circulation.
Ecological Role of the Wetland	Historic function (tidal) of wetland and regional context. Hydrologic isolation/connection
Potential for Ecosystem Enhancement	Potential for habitat restoration/enhancement. Feasibility for restoration of tidal influence (e.g., >¼mile).
Connectivity	Connectivity to intact or otherwise high quality wetland or upland habitats (including use as part of avian migration) considering the resources.
Hydrologic Function	Volume and retention time of water within the wetland. Ground water recharge & drainage. Flood attenuation value and velocity reduction function.

Additional Freshwater or Brackish Wetlands Quality Classification Criteria

1. As marine/terrestrial interface areas where saline and freshwater systems meet, tidally-influenced brackish wetlands are critical to natural wetland "flushing" processes and would generally be considered high quality wetlands.
2. Characterizations of freshwater and brackish wetlands flora and fauna should be performed during the proper season (i.e., blooming season for plants, and breeding season for birds). The actual survey window will depend on the potentially occurring species, which will be determined on a site-by-site basis.
3. Hydrologic modeling of the potential effects of any development related impacts on the upstream and downstream biota and flood regime must be conducted as part of the environmental review and buffer design processes.
4. Because areas of lower habitat quality tend to discharge runoff more rapidly, tend to remove fewer pollutants and contamination from stormwater runoff, and tend to be less capable of resisting erosion, buffers consisting of lower quality habitats may be considered less effective in protecting wetlands and riparian habitats.

3.3 Adjacent Land Use

Industrial /commercial, municipal, residential, and agricultural land uses all have the potential to discharge pollutants, including fertilizer, pesticides, sediment, and pet waste, or be detrimental to wetlands and riparian areas. Adjacent land use should therefore, be considered when designing a high-functioning buffer, which may require a larger area to protect adjacent wetlands and riparian habitats.

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4.0 Restricted Uses in Buffer Areas

Restricted uses within each buffer zone are described below and summarized in Table 5.

Table 5. Restricted Uses in Buffer Zones

Restricted Uses	Protection Zone (Inner)	Separation Zone (Middle)	Transition Zone (Outer)
Vegetation/Landscaping			
Invasive exotic species prohibited	x	x	x[3]
Non-invasive exotic species prohibited	x		Recommended
Irrigation prohibited[1]	x	x	
Reduced irrigation, runoff directed away from preserve			Recommended
Herbicdes/pesticides prohibited[2]	x	x	Recommended
Fuel Modification			
Fuel modification zone 1 prohibited[3]	x	x	x
Fuel modification zone 2 prohibited[3]	x	x	x[4]
Fuel modification zone 3 prohibited[3]	x	x	
Lighting			
Artificial lighting prohibited[5]	x	x	
Low intensity lighting directed away from preserve			x
Stormwater Devices, Utilities, and Other Impervious Surfaces (Non-Essential)			
No armoring/impervious surfaces[6]	x	x	Recommended
Sewage Treatment			
Installation of sewage disposal or treatment systems prohibited	x	x	Recommended

[1] Unless part of an approved restoration project

[2] Except to control exotic species

[3] Applies to new developments

[4] Unless approved by the City and Wildlife Agencies

[5] Unless required for safety reasons

[6] Except for essential flood control, storm water outflow devices (with force dissipaters), erosion control/grade stabilization devices, water, sewer, and utility crossings, and access roads. Within the Separation Zone, stormwater facilities are allowed if not detrimental to buffer function of the zone, maximum contributing basin does not exceed 100 acres, and ponds are used only to manage storm water quantity and quality within the buffer.

4.1 Protection Zone

1. Vegetation/landscaping: Native vegetation only. If possible, no alteration of existing native vegetation is allowed. If disturbed, the plant community must be restored to pre-development condition, or better. Abatement of invasive exotic plant species (HMP Table 12) shall be required as a condition of approval for new

development projects. Restore exotic weed removal areas with native species appropriate to biological goals. Avoid genetic contamination by using only locally collected seeds and locally propagated plants for habitat restoration. Irrigation is prohibited unless part of an approved restoration project. Herbicides and pesticides prohibited except to control invasive species, subject to Wildlife Agency approval.

2. Fuel modification: For new developments, fuel Modification Zones 1, 2, and 3 are prohibited.
3. Lighting: No artificial lighting unless required for safety reasons. If required for safety, use low intensity illumination sources. Do not use low voltage outdoor or trail lighting, spot lights, or bug lights. Shield light sources adjacent to the preserve so that lighting is focused downward.
4. Storm water devices, utilities, and other impervious surfaces: Only essential flood control, storm outflow devices (with force dissipaters), temporary water quality monitoring devices and stations, erosion control/grade stabilization devices, sewer, water transmission lines, other utility lines, and storm drains allowed. No other armoring/impervious surfaces shall be allowed (with the exception of access roads to essential facilities).
5. Sewage Treatment: Installation of new sewage disposal or treatment systems is discouraged.

4.2 Separation Zone

1. Vegetation/landscaping: Native vegetation or *non-invasive* naturalized vegetation (non-native plants that have become established without the use of irrigation). only. If possible, no alteration of existing native vegetation is allowed. If disturbed, the plant community must be restored to pre-development condition, or better. Abatement of exotic *invasive* plant species (HMP Table 12) shall be required. Restore exotic weed removal areas with native species appropriate to biological goals. Avoid genetic contamination by using only locally collected seeds and locally propagated plants for habitat restoration. Irrigation is prohibited unless part of an approved restoration project. Herbicides and pesticides prohibited except to control invasive species, and by Wildlife Agency approval.
2. Fuel modification: For new developments, fuel Modification zones 1, 2, and 3 are prohibited.
3. Lighting: No artificial lighting unless required for safety reasons. If required for safety, use low intensity illumination sources. Do not use low voltage outdoor or

trail lighting, spot lights, or bug lights. Shield light sources adjacent to the preserve so that lighting is focused downward.

4. Stormwater management devices, utilities, and treatment facilities: Storm water management facilities are allowed if the following conditions are met: facilities are not detrimental to zone function, maximum contributing drainage basin does not exceed 100 acres, ponds are used only to manage storm water quantity and quality within the buffer, and they are not hardscaped. Other structural devices to buffer and/or attenuate stream flow are permitted, including off-line flow-through treatment wetlands, detention basins, French drains, and storm drains with first-flush treatment devices (e.g. trash racks, oil-water separators, storm vaults, etc.)

5 Sewage treatment: Installation of new sewage disposal or treatment systems is discouraged.

4.3 Transition Zone

1. Vegetation/landscaping: Native and/or non-invasive naturalized plants are preferred. Eradicate exotic invasive species based on biological desirability and feasibility (HMP Table 12). Restore exotic weed removal areas with native species appropriate to biological goals. Use of invasive exotic species is prohibited for new public projects and for projects within the Coastal Zone. Ensure that no new surface drainage is directed into the preserve to protect stream hydrology and water quality, to reduce erosion, and to reduce invasion by non-native plant and animal species. Limit the use of herbicides and pesticides to the degree feasible.

2. Fuel Modification: Fuel modification zone 1 is prohibited. Fuel modification zone 2 is allowed if approved by the City and Wildlife Agencies. Fuel modification zone 3 is allowed.

3. Lighting: Low intensity lights only, directed away from the buffer.

4. Storm water devices, utilities, and other impervious surfaces: Impervious surfaces are discouraged. Generally, residential and commercial uses are acceptable; however, if the zone exceeds 10% impervious cover, it is recommended that these uses be placed outside of this zone. In addition, it is recommended that permanent structures and septic systems be placed outside of this zone. Urban runoff shall be treated before being released into the Protection Zone buffer areas.

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5.0 Allowable Uses

Restricted uses within each buffer zone are described below.

5.1 Protection Zone

1. Approved habitat restoration projects.
2. Essential stormwater control facilities, such as approved outfall devices with force dissipaters, and associated access roads.
3. Emergency flood control projects or essential flood control facilities. Access to facilities and for sediment removal to maintain flood capacity of creek or channel.
4. Essential sewer and water transmission lines and erosion control devices.
5. Essential utility access or roadway crossings, bridges, and culverts approved by the CEQA lead agency.
6. Essential bio-engineered erosion control/grade stabilization devices.
7. Utility right-of-ways.
8. Trails and passive recreation (e.g., hiking, bird watching, etc.) is conditionally allowed provided that construction of the trail and its proposed use is consistent with the preservation goals of the adjacent habitat, and that appropriate measures are taken for physical separation from sensitive areas. Within the Coastal Zone, recreational trails may be allowed within the first 15 feet of the buffer closest to the development if these conditions are met (HMP D-117). Although discouraged, other more intense uses, such as equestrian use or mountain biking may also be conditionally allowed if (a) consistent with the HMP and Open Space Management Plan (see issue 15, p. 3-23), (b) potential impacts are fully mitigated, and (c) approved by the City and wildlife agencies.
9. Temporary water quality monitoring devices or stations.

5.2 Separation Zone

1. All Protection Zone uses.
2. Approved stormwater BMPs and treatment facilities.
3. Critical public safety devices (Lighting, Traffic Control Signs, etc.).

5.3 Transition Zone

1. All Protection and Separation Zone uses.

2. Multi-use trails (pedestrian, bicycles, equestrian) Does not include motorized vehicle use.
3. Limited active recreation including:
    a. Public parks
    b. Athletic fields
    c. Golf courses
4. Fuel modification: Fuel modification shall be allowed only in accordance with the HMP, applicable local ordinances (City/County fire codes), and the Memorandum of Understanding with the San Diego County Fire Chiefs' Association Addressing Flammable Vegetation Abatement in San Diego County, dated February 1997. Fire retardant non-invasive ornamental plant species (e.g., some succulent groundcovers) permitted, which should be selected to minimize irrigation.
5. Low intensity grazing.
6. Low intensity agriculture may be allowed, except for commercial greenhouses.

6.0 Minimization and Mitigation Measures

6.1 Pre-Construction Minimization and Mitigation Measures

The following minimization and mitigation measures are designed to protect riparian and wetland habitats and associated sensitive biological resources from impacts related to pre-construction activities:

1. Proposed riparian/wetland buffer design, including buffer zones, shall be depicted on preliminary and final grading and landscaping plans;
2. Verify the suitability of the buffer for stormwater treatment;
3. Ensure that required stormwater and erosion control BMP's are properly integrated into the correct buffer zone;
4. Limit the number and conditions for riparian buffer crossings (e.g., roads, bridges, and underground utilities);
5. Prior to construction, buffer boundaries shall be demarcated with orange construction fencing, silt fence (if necessary) and appropriate signage so that all construction personnel and activities occur outside of the buffer;
6. As a condition of project approval, the Protection and Separation Zones shall become part of the HMP Preserve, and shall be subject to all requirements pertaining to preserve management, endowment funding, and the conservation easement. The Transition Zone may remain in private hands, but the landowner is encouraged to follow the Transition Zone recommendations, and must comply with HMP Adjacency Standards (HMP p. F-16), and restricted use standards within 200 feet of estuarine habitat (HMP p. D-95); and
7. Conduct pre-construction walk-through with construction superintendent, Resident Engineer (RE), Water Pollution Control Manager (WPCM) and other appropriate personnel to educate them about the buffer location, required stormwater and erosion control BMPs, and prohibited activities.

6.2 Construction-Related Minimization and Mitigation Measures

The following minimization and mitigation measures are designed to protect riparian and wetland habitats and associated sensitive biological resources during construction.

1. Erosion and Sediment Control: Appropriate minimization and mitigation measures shall be installed within the riparian/wetland buffer to prevent discharge

of sediment laden stormwater to the riparian zone or wetland during construction, as outlined in a Storm Water Pollution Prevention Plan (SWPPP).

2. Erosion and Sediment Control: Stabilize the banks around riparian buffer crossings and monitor crossings after severe storm and flooding events to determine if excess sedimentation is occurring.
3. Drainage: When the buffer receives flow directly from an impervious area, design curb cuts or spacers to spread runoff evenly over the riparian buffer area.
4. Vegetation: Minimize amount of existing vegetation that is disturbed for construction.
5. Light Abatement: Although discouraged, if nighttime construction is unavoidable, stationary lighting shall be shielded and directed away from riparian/wetland areas and buffers.
6. Noise Abatement: Construction noise shall not exceed 60dB Leq within the riparian/wetland habitat and buffer. If riparian/wetland habitat or buffer is occupied by sensitive species, species-specific conditions pursuant to the HMP and state and federal laws, must be met.
7. Dust Control: Standard dust control measures, such as street-sweeping and the use of water trucks, shall be employed as necessary during construction of all new facilities.
8. Hazardous Materials: No hazardous materials or petrochemicals may be disposed of or stored within any portion of mapped riparian/wetland buffer, or within 100 feet of riparian or wetland habitat.

7.0 Buffer Management and Monitoring

7.1 Buffer Management

1. Preserve Management Plan: As required by the HMP, a preserve management plan shall be prepared as a condition of approval to describe the biological resources, management, and monitoring strategies for the preserve area, including the Protection and Separation Zones of the riparian/wetland buffer.
2. Restoration and Enhancement: The restoration and enhancement potential for degraded portions of the buffer shall be determined and prioritized as part of the initial preserve area baseline assessment.
3. Access Control: As necessary, fences and signage shall be used to avoid non-allowable public uses within the riparian/wetland habitat and adjacent buffer.
4. Fire Control: Fuel modification shall be allowed only in accordance with the HMP, applicable local ordinances (City/County fire codes), and the Memorandum of Understanding with the San Diego County Fire Chiefs' Association Addressing Flammable Vegetation Abatement in San Diego County, dated February 1997.

7.2 Monitoring

For a preserve containing riparian or wetland habitats, the approved preserve management plan shall include the following monitoring activities in addition to any other requirements for monitoring the upland and non-riparian portions of the preserve:

1. Designated buffer areas shall be monitored annually as part of the regular preserve monitoring program to identify threats, including trash, illegal dumping, unauthorized trails, erosion, and non-native species.
2. It is recommended that the condition of riparian and wetlands habitat be monitored using the (California Rapid Assessment Method (CRAM), as described in http://www.cramwetlands.org to determine appropriate wetlands and buffer functions, and to recommend potential changes in buffer design and configuration. Resulting data should be entered into the CRAM database.
3. Buffer crossings shall be monitored for adverse effects on buffer function. Actions to eliminate identified threats shall be initiated immediately.

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