RETAINING WALL DESIGN GUIDELINES

PREPARED FOR:
THE CITY OF LAKE FOREST

BY:
TRG Land

Approved by City Council June 15, 2010

A. PURPOSE AND APPLICABILITY

The Land Use Element of the General Plan contains goals and policies to ensure that new development is compatible with the community and that a distinctive image and identity is created. These Retaining Wall Guidelines are an outgrowth of those policies. The objective of the Guidelines is to ensure that proposed retaining walls are constructed in an aesthetically-pleasing and high quality manner that fits within the character of the community.

The Guidelines will assist City Staff and the Planning Commission in evaluating projects that include retaining walls. The Guidelines and Application Submittal Requirements are not intended to apply to existing single-family residential properties. Design solutions not listed in the Guidelines that result in a better aesthetic image while preserving community compatibility are welcome and will be considered.

The Guidelines are not specifications and should not preclude alternatives of equal quality or restrict creativity. Rather, they are intended to be used as a resource for the land developer, engineer, and land planner to ensure that the design and character of proposed retaining walls are appropriate to the location in which they are used.

The Guidelines should be viewed as qualitative rather than mandatory development standards and may be interpreted with some flexibility, subject to Planning Commission approval. Design Guidelines that utilize the term "shall" are to be applied as the preferred mechanism for development projects. Guidelines that use the word "should" are discretionary and alternative measures may be considered if those measures meet or exceed the intent of the Guidelines.

Although these Guidelines have been established, it should be well understood that the use of retaining walls along the exterior perimeter of a development is not encouraged. A strong preference exists to utilize grading measures and manufactured slopes along the exterior perimeter of a development.

B. GOALS AND OBJECTIVES

The primary goal of the Retaining Wall Design Guidelines is to promote a positive physical image and high quality design. This Goal is supported by the following objectives:

- Ensure that retaining walls are designed to:
  - Minimize visual impacts.
  - Exhibit appropriate scale, mass, form and character.
  - Incorporate quality design features.
  - Achieve compatibility with surrounding environment.
  - Coordinate with the design of associated development.
  - Incorporate provisions for public safety.
  - Provide for long-term maintenance.
- Promote a balance between the desire of the property owner to create developable land with the Community's desire for high quality, visually harmonious development.
- Encourage early coordination between project proponents and City staff.
- Facilitate the review and processing of development applications by establishing submittal requirements for projects that include retaining walls.

C. GENERAL GUIDELINES

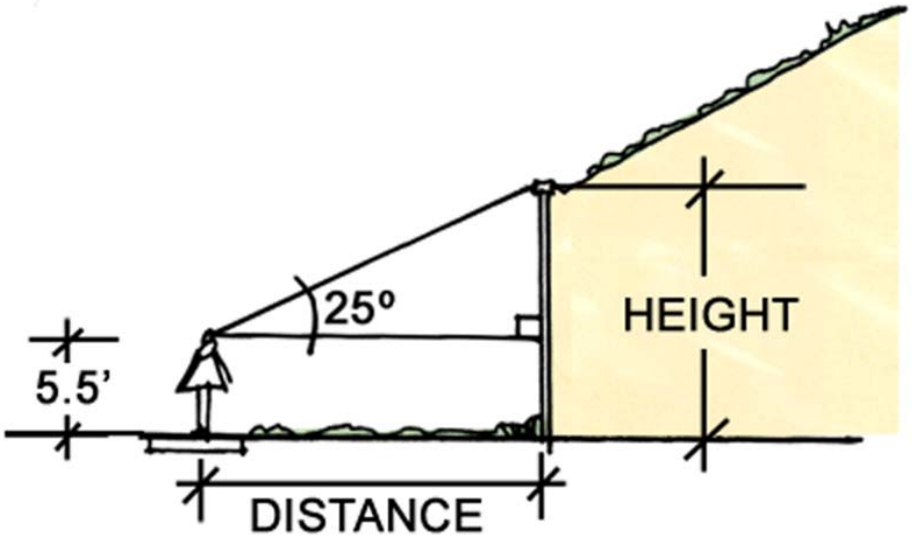
1. WALL HEIGHTS AND SETBACKS

- Retaining walls should exhibit a height to setback relationship that is appropriate to the context and setting, and which allows the viewer to not be overwhelmed by the wall; and in general, consistent with the ratios provided in Table 1.
- In general, a landscape setback in front of a retaining wall should be increased in proportion to the height of the wall.
- The following table provides suggested setbacks for a progression of wall heights. The "DISTANCE" should be considered a baseline or starting point from which to determine the appropriate setback for any particular wall, based on the context of the wall and the design features incorporated.

Table 1

HEIGHT OF WALL (FT.)	DISTANCE (FT.)
10	10
15	20
20	30
25	40
30	50
35	65

*SEE APPENDIX FOR FORMULA USED TO DERIVE RATIOS AND GRAPHIC REPRESENTATIONS



2. COMPATIBILITY IN CONTEXT

Retaining walls should be designed with consideration to the following:

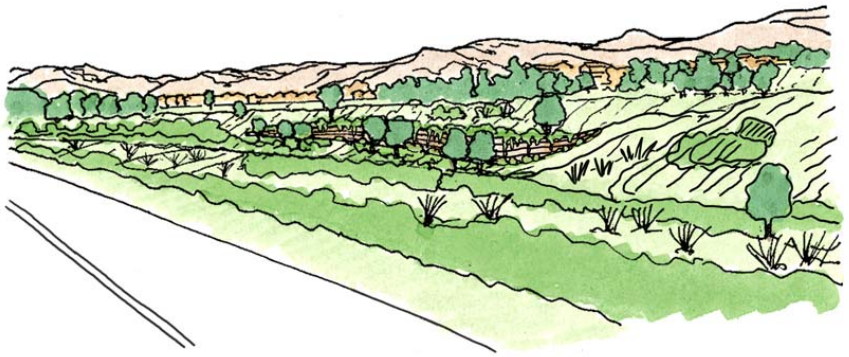
- The perspectives from which the wall may be viewed.
- The time frame generally presented for viewing the wall by pedestrians, motorists, etc., and from likely (stationary or mobile) vantage points.
- The color of the wall in relationship to other existing and proposed site features, including buildings, landscaping and hardscaping.
- The geometry or shape of the wall and the transitions at the top and base of the wall.
- The solar orientation of the wall and resulting shade and shadow lines.
- The proximity of the wall to the viewer.

Retaining walls should be designed to achieve the following:

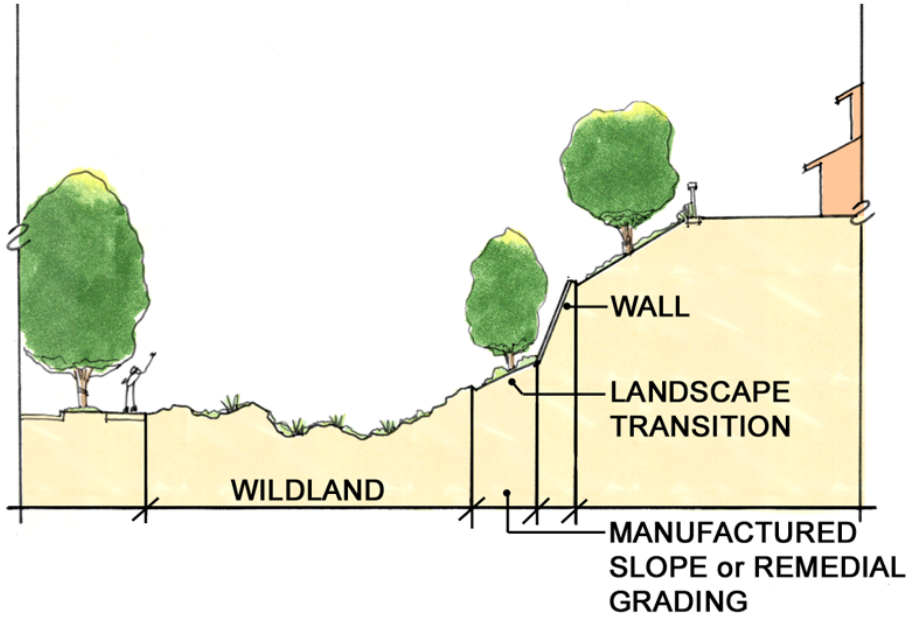
- Compatibility with the scale, mass, form and character of the proposed project (colors, materials, etc.) and the surrounding environment.

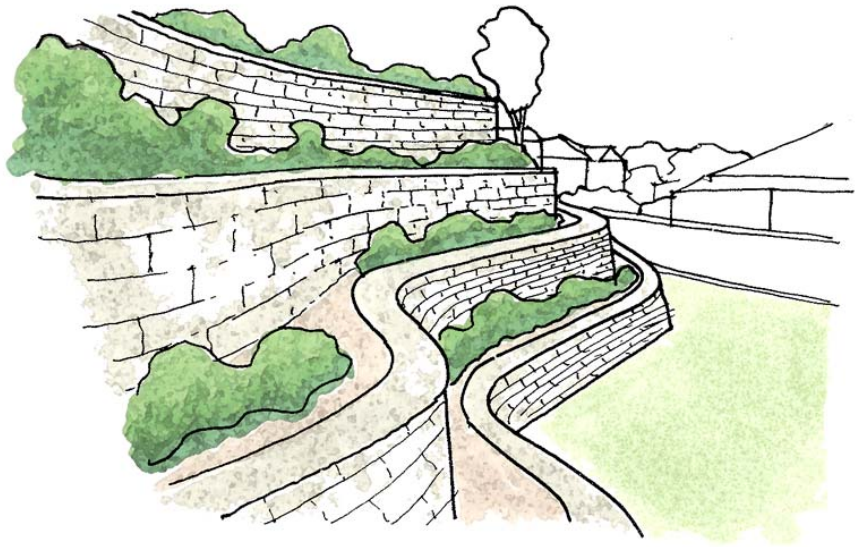
- In commercial and industrial areas, place necessary walls at the rear of sites as opposed to on the street side.
- At corner locations, curve or angle the wall along the street frontages to avoid “sharp” corners.

- In vehicular-oriented settings where the wall is viewed from a distance or when traveling at greater speeds, use techniques that help the wall blend in with the environment, such as varied height, terracing and landscaping.
- In areas adjacent to natural open space, incorporate native landscaping and undulating, irregular configurations in an effort to blend the wall into the surroundings.



- In areas of wildland interface, remedial grading should be anticipated beyond the toe of slope.
- Landscaping within wildland interface areas must comply with local fire codes and regulatory agency requirements.





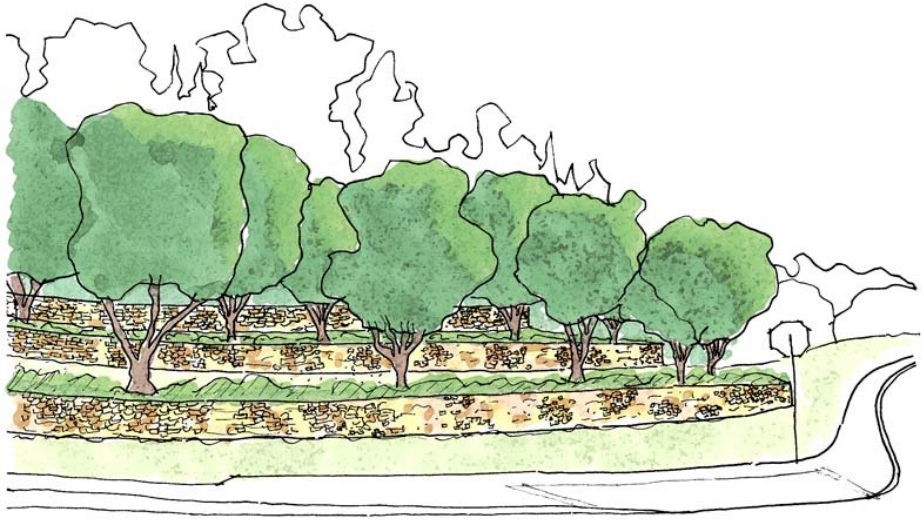
3. DESIGN FEATURES

Retaining walls should include design features to soften the wall's appearance.

- Avoid large expanses of blank, flat wall surfaces.
- Incorporate offsets, varied setbacks and/or curvilinear forms.
- Long retaining walls should incorporate terracing, with sufficient planter width provided between the terraces to create a functional planter area for trees and shrubs and drainage improvements.
- When individual walls of varying height are used in a terraced configuration, the wall nearest the sidewalk, street or other useable space should be the shortest.
- Incorporate a 2:1 slope at the base of the wall in order to soften its appearance and create a planting opportunity.

4. VISUAL INTEREST

Retaining walls should provide visual interest and incorporate quality design features.



- Include design features, such as pilasters, decorative caps and color or material changes to add visual interest.
- Walls with exposed faces visible from sidewalks, streets, parking lots and other public spaces should be designed with aesthetically pleasing surfaces, such as split face concrete block, natural stone or decorative veneer.

5. LANDSCAPE CONSIDERATIONS

Retaining walls should be designed to minimize their negative visual impact on the surrounding environment through the incorporation of landscape elements.

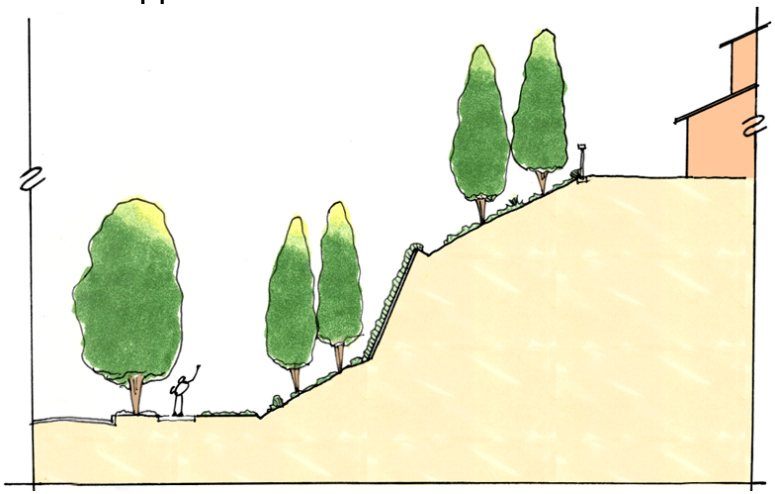
- Incorporate the use of water efficient landscape materials, in accordance with the City's Municipal Code.
- Carefully evaluate the soil conditions, solar orientation and maintenance requirements during the design of retaining walls to insure landscape material will thrive in perpetuity.
- Walls should be designed in conjunction with a landscape architect and with consideration for plant selection, planter widths, slope angles, drainage and irrigation.

- Provide adequate space at the top and base of retaining walls to allow for drainage improvements.

- Carefully consider options for irrigation in terms of aesthetics and maintenance.

- Provide a landscape area at the top of the wall as a transition or buffer to the building pad.

- Incorporate landscape planting areas at the base and top of the wall, and in the terraces and off-sets as applicable.



- Coordinate with the Orange County Fire Authority and Resource Agencies to create a suitable landscape palette for projects with retaining walls proposed in the Wildlife Interface Zones or in areas with native vegetation.

6. SAFETY AND MAINTENANCE

Retaining walls shall be designed to promote safety and to ensure long term maintenance.

- Incorporate the use of landscaping and appropriate plant materials to deter climbing where walls are accessible.

- Where applicable and appropriate, provide a safety railing at the top of the wall. Open fencing is encouraged where appropriate, in lieu of a wall or solid fence.

- Maintenance responsibility for walls on common property or spanning multiple, independently owned parcels shall be assured in Covenants,

Conditions and Restrictions (CC&R's) or other legal document.

- Provisions shall be made for access to walls which incorporate landscaping or otherwise necessitate periodic maintenance, including any necessary easements over private property.
- Establish landscape easements over subterranean retaining wall geogrids, and require minimum setbacks to allow for trees to be planted without diminishing the integrity of the geogrid, where necessary.
- Areas with building restrictions related to proposed retaining walls shall be clearly identified on the project plans and identified in the CC&R's.

D. APPLICATION SUBMITTAL REQUIREMENTS

The application submittal requirements listed below are intended to apply generally to all retaining walls that are proposed in conjunction with new development projects.

The submittal requirements shall include sufficient detail and information to allow a non-expert to fully evaluate the consistency of the wall(s) with these guidelines and to visualize the full scope and design of any proposed retaining wall, including the footing. Project applicants are encouraged to consult with Development Services Department staff regarding the applicability of any particular submittal requirement prior to formal application submittal.

- All proposed retaining walls, including locations, heights and materials, shall be depicted on each applicable sheet of the project plans submitted to the City for review and approval. Wall heights shall be noted at changes in wall height, where height variations occur, and at regular intervals of sufficient frequency to fully describe the proposed wall. Measured wall heights to be noted include the full height (from the top of footing to the top of wall, the exposed face height, and the height from the daylight line to the top of the wall. Plans shall depict property lines and right-of-way lines, and shall be stamped and signed by a Civil Engineer registered in the State of California.

- Project plans shall include section drawings at 1:1 ratio for all proposed walls, such that, at minimum, all distinct wall segments are generally represented in section view, including retaining and non-retaining portions of each wall. Section drawings shall depict existing and proposed grades on both sides of the proposed wall to a minimum distance equivalent to the height of the wall, and beyond the daylight line where retaining walls are used in combination with slopes. Where the height of any distinct wall segment varies, sections drawings shall represent the tallest condition. A sufficient number of section drawings shall be submitted to depict the retaining at prominent locations, such as along the public street, at the project entry and key vantage points viewed by the public.

- A cut and fill map identifying proposed fill areas graphically, with the depths of such areas clearly shown in 5-foot maximum contour lines. Quantities of each cut and fill area shall be specified on the map.

- A minimum of two photo simulations depicting the proposed retaining wall(s) as viewed from prominent locations on and off site, without landscaping, with newly planted landscaping and with mature landscaping of approximately five years. For retaining walls used in combination

with landscaping (in front, behind or on the wall), photo-simulations shall depict the proposed wall with anticipated landscaping at one year and five years following construction. Please consult with City staff regarding the vantage points of the simulation prior to preparing the exhibits.

- A detailed soils analysis shall be prepared by a registered engineer and submitted in conjunction with plans for development projects that include retaining walls. This analysis shall include on-site soil sampling at the precise wall location and laboratory testing of materials to provide detailed recommendations for grading, chemical and fill properties, retaining walls, streets, utilities, dewatering, protection of adjacent existing structures, landscaping, and liquefaction requirements. Said report shall certify that post development ground water conditions shall not be affected or affect improvements, and provide sufficient detail to substantiate and support the design concepts represented in the development application.

- Areas with building restrictions related to proposed retaining walls shall be clearly identified on the project plans and identified in any applicable CC&Rs.

- The basis for determining the type of retaining wall(s) proposed for each project/ site shall be described in a written narrative submitted with each project proposal. The narrative shall identify and discuss factors such as whether the wall will retain in a cut or fill slope, soil composition, accessibility of the wall for construction and maintenance, the use of slopes in combination with the wall, the height and rate of grade of any slope(s), aesthetics, lateral pressure, surcharge, internal and external loads, ground water and surface water drainage, climate and solar orientation, cost, use of integrated landscaping, setbacks at the top and base of the wall, public safety and any regulatory specifications.

- The applicant shall submit a written narrative identifying and describing in detail the proposed means (e.g., CC&Rs) of ensuring the long-term maintenance of retaining walls which traverse multiple independently owned parcels, and/or walls under common ownership via a property owners association.

- Engineering studies, prepared by a registered engineer, demonstrating the appropriateness of the proposed wall for the project site, shall be submitted concurrent with the project plans. Required studies shall, at a minimum, address the following:

  - Geotechnical design parameters include seismic information and shear strength calculations.

- Whether onsite materials will be acceptable for backfill between any proposed geogrids, or if soil import is needed for wall construction.
- Recommendations for minimum setbacks from proposed walls to proposed structures, based on the design parameters of the proposed wall.
- Recommendations for restrictions on structures and improvements, including swimming pools, walls/fences and trees, within proximity of proposed retaining walls.

E. STANDARD CONDITIONS OF APPROVAL

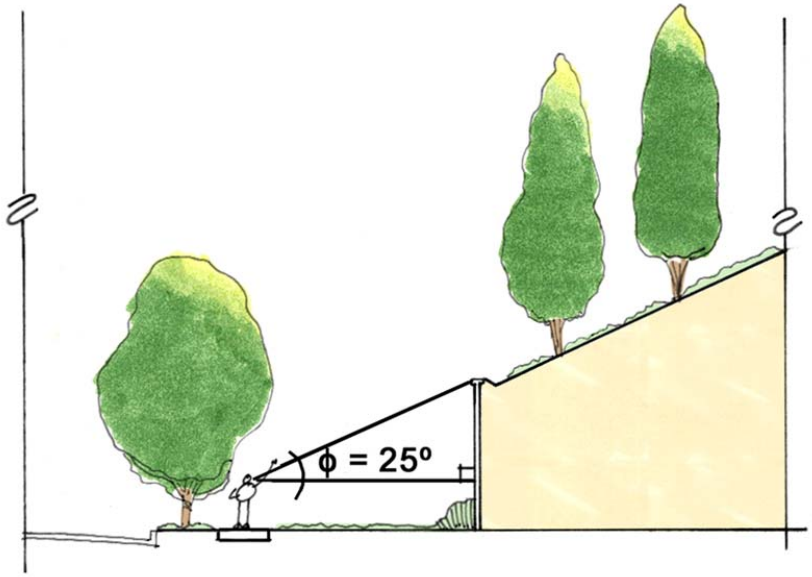
- An encroachment permit shall be obtained from the Public Works Department for any wall adjacent to or within the public right-of-way.
- All retaining walls and associated landscaping shall be maintained in the City-approved condition.

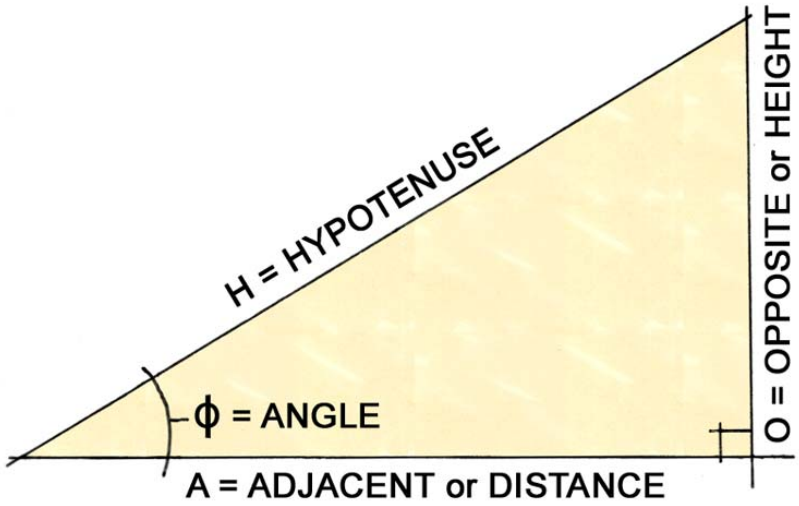
The following conditions of approval shall be applied to any project that contains retaining walls which are: (a) under common ownership and/or (b) traverse multiple, independently-owned parcels:

- CC&R's shall be submitted to the City for review and approval by the Director of Development Services, the Director of Public Works/City Engineer and the City Attorney, prior to recordation. CC&Rs shall identify the entity (e.g., property owners association) responsible and liable for the maintenance and repair of all common area improvements and shall specify those improvements, including but not limited to: retaining walls, non-retaining walls, slopes, landscaping, irrigation and drainage improvements, private streets, driveways, walkways, and community facilities. The CC&R's shall identify the mechanism for funding all necessary (anticipated and unanticipated) maintenance and repairs.
- A property owner's association shall be formed for the purpose of assuming maintenance responsibility for retaining walls in all instances where retaining walls traverse multiple independently owned parcels.

APPENDIX 1: TABLE 1 DISTANCE FORMULA

The distances provided in Table 1 were derived based on the formula represented in the following graphics. The formula is based on the premise that the appropriate height to setback relationship generally allows for the viewer to see the top of the wall, using normal lines of sight from a standing position.





APPENDIX 2

At the June 1, 2010, City Council meeting, City Council directed staff to review the following supplemental text, and to advise City Council how the language would be interpreted by staff:

> *"Although these guidelines have been established, it should be well understood that the use of retaining walls along the exterior perimeter of a development is not encouraged. A strong preference exists to utilize grading measures and manufactured slopes along the exterior perimeter of a development."* (Retaining Wall Design Guidelines – Page 2)

In the context of the Guidelines, staff would interpret the language as follows:

> While retaining walls along the exterior perimeter of a project are strongly discouraged, they may be permitted on a case by case basis, at the discretion of the Planning Commission, if they result in a better aesthetic image, preserve community compatibility and meet or exceed the intent of the Guidelines. Furthermore, although the City maintains a strong preference for manufactured slopes over retaining walls, other solutions which result in a better design may be considered.

RETAINING WALLS

MARCH 2009

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I. INTRODUCTION

The City Council has directed staff to prepare a report on retaining walls for consideration by the Planning Commission. The purpose of the report is to provide information on the use of retaining walls generally and the associated issues, such as design standards and maintenance. The City Council further directed that the Planning Commission, after consideration of this report, report back to the City Council.

This report focuses on basic retaining wall concepts and applications and identifies options available for regulating retaining walls which the City may opt to explore further. The issue of retaining walls is relevant to Lake Forest, which features generally sloped topography in areas of the City between Trubuco Road and Foothill Ranch and a change in elevation of more than 700 feet between I-5 and Foothill Ranch.

II. RETAINING WALL CONCEPTS

A retaining wall is a structure, either freestanding or laterally braced, that bears against an earth or other fill surface and resists lateral and other forces from the material in contact with the side of the wall. Retaining walls are commonly used to level, retain or terrace a sloping area and to minimize the grading necessary to achieve developable building pads. Retaining walls are also used, in combination with backfill, to increase the usable/developable areas of a site and as an alternative to manufactured slopes, the use of which is limited by maximum slope steepness. Retaining walls may be used to alter the character of a slope and achieve a more vertical form, to allow a more abrupt change in grade than can be achieved with graded slopes, and to support a level area such as a patio or driveway. The use of retaining walls varies widely – from do-it-yourself backyard/ homeowner projects to major landform stabilization projects associated with tract developments or commercial centers.

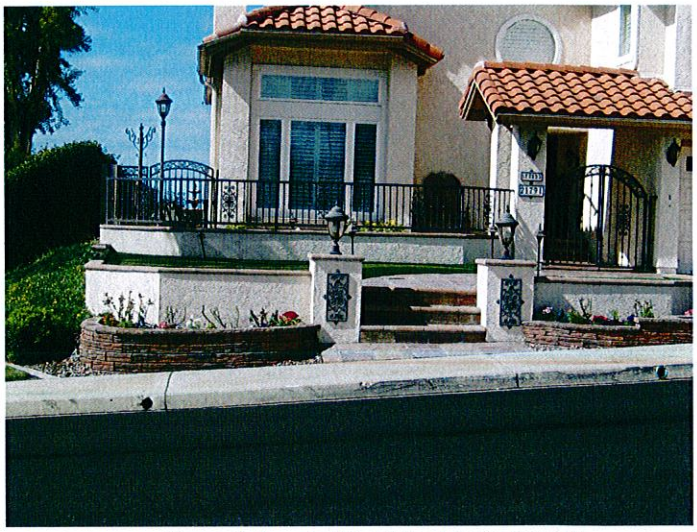
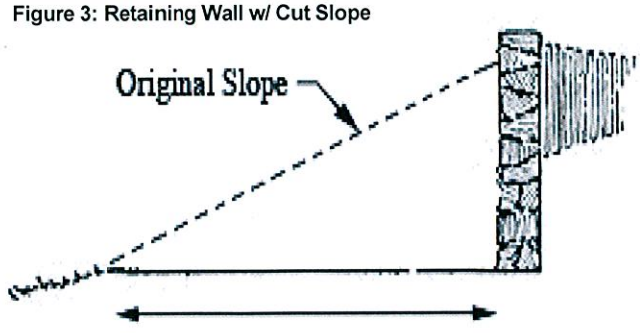


Figure 1: Leveled Front Yard (Lake Forest)

Figure 2: Rear of Arbor District Home Depot Site

Figure 3: Retaining Wall w/ Cut Slope



Retaining walls are a common feature of development projects in communities with sloped or varied topography. Retaining walls allow sloping areas to be leveled in order to accommodate building pads, parking areas and usable open space areas, and allow a given site to achieve its maximum development potential. Although alternatives to the use of retaining walls (2:1 slopes, mass grading) are feasible, retaining walls often offer the most practical solution from the perspective of the developer or property owner. The reason for this is that, unlike manufactured slopes which are generally limited to a maximum steepness of 2:1, retaining walls may be constructed at a near vertical (90 degree) angle, thus increasing the usable area of a site. Because retaining walls may allow a property owner to utilize otherwise undevelopable land, the use of retaining walls is sometimes considered a property rights issue. Figures 3 and 4 illustrate how a retaining wall increases the usability of a site versus a 2:1 slope.

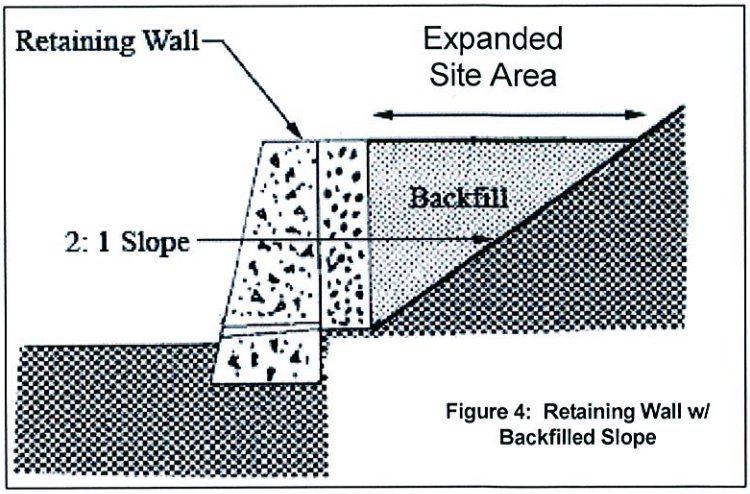


Figure 4: Retaining Wall w/ Backfilled Slope

Measuring Slope Steepness

Unlike manufactured slopes, retaining walls are not restricted by slope steepness. Slope is defined as the vertical change in elevation over a given horizontal distance. It can be measured as a percentage, a ratio, or as an angle (as illustrated in Figure 5). A 10 percent slope is one that rises 10 feet over a horizontal distance of 100 feet. That same slope would have a 10:1 ratio (10 feet horizontal distance for each 1 foot in vertical rise). A 2:1 slope (the steepest slope that is generally permitted for cut slopes in a grading operation) would have a 50-foot vertical rise over a 100-foot horizontal distance (50 percent grade), and a 26 degree angle to the slope.

Figure 5: Slope Measurement

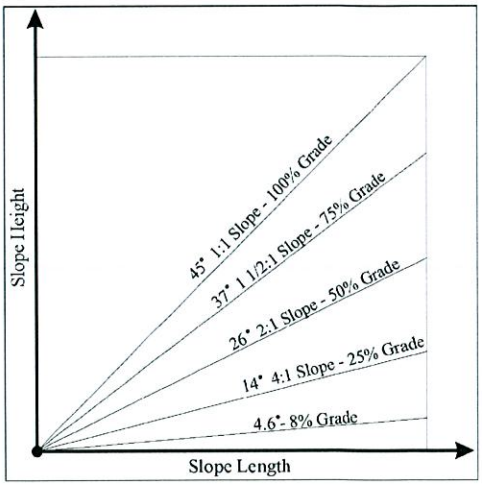


Figure 6: 2:1 Slope (Lake Forest)

In certain applications and with proper engineering, retaining walls can be constructed at a 90 degree angle. More commonly however, to enhance their stability and for aesthetic purposes, retaining walls are constructed with what is called "batter" - where the base of the wall is wider than the top, and a slight slope (typically 1"-3" per foot of wall height) results in the wall leaning into the hillside. Batter serves to enhance the gravitational stability of the wall and to provide resistance against uneven lateral pressure from the retained earth, thereby preventing misalignment of the units which compose the wall.

Notwithstanding, it is the vertical character of retaining walls, along with the erosion control function and flexibility in terms of creating a variety of land forms and building site configurations, that provides the primary advantage over manufactured slopes – which, as indicated above, are generally limited to a maximum steepness of 2:1 (26 degrees).

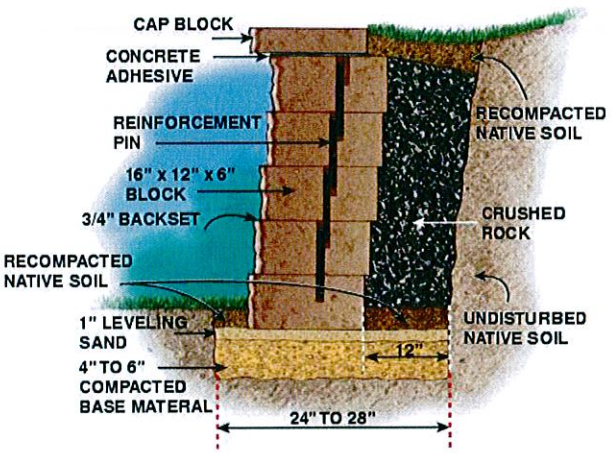
Alternatively, the primary advantage of manufactured slopes over retaining walls is that they have a lower cost to design and construct and, depending on the treatment, they offer the potential to create a more natural appearance. In some instances however, manufactured slopes are designed with a uniform slope and formal landscaping (regular spacing of plants/trees in a geometric or linear pattern) which can also result in a man made appearance. In addition, despite the best efforts of geologists and civil engineers, some man-made slopes created by past development within hillside areas have been subject to slope failure.

Each method (retaining walls, 2:1 slopes) has certain advantages over the other. In some contexts/applications, the best solution may be a design which employs a combination retaining wall(s) and slope(s) design.

Retaining Wall Types:

There are three basic types of retaining walls: gravity walls, cantilevered walls and mechanically stabilized earth (MSE) walls. Each type may be construction in a wide array of design variations.

Figure 7: Reinforced Gravity Wall Section



Gravity Walls

A gravity wall is a retaining wall that uses the weight of the wall slab, or blocks combined with the friction of the blocks, gravel and soil, to give the structure its strength. Gravity walls are stabilized by their mass and do not use geogrid reinforcement. They are constructed of dense, heavy materials such as concrete and stone masonry and are usually reinforced with steel. For short walls, they are often made from mortarless stone or

segmental concrete units relying solely on their weight to stay in place, as in the case of dry stone walls. Gravity walls are usually a minimum of 50 to 60 percent as deep (thick) as the height of the wall. A greater depth to height ratio may be needed if there is a slope at the top of the wall or a surcharge (e.g., from a structure) on the wall. Gravity walls are considered "flexible" walls, because some normal shifting and movement of the structure will not affect its integrity. In addition to dry-laid stone walls, other kinds of gravity walls use open, stacked cellular elements that are filled with granular materials, such as gravel, which holds them in place while allowing for drainage through the wall. Gravity walls are more commonly used in "cut slope" situations – where a natural slope is cut back and retained, as opposed to "fill" situations – where a void between the natural slope and the retaining wall is backfilled with earth (see Figures 3 and 4).

Crib Walls

A crib wall is a type of gravity wall made up of interlocking individual boxes ("cribs"), made from timber or pre-cast concrete, which are stacked like the walls of a log cabin. The boxes are filled with crushed stone or other coarse granular materials to create a free-draining structure.

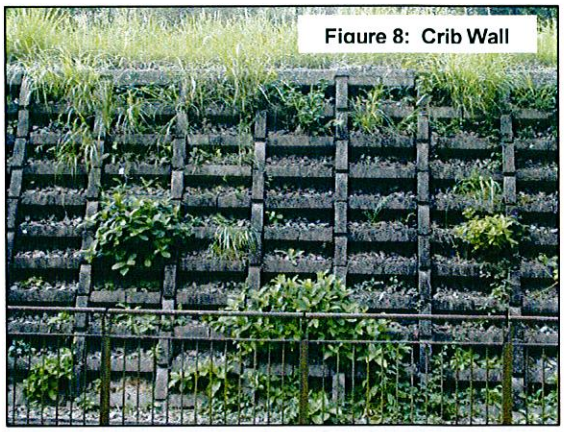


Figure 8: Crib Wall

Modular Block Retaining Walls

Modular block retaining walls employ individual, usually identical, precast concrete units – either interlocking, offset stacked, or placed structurally independent of each other and anchored into the backfill. Being gravity structures, these systems rely on their own weight and mass to resist overturn and sliding forces. Some systems allow for landscaping of the wall between tiers, while others are designed as structural frames to be covered with landscaping.

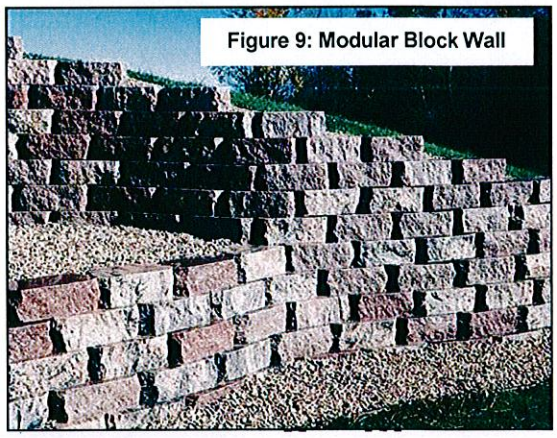


Figure 9: Modular Block Wall

Cantilevered Walls

Cantilevered walls are sometimes referred to as "rigid" walls because the retaining structure is intended to remain absolutely stationary. In cross section, most cantilevered walls look like "L"s or inverted "T"s. To ensure stability, they are built on solid foundations with the base tied to the vertical portion of the wall with reinforcement rods. The base is then backfilled to counteract forward pressure on the vertical portion of the wall. The canti-

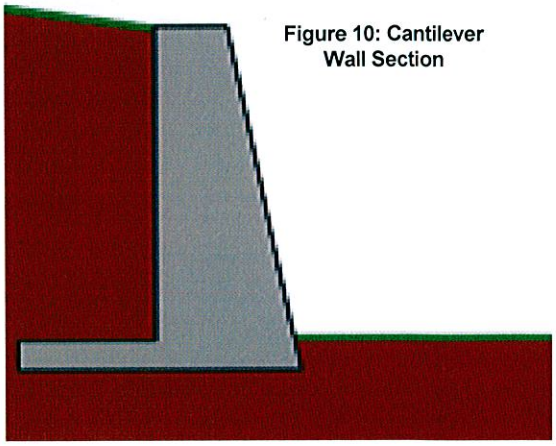
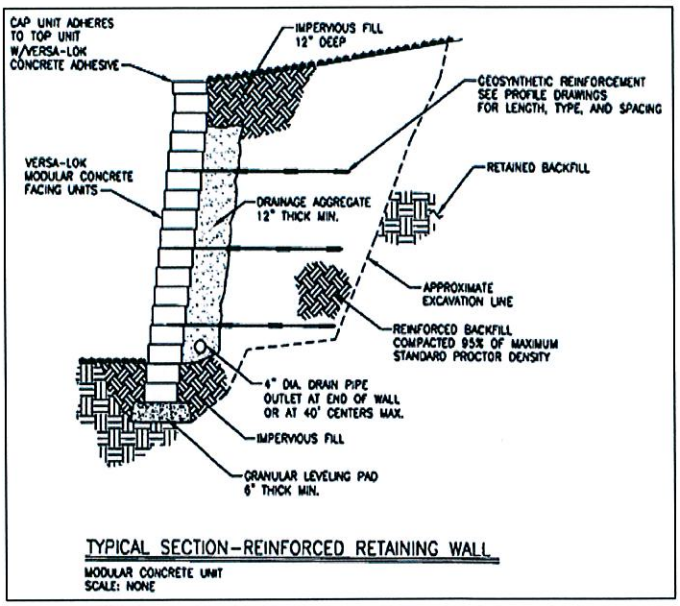


Figure 10: Cantilever Wall Section

levered base is reinforced and is designed to prevent uplifting at the heel of the base, making the wall strong and stable. Reinforced concrete cantilevered walls sometimes have a batter. They can be faced with stone, brick, or simulated veneers. Their front faces can also be surfaced with a variety of textures. Reinforced concrete cantilevered walls are typically poured in place using forms. When the use of forms is not desired, reinforced concrete block cantilevered walls are an option.

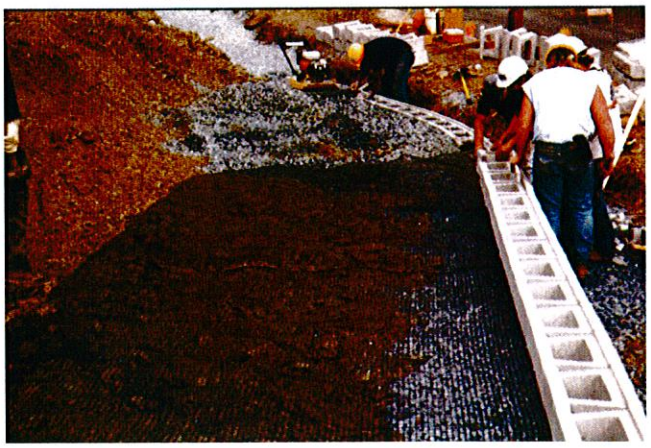
Mechanically Stabilized Earth (MSE) Walls

Figure 11: MSE Wall Section



Mechanically Stabilized Earth (MSE) retaining walls (also known as Earth Tieback Retaining Walls and Reinforced Soil Walls) are typically constructed in fill situations using a construction technique that alternates layers of compacted soil and horizontal soil reinforcing elements or "mats". The horizontal elements are made of wood, metal, or synthetic materials such as geotextiles that extend out perpendicularly from the face of the wall into the slope. The weight and friction of the soil fill against the horizontal mats anchors the structure and provides internal shear resistance beyond that of a simple gravity wall structure. Structures built on soil retained by an MSE wall must be setback from the horizontal reinforcing elements (i.e., structures can not be built directly above the subterranean mats).

Figure 12: MSE Wall Construction

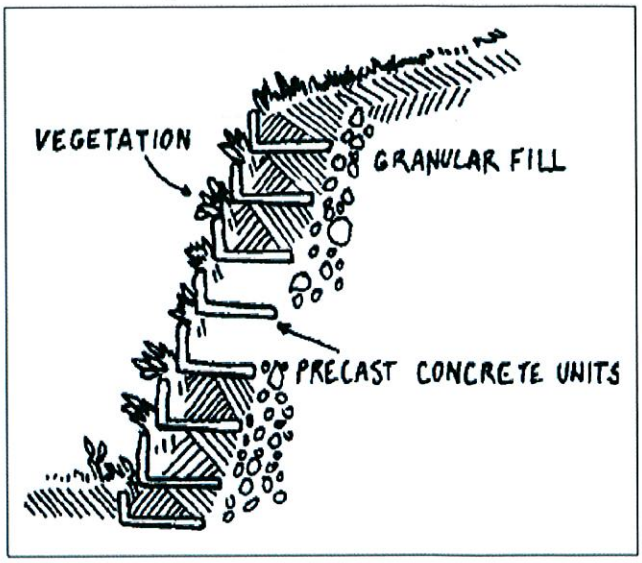


The face of an MSE structure is composed of stacked precast concrete units that tolerate differential movement. This attribute provides an advantage over rigid walls in seismic conditions. The face of the wall also acts to prevent erosion of the retained earth. MSE walls are considered state-of-the-art technology and the most commonly constructed type of retaining wall in the past 20 years due to their load-supporting characteristics, performance in seismic zones, adaptability to a variety of conditions, ease of construction and other factors.

Landscaping and Retaining Walls

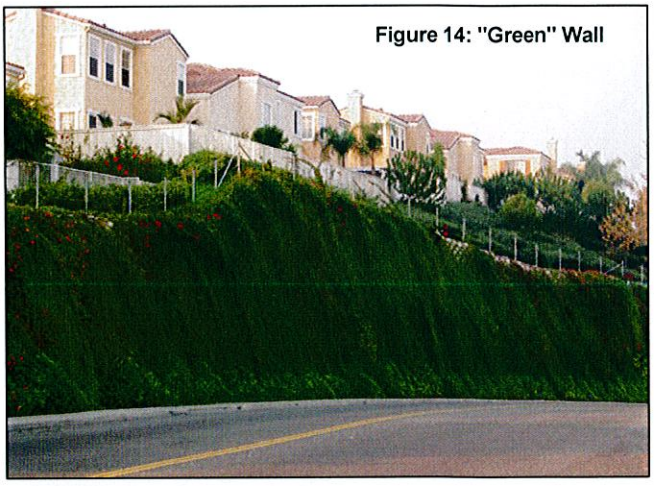
Several of the retaining methods previously discussed may be constructed using landscaping. Landscaping is commonly used in conjunction with retaining walls for two primary purposes: aesthetics and erosion control; and in two ways: as an integral component of the wall or as a separate feature. Walls which use landscaping as an integral component are commonly referred to as "green" walls. Green walls are composed of stacked interconnected precast concrete units. Each unit has a void that is filled with soil to serve as a planter for vegetation. Initially, the wall structure stabilizes the slope, but over time, the vegetation covers the face of the structure and prevents erosion by binding the soil together.

Figure 13: Integrated Landscaping



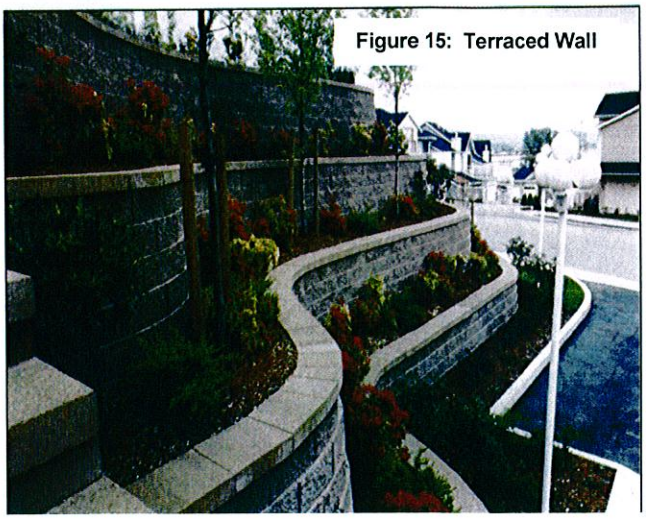
Green walls may be constructed in a variety of designs and configurations. Examples of walls which may be designed with integrated landscaping include gravity crib walls and MSE walls. "Green" walls may be constructed in a curvilinear form, or be shaped to follow irregular topographic contours, in order to give the wall a more natural appearance. The wall surface may also be textured and colored to simulate the appearance of natural stone. The ultimate character of the landscape is dependent upon solar orientation of the wall and the type of landscape materials selected.

Figure 14: "Green" Wall



The use of landscaping as a separate component of a retaining wall project typically takes the form of landscaping planted in a setback area at the base of the wall and/or landscaping in a level planter bed formed by a terraced retaining wall (Figure 15). Some designs use retaining walls and landscaped slopes in combination. In such a configuration, a retaining wall could form the vertical, lower component, and a 2:1 slope would begin at the top of the wall and slope away from it (Figure 20) Retaining walls used in conjunction with slopes have additional engineering considerations because the slope places a greater surcharge on the wall than a level-graded plane.

Figure 15: Terraced Wall



III. RETAINING WALL MAINTENANCE and RESPONSIBILITY

Retaining walls that are properly designed, engineered and constructed generally have a lifespan equivalent to the associated development and do not require regular structural maintenance. Proper design and engineering of retaining walls is assured through the building permit process. The City of Lake Forest requires plans, engineering calculations (prepared by a licensed engineer) and a building permit for all retaining walls exceeding three feet in height, in compliance with the requirements of the California Building Code (CBC). The CBC requires adherence to the newest technologies and construction methods and includes (effective Jan. 2008) stringent seismic safety standards specific to retaining walls and appropriate to Southern California.

"Green" walls (walls with integrated landscaping) may require periodic landscape maintenance or repair of the irrigation system (if present). Typically however, green walls are planted with low-maintenance landscaping and drought-tolerant plants. Consequently, only minimal maintenance may be necessary. Retaining walls of all types may also be subject to graffiti or damage from random occurrences such as a vehicle collision.

Retaining Wall Responsibility

Retaining walls on private property may be individually owned, owned in common by adjoining neighbors, or owned in common by a property owner's association. Examples of individually owned retaining walls include walls on a single-family residential lot, at an apartment complex, or on a commercial property. Examples of common ownership retaining walls include those straddling a property line; walls associated with condominium developments; and walls constructed in private common open space or recreation areas of residential subdivisions.

In the case of individually owned walls, the corresponding property owner would have sole responsibility for any necessary wall maintenance, repair or replacement. However, in rare cases, homeowner's associations (HOA's) are formed to assume responsibility for certain improvements on individually owned lots. This might occur, for example, where retaining walls are constructed on individually owned townhome lots that are part of a homeowner's association.

Common Interest Subdivisions

Retaining walls that are owned in common are the responsibility of the corresponding property owner's (i.e., the adjoining neighbors which share the common property line wall) or, if applicable, the property owner's association. Where a development includes common ownership, the California Department of Real Estate (DRE) requires the formation of a property owner's association. The DRE is also tasked with ensuring that the corresponding CC&R's (covenants, conditions and restrictions)[1] and HOA budget provide adequate reserves for maintenance, repair or replacement of all common area improvements (including retaining walls[2]) and common open space. CC&R's, unlike HOA budgets, vary in

[1] CC&R's identify the association's common area and responsibilities; explain the obligations of the association to collect assessments and the obligation of the owners to pay assessments; and (typically) state insurance requirements and architectural controls.

[2] Retaining walls were added as a line item to the DRE budget guidelines in 1997.

their specificity and may reference common area improvements generally and/or identify specific improvements (such as retaining walls) which shall be the responsibility of the HOA.

The DRE also requires that HOA's prepare and submit an updated budget reserve study every three years, the purpose of which is to assess the adequacy of the current budget reserve, and to identify any previously unanticipated funding needs. Typically, HOA's hire independent contractors to perform site inspections, cost-estimating and funding analyses. A site inspection would identify, for example, the need to replant "green wall" landscaping or repair a wall's irrigation system. Based on the site inspection and funding analysis, an HOA would determine if a special assessment or increase in regular HOA dues is necessary.

It is also common practice for cities (including the City of Lake Forest) to apply a condition of approval to subdivision maps which requires that the corresponding CC&R's provide for maintenance of specific common areas and/or common area improvements, in order to prevent any oversight in this regard. The City of Lake Forest requires that CC&R's be reviewed and approved by the City Attorney prior to recordation.

Generally, retaining walls do not require City oversight once building permits are finaled. An exception would be in the unlikely occurrence that a retaining wall was found to be structurally failing (and thereby presenting a threat to public safety) or landscaping was not being properly maintained. Such instances may necessitate Code Enforcement involvement and contact with the wall's owner to solicit needed repairs. A recent example of landscape maintenance deficiency involves a crib wall along Cañada Road.

In mid-2008, the City was contacted by the HOA having ownership and maintenance responsibility of the Cañada Road wall. The HOA requested that the City assume ownership and maintenance responsibility for the wall and the underlying property (the City later declined this offer). A review of the history of the property at that time revealed previous Code Enforcement action to mitigate non-structural property maintenance violations associated with this wall; the specific violations consisted of dead and overgrown weeds and vegetation, as well as an absence of adequate erosion and sedimentation controls. Although not a requirement, Code Enforcement encouraged the HOA to plant landscaping so as to cover the face of the wall, as this would not only be an aesthetic improvement, but would ideally serve as a long-term solution to both conditions of violation. The HOA was responsive to Code Enforcement in removing the weeds and implementing basic erosion and sedimentation controls, but opted not to improve the wall with vegetation.

Slope Maintenance

Figure 16: 2:1 Slope (Foothill Ranch)

The maintenance concepts previously discussed also generally apply to manufactured slopes. A distinction, however, is that unlike retaining walls which are by and large maintenance free structures, manufactured slopes typically require regular maintenance (landscaping, irrigation systems and erosion control). Without appropriate maintenance, manufactured slopes can erode and become unstable over time. Consequently, ensuring their ongoing maintenance is critical. The maintenance of common area slopes often represents a significant proportion of HOA budgets.

IV. FACTORS AFFECTING THE SELECTION OF EARTH RETAINING STRUCTURES.

Retaining wall design/type selection is driven by many factors, as outlined in the following table:

Factor	Examples
Nature of Project	Cut or Fill Situation
Size of Project	Retained Height, Construction Duration
Site Conditions	Accessibility, Available Space, Underground Services
Ground Conditions	Soil Types, Strength, Compressibility
Environmental	Sensitivity of Location, "Green" Face
Aesthetics	Appearance, Cladding, "Green" Face
Durability	Design Life, Maintenance
Groundwater	Ground Water Level, Tidal Conditions
Contractor Capabilities	Specialist Techniques and Equipment
Construction Requirements	Time, Noise and Ground Disturbance
Cost	
Others	Political Issues, Local Policies

V. VISUALIZING PROPOSED RETAINING WALLS

When considering projects which include retaining walls, it is essential that sufficient information be provided to evaluate the proposal and its potential visual impacts. In some instances, additional tools may be helpful to augment the basic information (site plans, landscape plans and elevations), such as three-dimensional modeling and computer-generated photo-simulations.

Another example of a valuable visualization tool is a computer-generated graphic model of a proposed wall. Computer models allow a proposed wall to be visualized in context and true color, and from all perspectives. This is particularly useful since a given wall may have attributes which are only apparent when viewed from a particular vantage point. Computer-generated models also allow for a better perception of scale than two-dimensional drawings, and can be used to depict the appearance of a wall in a time-progression format – which is particularly useful for "green" walls or walls built adjacent to graded open-space areas that may change in appearance as landscaping matures.

Computer-generated models are also useful as a tool to evaluate and compare alternative designs. As discussed above, retaining walls may be constructed in virtually unlimited configurations and in a wide variety of designs. In some instances, it is helpful to consider alternative designs and to use a comparative process to evaluate a project.

VI. REGULATORY OPTIONS

Although local governments vary considerably in their approach to regulating retaining walls, the means and methods generally fall into three categories: (1) codes/development standards; (2) design guidelines; (3) case by case review/ permitting. Since, the structural design of retaining walls is addressed by applicable building codes and engineering requirements, the three approaches are generally aimed at achieving the same objectives: minimizing any potential adverse visual impacts of retaining walls and ensuring compatibility with surrounding property.

Development Standards

Development standards applicable to retaining walls, when adopted, are typically contained within the zoning ordinance and may include height limits, minimum setbacks (sometimes expressed as a ratio to height), offset requirements (minimum recesses and projections) or required tiering/ terracing (to achieve a "stair-step" configuration). Most zoning codes include only height limits applicable to fences and walls generally, rather than a broader set of standards specific to retaining walls. A likely reason for this is that retaining walls are typically proposed on sites with unique constraints (varied topography, sloping terrain) and a "one-size-fits-all" approach represented by a set of development standards may restrict site specific design solutions.

Design Guidelines

Some jurisdictions adopt formal design guidelines and/or policy statements applicable to retaining walls. Guidelines are typically broader in scope than development standards and devoid of specific numeric limitations (e.g., maximum height or minimum setback). Instead, guidelines apply more general criteria and phrasing; focusing instead on broader concepts of compatibility and proportion. In suburban areas, guidelines may seek to maintain a more natural appearance with respect to retaining wall designs ("green walls", wider setbacks, natural stone, irregular configurations, etc.); whereas guidelines in urban areas or commercial areas may focus on a particular design theme that closely relates to the associated project or district architecture. Guidelines provide an advantage over development standards in that they allow a developer the flexibility to adapt the design of the wall to the context in which it is proposed and to avoid the need for variances or other code exceptions. Similarly, policy

statements man be used to establish guidance for the use and appearance of retaining walls and may be adopted by resolution, included within the General Plan, or stated within a Design Guideline document.

Case by Case Review

Most local jurisdictions review and evaluate retaining walls associated with a larger development project in conjunction with the corresponding entitlement (e.g., subdivision map, site development permit, use permit, road widening project) and make determinations on a case-by-case basis. This method allows proposed walls to be evaluated in the context of the associated project and its surroundings, and for decisions to be made accordingly. Retaining walls for individual sites that are not associated with a larger development project are typically reviewed at staff level as part of the building permit and plan check process.

VII. RETAINING WALLS IN LAKE FOREST

The City of Lake Forest has a wide variety of retaining walls within its limits, in a wide variety of applications. Examples range from small (1-3 ft. tall) walls used to level sloping front yards in residential neighborhoods, to a large (28 ft. tall) crib wall associated with a residential development along Canada Road.

Figure 17: Small Residential Wall (Lake Forest)

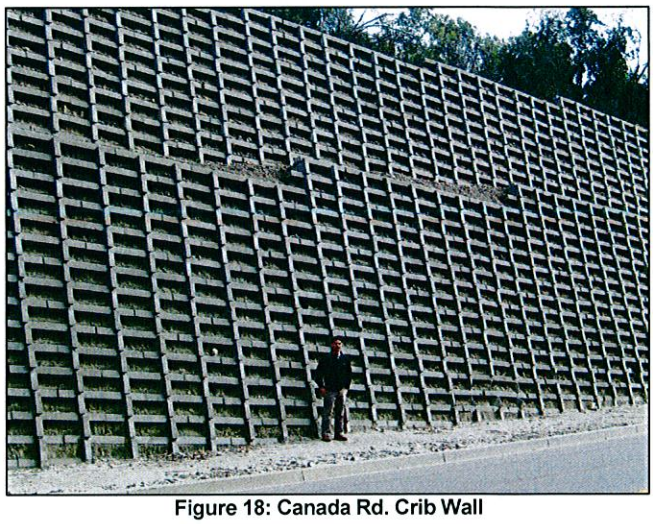


Figure 18: Canada Rd. Crib Wall

Retaining walls also exist along many stretches of the City's arterial highways and behind several commercial centers. In many instances, retaining walls exist which are only visible from inside the property, such as those along the various arterial highways situated at a higher grade than the adjacent residential tracts (see Figure 19). In other instances, the topography is reversed and the roadway is lower than the adjacent properties.

Figure 19: Retaining Wall Along Arterial Highway (Lake Forest)

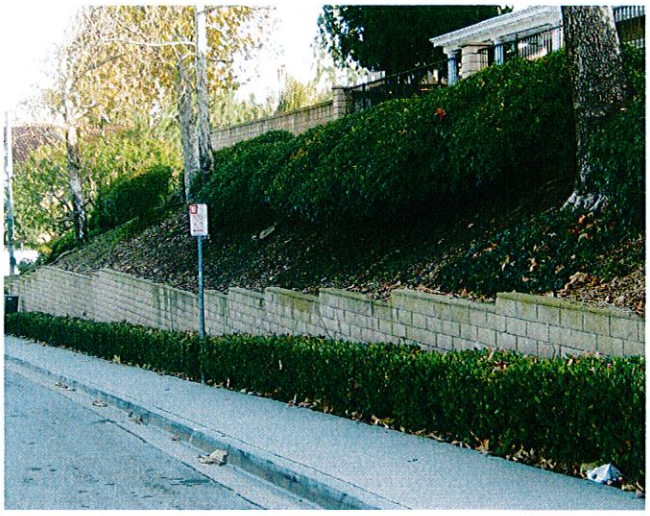


Figure 20: Retaining Wall/Slope Combination (Lake Forest)

Examples of retaining walls used in conjunction with commercial properties include those behind both of the City's Home Depots and the wall behind the automotive center at Regency Lane/ Lake Forest Drive. Some retaining walls in the City are built in a terraced configuration or in combination with 2:1 slopes (see Figure 20), such that the height of the individual wall belies the height of the landform behind it.

Figure 21: Rear of Home Depot Site @ SR 241

Figure 22: Crib Wall @ Lake Forest Dr./Regency Ln.

Retaining walls have also been used in Lake Forest in conjunction with roadway widening projects. In many of these instances, the use of retaining walls provided for the preservation of yard areas (adjacent to the widened roadway) which otherwise would have been lost in order to accommodate a 2:1 slope. An example of the use of a retaining wall in conjunction with a road widening project is depicted in Figure 23.

Figure 23: Retaining Wall/ Road Widening Project – Rockfield Blvd., south of Lake Forest Dr.

VIII. RECOMMENDATIONS:

Given the topography of Lake Forest and the potential for future projects to include a proposal for retaining walls, it may be beneficial to refine the City's retaining wall review process. Toward this end, staff recommends the creation of design guidelines which express expectations for the design and use of retaining walls in the City. Such design guidelines could be broad based and establish basic design principles for retaining wall design and use. Design guidelines may also be a useful resource for developers in the early stages of the design process. Upon adoption, the guidelines could be incorporated into the citywide design guidelines recently prepared by staff and pending further review by the Planning Commission and final approval by the City Council.

In addition, staff recommends that the application submittal requirements specific to retaining walls be revised, in order to ensure that staff and the Planning Commission are provided the necessary tools to properly evaluate proposed retaining walls and potential design alternatives. By formally establishing submittal requirements, the City also provides project applicants advance notice of such requirements, which in turn may facilitate processing of the application.