PROPOSED ADDITION TO SANTA CLARA CITY CONSTRUCTION DESIGN STANDARDS

4.3.5 ROCKERY AND SEGMENTAL BLOCK RETAINING WALLS. The requirements for design and construction of Rockery and Segmental Block Retaining Walls within the City.

4.3.5.1 HEIGHT LIMITATIONS. The height of any single rockery and segmental block retaining wall shall not exceed a maximum height of ten feet (10').

4.3.5.2 TERRACING. The total combined height of all rockery and segmental block walls shall not exceed sixteen feet (16').

Terraced retaining walls shall be separated by a minimum distance of one-half (½) the largest exposed of the two walls as measured from the top face of the lower wall to the bottom face of the upper wall. The bench between the two walls shall have a maximum slope of 10 horizontal to 1 vertical (10h:1v).

Terraced retaining walls with a separation of at least two times the height (2h) of the largest exposed height of the two walls from face of wall to face of wall shall be considered as separate walls for analysis purposes and applicability to this section. If walls are within 2h, then the combined height of the terraced walls shall be used for limitation of height not to exceed sixteen feet (16').

B. Any rockery or segmental block retaining walls that are adjacent to public streets, or visible to the public, shall be designed to include landscaping between the walls (bench area). Landscape design shall include the following factors: separation between walls, backfill zone for drainage, controlled drip systems, no deep-rooted vegetation, and maintenance of landscaping.

The rockery or segmental block wall design must explicitly state that the walls were designed to accommodate water. If the walls cannot be designed to accommodate water, rock mulch and desertscape or xeriscape plants should be used.

4.3.5.3 SEPARATION REQUIREMENTS. The separation from the face of rockery and segmental block walls to a building/ structure footing and/or pool shall be at least ten feet (10'), or
as outlined in the International Building Code. This provision applies to building/ structure footings and/or pools at the low and high sides of the wall.

Ornamental fences, guards, or screen walls shall be a minimum of three feet (3') from the front face at the top of the rockery/segmental block retaining wall, or to the back of the rock/block. Ornamental fences, guards, or screen walls shall have their own foundations and not rely on the retaining wall for structural support.

Where the minimum retaining wall separation requirements exceed that of the land use setback zone, additional design analysis and calculations, along with a geotechnical letter shall be submitted to the City for a retaining wall separation exception to this standard for accessory buildings, structures, and/or pools.

At property lines, the retaining wall shall be constructed on the property it is retaining. No retaining wall component shall extend beyond the property line. Property lines may be located between (in the middle of) terraced retaining walls provided the walls are separated by a distance of at least 2h (h of tallest exposed height of the 2 walls), from face of wall to face of wall.

No component of a rockery or segmental block retaining wall shall be constructed within public rights of way or trails.

4.3.5.4 SITE PREPARATION. As a minimum, subgrade preparation within the limits of the wall construction shall be performed in accordance with the City Standard Specifications 4.3.2.3. Additional subgrade preparation such as over excavation and recompaction may be required in the geotechnical report. Groundwater discovered during construction shall not be ignored and shall be addressed by the Geotechnical Engineer.

4.3.5.5 MONITORING. The phases of rockery and segmental block wall construction, including site preparation, shall be monitored in accordance with the inspection frequency schedule specified on the construction drawings prepared by the Design Engineer. The Geotechnical Engineer employed by the Owner/Contractor shall verify that the nature and quality of the materials being used are appropriate and that the construction is in accordance with the engineered design. The Geotechnical Engineer shall verify to the City in writing that the materials and construction of the rockery/segmental block wall as-built is in accordance with the engineered design after construction is complete.

4.3.5.6 BACKFILL. Backfill materials shall consist of quality fill materials meeting the requirements specified by the Design Engineer and the geotechnical report. Backfill shall be placed in uniform lifts not to exceed six to twelve inches (6" - 12") in thickness as specified by the geotechnical report before compaction.

4.3.5.7 BACKFILL COMPACTION AND TESTING. Compaction shall be in accordance with the geotechnical report recommendations. The maximum lift thickness shall be decreased as necessary to obtain the specified density. Compaction within three feet (3') of the back of the facing units shall be accomplished with walk-behind compactors. No heavy equipment shall be operated within three feet (3') of the back of the rocks/blocks. Density tests to verify compaction shall be taken at random locations. At least two (2) tests per one hundred feet (100') of wall length per one and a half feet (1½') of backfill shall be taken. In critical locations, the Geotechnical Engineer may request additional testing.

4.3.5.8 GEOGRID REINFORCEMENT. Mechanically stabilized earth (MSE) retaining walls shall be reinforced with geogrid as specified by the Design Engineer. Geogrid design embedment length shall be measured from the back of the rock or segmental block facing units. Geogrid shall be positively connected to the block facing units. No substitutions of geogrid reinforcement products shall be allowed unless specifically approved by the Design Engineer. Gravity segmental block retaining walls generally do not require fill reinforcement in their design.

4.3.5.9 ROCK SELECTION AND PLACEMENT. The rock source shall be preapproved by the Geotechnical Engineer. The Contractor shall have sufficient space and stockpile material available to select from among a number of rocks for each space in the rockery wall to be filled. Rock shall be of a generally cubical, tabular or rectangular shape. Rounded rocks shall not be used. Internal void spaces in the facing shall be kept to a minimum. Prior to being placed, rocks shall be inspected and approved by the Geotechnical Engineer. Basal keyway rocks shall have a minimum width extending back into the wall of at least one third (1/3) the exposed height of the wall tier. Rocks shall be placed to decrease in size with increasing wall height. Cap rocks shall have a minimum width of two feet (2') extending back into the wall.

Rocks shall be placed to bear on good flat-to-flat surfaces. The long dimension of the rocks shall extend back toward the cut/fill face. Except for basal rocks, rocks shall bear on at least two (2) or more other rocks. The base rocks shall be embedded at least one foot (1') to provide a keyway into unyielding soil competent subgrade soils. Additional embedment may be required by the Design Engineer.

4.3.5.10 SEGMENTAL BLOCK RETAINING WALL UNITS Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and have a

minimum net average twenty-eight (28) days compressive strength of 4,000 psi. The concrete shall have adequate freeze/thaw protection and meet the requirements of ASTM C 1372. Higher strengths may be required by the Design Engineer based on site conditions.

All units shall be: (a) obtained from the same manufacturer, (b) sound, and (c) free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Any cracks or chips observed during construction shall fall within the guidelines outlined in ASTM C 1372.

Except for basal blocks, each block unit shall bear on at least two (2) blocks. The base blocks shall be embedded at least 1 foot to provide a keyway into unyielding soil competent subgrade soils. Additional embedment may be required by the Design Engineer.

Segmental block units shall match the color, surface finish, and dimension for height, width, depth, and batter as shown on the drawings.

If pins or clips are used to interconnect block units, they shall consist of a non-degrading polymer or galvanized steel and be made for the express use with the block units supplied.

Any cap adhesives shall meet the requirements of the block unit manufacturer.

4.3.5.11 WALL DRAINAGE. Wall drainage behind the retaining walls shall include a free draining gravel layer and filter fabric with a drainpipe daylighting to a proper outlet. A synthetic drainage composite may be used behind segmental block walls if a materials specific shear testing is completed to determined friction properties between the backfill and synthetic drainage composite. A synthetic drainage composite shall not be used behind rock walls.

If the engineering can substantiate proper filtering between the retained soils and the drain rock, then the filter fabric may be omitted. If the retained soils or backfill is free draining as substantiated through appropriate testing, then drainage material may be omitted from the design.

4.3.5.12 SURFACE DRAINAGE. Surface drainage shall be directed away from the rockery/block wall face to a positive and permanent discharge well away and beyond the retaining walls. The surrounding site shall be graded such that water cannot flow over the top of the retaining walls.

4.3.5.13 BATTER. The batter (steepness) of a rock wall face shall not exceed one horizontal to six vertical (1h:6v).

Batter requirements for segmental block retaining wall shall be noted on the design drawings from the Design Engineer. The steepness of the wall face shall not exceed the block Manufacturer's design recommendations.

4.3.5.14 SLOPES. Slopes above and below rockery and segmental block retaining walls shall not exceed two horizontal to one vertical (2:1); shall be noted on the drawings; and shall be included in the stability analyses and the design considerations.

4.3.5.15 STRUCTURAL ANALYSIS. Structural analysis of rockery retaining walls should be in general accordance with the current Federal Highway Administration (FHWA) Guidelines for Rockery Walls for both static and seismic forces with minimum factors of:

	Static	Seismic
Sliding	1.5	1.1
Overturning	2.0	1.5
Bearing	2.5	1.5
Global	1.5	1.1

Structural analysis of stacked segmental block retaining walls should be in general accordance with the current National Concrete Masonry Association (NCMA) Design Manual for both static and seismic forces with minimum factors of:

	Static	Seismic
Sliding	1.5	1.1
Overturning	2.0	1.1
Bearing	3.0	1.5
Global	1.5	1.1

The following analysis provisions shall apply:

1. The maximum unit weight of the rocks and blocks used in the design of a wall system shall be specific to the construction material used.
2. The maximum coefficient of friction between rocks or blocks in a wall system shall be specific to the construction material used.
3. Terraced walls shall be considered as a single retaining wall system for design purposes, unless separated by a horizontal distance equal to or greater than 2h (h of tallest exposed height of the walls) measured from top of exposed face of the lower wall to base of exposed face of the upper wall.
4. Surcharge loading conditions with a horizontal distance equal to the height of the upper most wall shall be taken into consideration in the analysis. The distance shall be measured from the exposed face of the upper most wall.
5. Specifications shall be provided to clearly define acceptance criteria for rock or block materials.
6. Retaining wall shall be designed assuming wet conditions.

The design engineer shall provide design details specific to the location and conditions with a professional stamp. The design engineer shall provide upon request a printout of the input and output of the files with factors of safety within the applicable design standard used as follows:
1. Design calculations ensuring stability against overturning, base sliding, excessive foundation settlement, bearing capacity, internal shear, and global stability.
2. Calculations shall include analysis under static and seismic loads.
3. Factors of safety results shall be presented to the nearest hundredth.
4. Seismic loads shall be based on the Peak Ground Acceleration (PGA) as determined from probabilistic analysis for the maximum credible earthquake, with spectral acceleration factored for site conditions in accordance with the current International Building Code.
5. Upon request, a cross-sectional view of each analysis shall be provided, and the printout of the input and output files in an appendix.
6. The Design Engineer shall include wall drainage details, if applicable.
7. The Design Engineer shall acknowledge that the site is suitable for the retaining wall.
8. The Design Engineer shall specify an inspection frequency schedule on the drawings

4.3.5.16 INSPECTIONS. Construction of rockery and segmental block retaining walls shall be observed by a qualified geotechnical engineer employed by the owner/contractor and shall include all phases of construction. Testing shall be at the frequency specified by the design engineer. Rock material used in construction shall be specifically preapproved by the geotechnical engineer.

Upon completion of the wall, the geotechnical engineer shall submit a final compliance report to the authority having jurisdiction. The report shall include a summary of testing

and observations per the Pre-Wall Geotechnical Data Sheet provided as part of the construction permit. The report shall provide a professional opinion as to the compliance with the design recommendations and acceptance of the construction. All pertinent compaction testing results shall be included with the final report.