Broad Street Plaza Architectural and Structural Design

A Senior Project

Presented to:

Faculty of the Architecture and Architectural Engineering Department

California Polytechnic State University, San Luis Obispo

In Partial Fulfillment

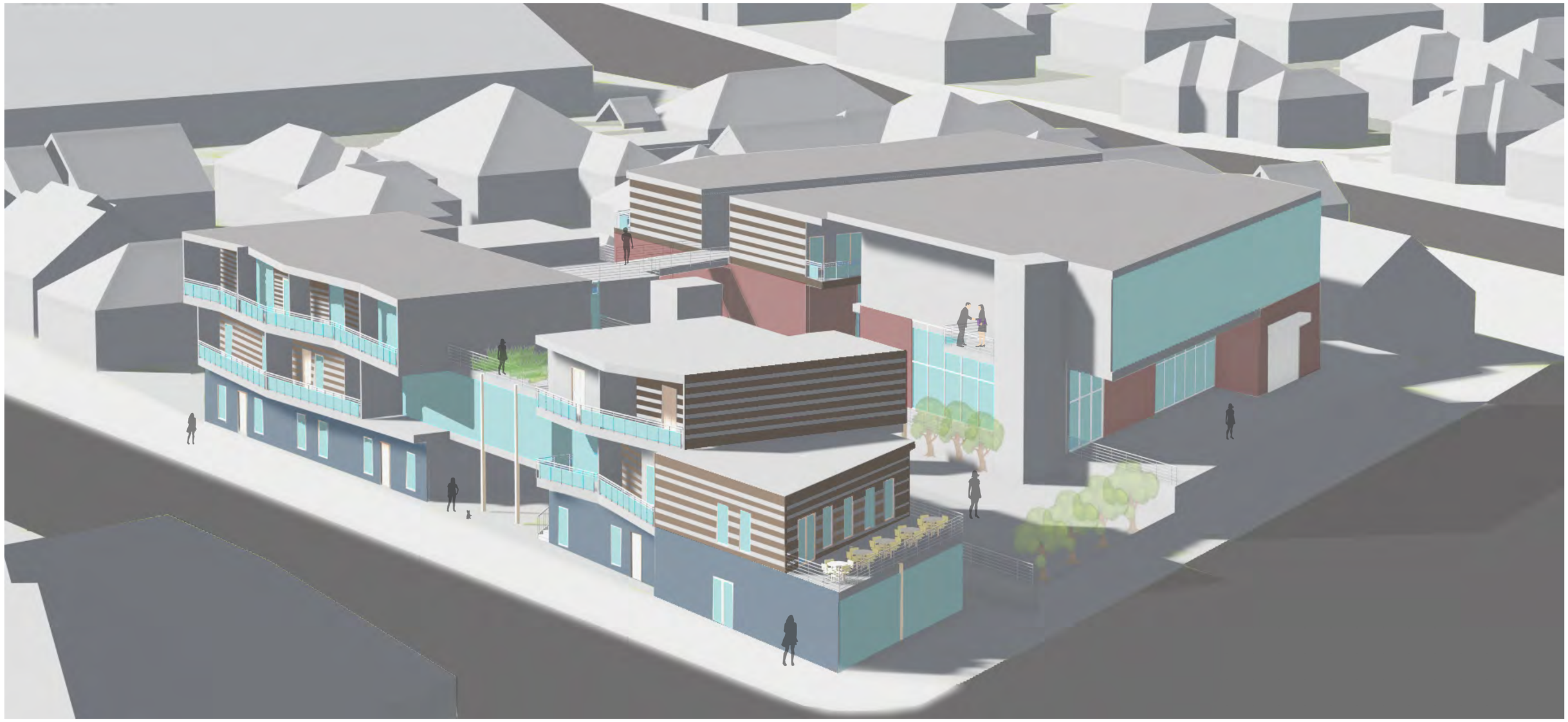
Of the Requirements for the Degree

Bachelor of Science

By

Madison Busby and Jenny Nguyen

June, 2015



2115 BROAD ST

JENNY NGUYEN | MADISON BUSBY

2115 BROAD STREET | SAN LUIS OBISPO

ARCH 453 | ARCE 415

WHITE | NUTALL

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DEAR MS. WHITE,

THANK YOU FOR GIVING US THE OPPORTUNITY TO EXPRESS OUR CREATIVITY THROUGH THE DESIGN OF THIS PROJECT. IT HAS BEEN A PLEASURE CREATING A PROJECT FOR THE UNIQUE LITTLE CITY OF SAN LUIS OBISPO THAT WILL BRING THE COMMUNITY TOGETHER AS WELL AS CREATE AN ECLETIC ENVIRONMENT THAT WILL BORDELINE MULTIPLE DIFFERENT PORTIONS OF THIS CITY.

JEMA ARCHITECTS IS A FIRM CONSISTING OF ONE FOURTH YEAR ARCHITECTURAL ENGINEERING STUDENT AND ONE FOURTH YEAR ARCHITECTURAL STUDENT FROM CALIFORNIA POLYTECHNIC STATE UNIVERSITY, SAN LUIS OBISPO.

WE ARE HAPPY TO PRESENT THE OUTCOME OF OUR INTEGRATED DESIGN PROCESS PRESENTED WITHIN THIS PROJECT. IN THIS PACKAGE, YOU WILL FIND IMAGES DEPCITING BOTH DESIGNS FOLLOWED BY A BRIEF DESCRIPTION OF OUR INTENT. OUR DESIGN INCLUDES RESIDENTIAL PROGRAMS, COMMERCIAL AREAS, OFFICES, AND A SHARED COMMUNITY CENTER. WE HOPE THESE DESIGNS MEET YOUR EXPECTATIONS; AND IF THEY DO NOT, WE ARE MORE THAN HAPPY TO COLLABORATIVELY RE-DESIGN FOR YOUR BEST INTEREST.

CHEERS!
JEMA ARCHITECTS
{JENNY & MADISON}

THE MAJOR FOCUS OF THIS DESIGN WAS TO CREATE AN ENVIRONMENT THAT WILL BRING THE COMMUNITY TOGETHER WHILE STILL GIVING THE RESIDENTIAL SPACE ITS PRIVACY. THIS WAS ACCOMPLISHED BY CREATING AN OUTLET FOR PEDESTRIANS AND BIKERS THROUGH THE OPEN COURTYARD. WITHIN THIS COURTYARD ARE SHARED OPEN SPACES AND GARDENS. WE ALSO KEPT THE RESIDENTIAL UNITS CLOSER TO BRANCH STREET AND TUCKED NORTH ABOVE THE RESTAURANTS ON THE SECOND FLOOR. THESE NATURAL URBAN SPACES ARE INTERTWINED WITH THE PROGRAMS SUCH THAT THEY CREATE A CONNECTED ATMOSPHERE WITH THE BUILDINGS

OUR PROGRAM PROMOTES HEALTHY LIVING BY PROVIDING BIKE RACKS, EASY ACCESS TO WALKWAYS, LIMITED PARKING, AND ON SITE LOCAL PRODUCE MARKET. ALL PARKING ARE HIDDEN UNDERGROUND AND COMPLETE MECHANICAL.

IN ORDER TO WORK THE THE SURROUNDINGS, ALL OF OUR BUILDINGS ARE UNDER THE 35’ MAXIMUM CONSTRAINED BY THE CITY CODES. AN UNDULATED FACADE AND WOOD CONSTRUCTION ALLOWS THE APARTMENTS TO BLEND INTO THE REST OF BRANCH STREET. WE DEALTH WITH THE SITE SLOPE BY CREATING DIFFERENT STEPS FOR DIFFERENT SITE USES. OUR PROGRAM PUSHES DENSITY, BUT ALL WITHIN REASON.

CLIENT GOALS | DESIGN APPROACH

PROGRAMATIC BREAKDOWN:

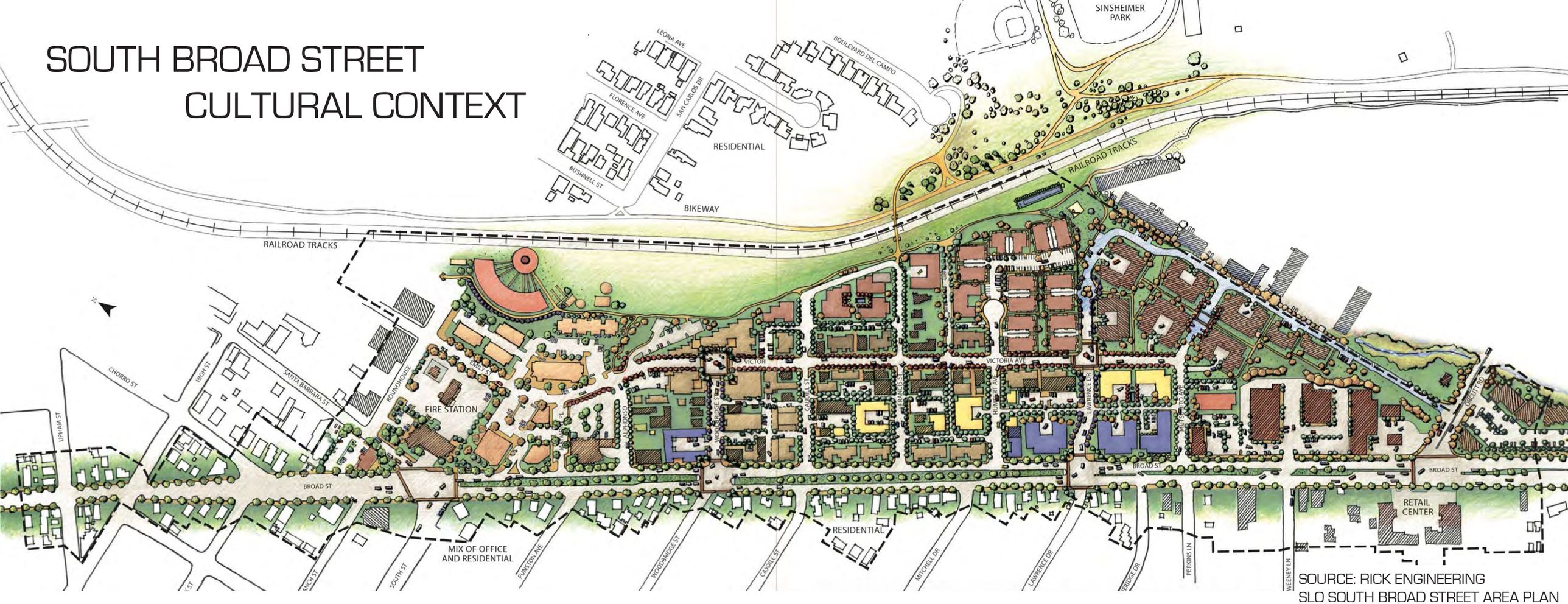
(5) ONE BEDROOM
(3) TWO BEDROOM
(3) THREE BEDROOM
(8) STUDIO UNITS
(3) OFFICES
(2) RESTAURANTS
(1) CAFE
(1) MARKET
(1) RESIDENTIAL MECHANICAL PARKING
(1) COMMERCIAL MECHANICAL PARKING

- ALLOW FOR BOTH RESIDENTIAL AND COMMERCIAL PROGRAMS TO COEXIST WITHOUT INTRUDING ONTO ONE ANOTHER (EXCLUDING THE SHARED COURTYARD)

- CREATE A PLACE OF REFUGE WHERE PEDESTRIANS AND BIKERS CAN ESCAPE FROM THE BUSY BROAD STREET TRAFFIC

- INCORPORATE SUSTAINABLE ELEMENTS WITH EACH USE (ROOFTOP GARDEN, LOCAL FARMER'S MARKET)

SOUTH BROAD STREET
CULTURAL CONTEXT



SOURCE: RICK ENGINEERING
SLO SOUTH BROAD STREET AREA PLAN

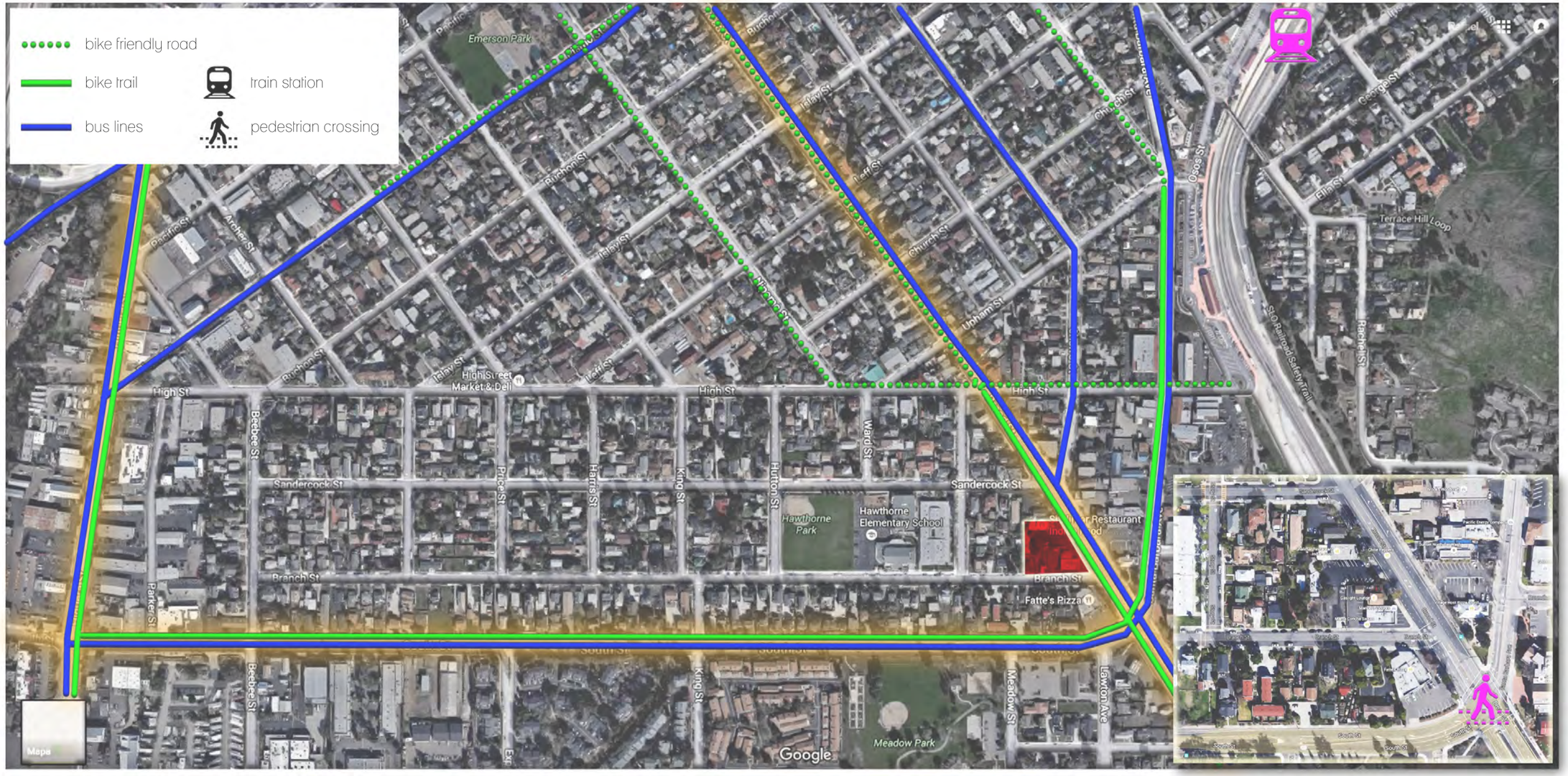
THE SITE IS LOCATED WITHIN THE SOUTH BROAD STREET AREA NEIGHBORHOOD, WHICH IS BOUNDED BY HIGH STREET, UNION PACIFIC RAILROAF, ORCUTT ROAD, AND BROAD STREET ON THE FOUR CARDINAL DIRECTIONS, RESPECTIVELY. LOCATED IN THE CENTER OF THE CITY, THIS NEIGHBORHOOD IS ADJACENT TO HIGHWAY 101, DOWNTOWN SLO, THE HISTORIC RAILROAD DISTRICT, AND LITTLE ITALY.

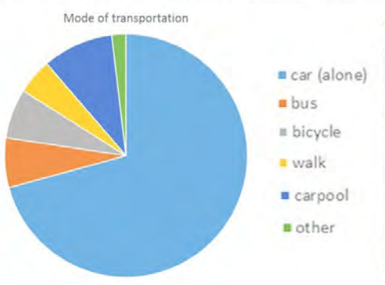
SINCE BROAD STREET IS A MAIN TRANSPORTATION CORRIDOR THAT RUNS CONTINUOUSLY FROM DOWNTOWN SLO DOWN SOUTH TOWARDS ARROYO GRANDE, PISMO BEACH, AND GROVER BEACH, THE AREA IS CLOSE TO MANY SHOPPING STORES, SCHOOLS, EMPLOYMENT CENTERS, AND MAJOR TRANSPORTATION FACILITIES LIKE PUBLIC TRANSIT STOPS, THE COUNTY REGIONAL AIRPORT, AND AMTRAK TRAIN STATIONS

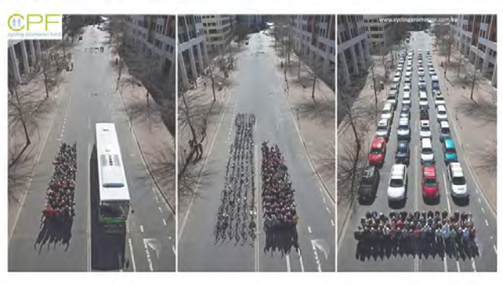
THIS AREA CURRENTLY HOUSES VARIOUS TYPES OF BUILDINGS AND PROGRAMS. ALONG WITH THE MIXED-DENSITY RESIDENTIAL, SMALL SCALE RETAIL AND RESTAURANTS, THERE ARE PLENTY OF MANUFACTURING AND INDUSTRIAL SERVICES ALONG THE STREET, INCLUDING PARTS THAT WERE ORIGINALLY DEVELOPED IN THE IMPERIAL ADDITION (1888). OVER TIME, ZONING CHANGED AND NON-RESIDENTIAL USES APPEARED WHILE MOST OF THE OLD NEIGHBORHOOD WAS DEMOLISHED. THE FEW REMAINING HOMES FROM THAT PERIOD IS LOCATED BETWEEN HUMBERT AVENUE AND WOODBRIDVE STREET.

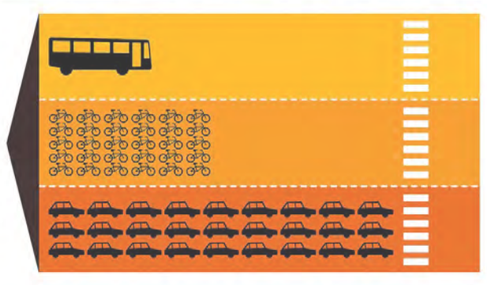
IN 2012, THE SOUTH BROAD STREET AREA HAS BEEN DESCRIBED AS A NEIGHBORHOOD IN TRANSITION WITH FUNKY, DIVERSE, AND/OR DILAPIDATED CULTURE DUE TO THE MIX OF OLDER COMMERCIAL AND RESIDENTIAL BUILDINGS, LACK OF PUBLIC FACILITIES, AND UNDERUTILIZED PROPERTIES.

SITE ANALYSIS









Increase the percentage of all trips made by bicycle within San Luis Obispo. Establish and maintain an integrated system of bikeways and parking facilities that enables safe and convenient bicycling, with an emphasis on travel to employment centers, commercial districts, schools and recreational destinations.

Advocate bicycling as a way of addressing climate change, preserving clean air, reducing traffic congestion and noise, conserving land and energy resources, and promoting good health.

Develop financial partnerships with other organizations when the resultant bicycle facilities or activities provide significant benefits to San Luis Obispo residents.

SITE ANALYSIS

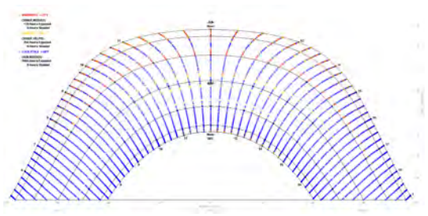
AVERAGE TEMPERATURE

	Jan	Feb	March	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Average High °F	64	64	65	69	72	75	77	80	79	76	70	64
Average Low °F	41	42	44	45	48	51	54	55	54	49	44	40
Average Precipitation inches	3.66	3.66	3.19	1.1	0.39	0.08	0.04	0.04	0.2	0.87	1.73	4.06

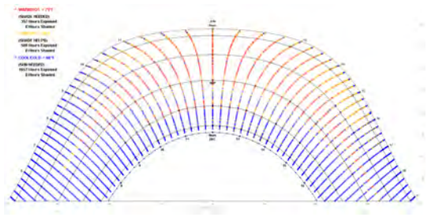
CLIMATE ANALYSIS

SAN LUIS OBISPO, CA

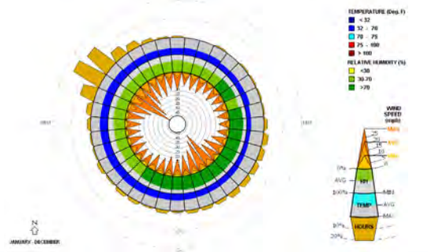
SUN SHADING CHART WINTER - SPRING



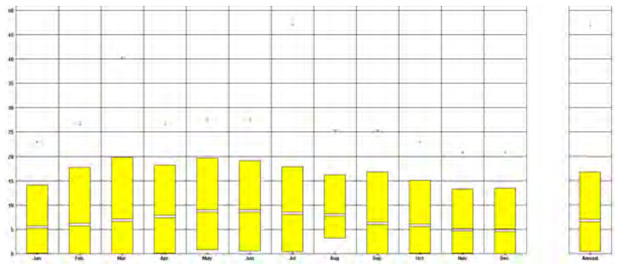
SUN SHADING CHART SUMMER - FALL



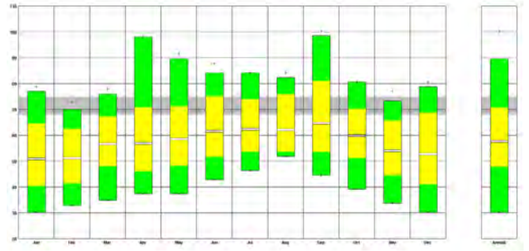
WIND ROSE



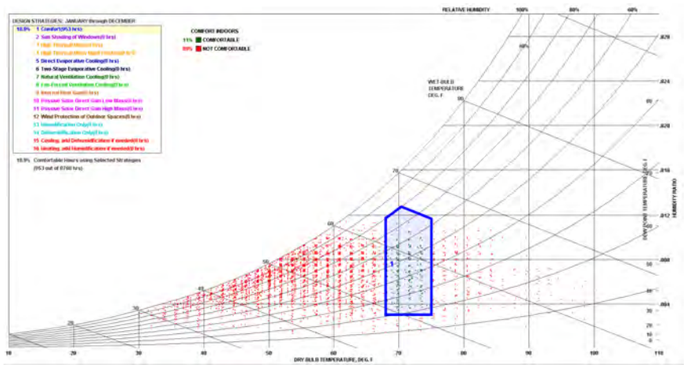
AVERAGE WIND VELOCITY



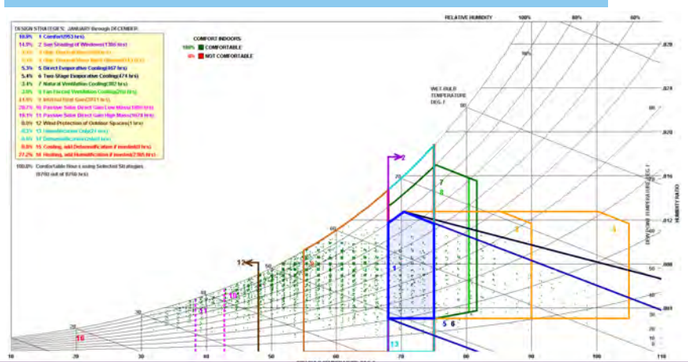
AVERAGE TEMPERATURE



PSYCHROMETRIC CHART (WITHOUT STRATEGIES)



PSYCHROMETRIC CHART (WITH STRATEGIES)



Most of the wind direction is W - NW throughout the year.

During Fall and Winter the wind also has a E - SE direction

SLO is sunny most of the year.
some strategies:

Passive solar heating
Entrance of winter light
Summer shading
Natural Ventilation

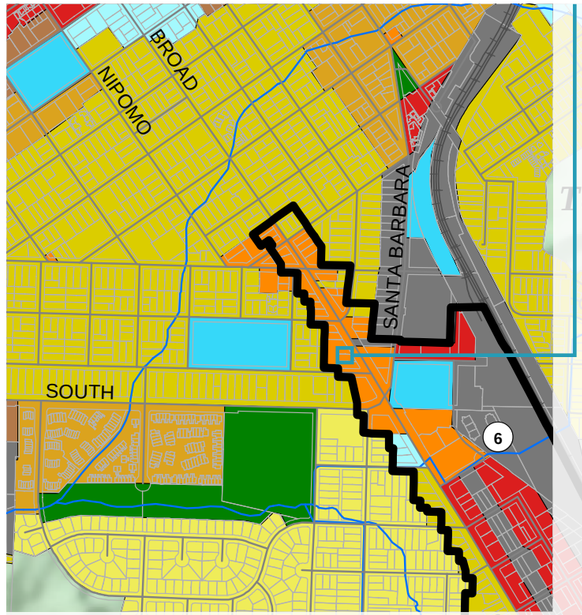
Precipitation in San Luis Obispo is higher during winter and early spring.

Most of the noise comes from Broad street.

SUN PATH + WIND + NOISE

Graphs taken from ClimateConsultant 6.0

SITE ANALYSIS



2115 Broad St

Land Use Designation

Neighborhood Commercial | C-N

Zoning Regulations

Density

Average Cross-Slope

	Maximum Density Allowed (density units per net acre)					
	R-1	R-2*, O, C-N, C-T	R-3	R-4	C-R, C-D, C-C	C-S, M
0-15	7	12	18	24	36	24
16-20	4	6	9	12	36	24
21-25	2	4	6	8	36	24
26+	1	2	3	4	36	24

Density Bonus
(low/moderate-income housing)

Percentage Moderate-Income Units	Percentage Density Bonus
10	5
11	6
12	7
13	8
14	9
15	10

Occupancy Standards | C-N

25 max population density/net acre

12 density units/net acre

Development Standards

Maximum Heigh: 35 feet

Maximum Coverage: 75%

Maximum floor area to site ratio: 2.0

Building Setback Lines

Broad Street

40ft from centerline of Broad St

Parking

Live/work Units	2 spaces per unit
Mixed-use	Same as Multi-family
Multi-family	1 per studio apartment, 1-1/2 for first bedroom plus 1/2 for each additional bedroom in a unit, plus 1 for each five units in developments of more than five units
Bakery, retail	One space per 200 ft² gross floor area
Convenience store	Two spaces for employee parking, plus one space per 500 sq.ft of gross floor area and a minimum of five bicycle parking spaces
Retail ≤2000 ft²	One space per 300 ft² gross floor area
Bicycles, retail	One space per 500 ft² gross floor area
Restaurant	One space per 60 sq. ft. customer use area, plus one space per 100 sq. ft. food preparation. Walls, halls, restrooms, and dead storage areas do not count as either customer use or food preparation floor area
Office - Accessory	As required for principal use
Office - Business	One space per 300 ft² gross floor area

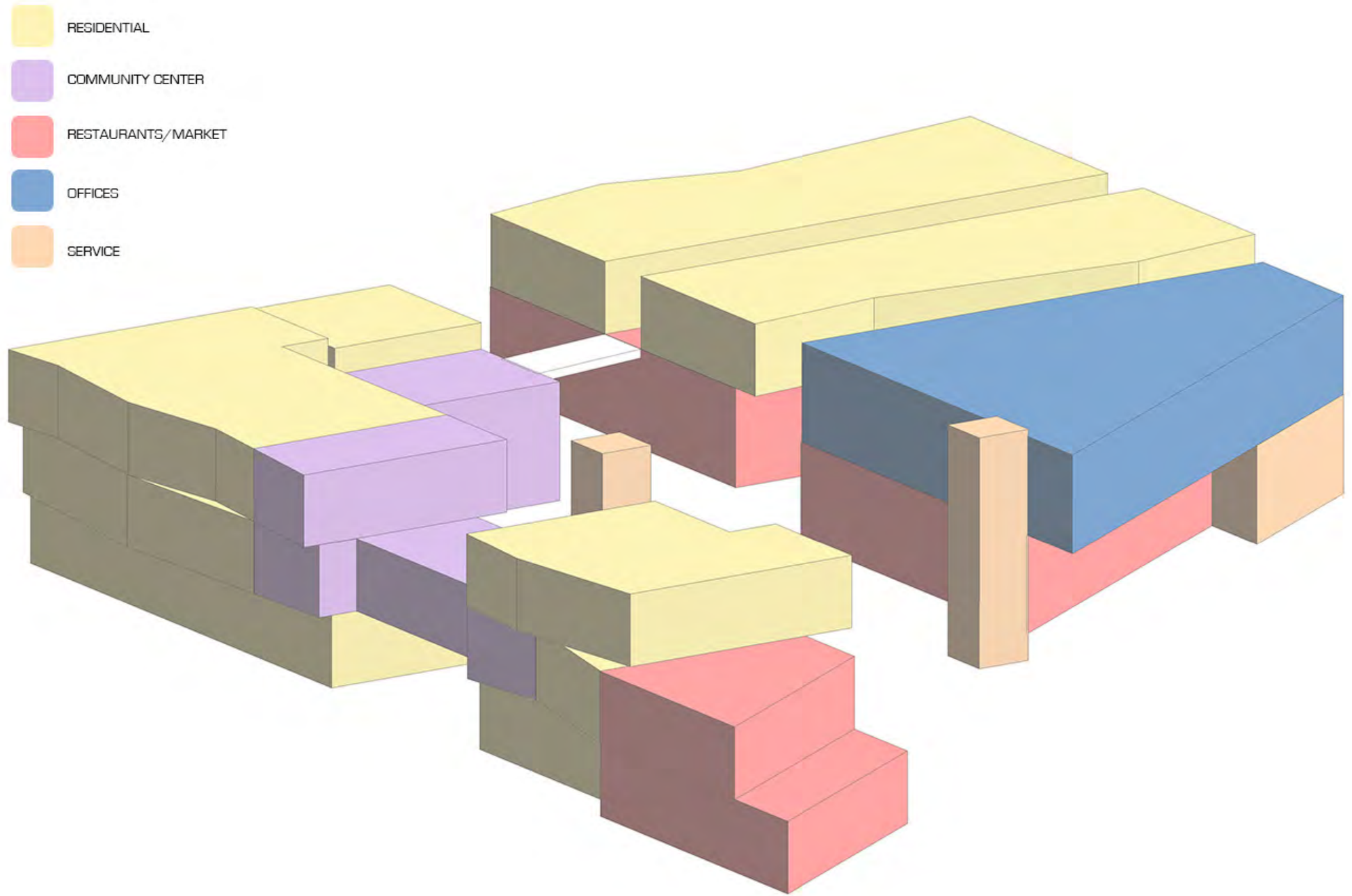
Bicycle Parking

	Spaces as a percentage of required auto spaces*	Minimum short-term bicycle spaces**	Minimum long-term bicycle spaces***
C-N	15%	50%	40%

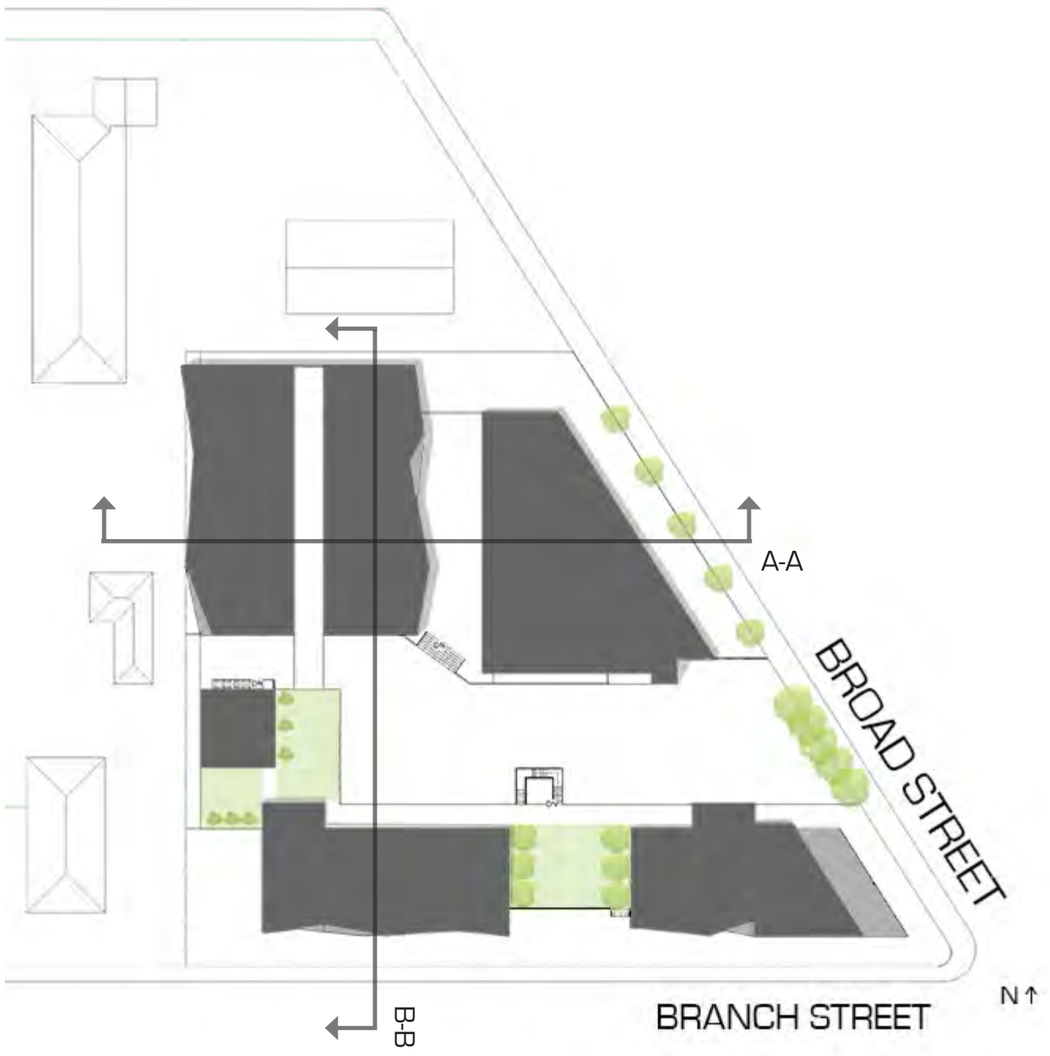
* Requirements apply to uses that require 10 or more vehicle parking spaces. When less than ½ space is calculated, one space is required

** “Short-Term” bicycle parking is used by visitors to multi-family housing and by patrons of commercial uses. Bicycle racks are used to satisfy this need

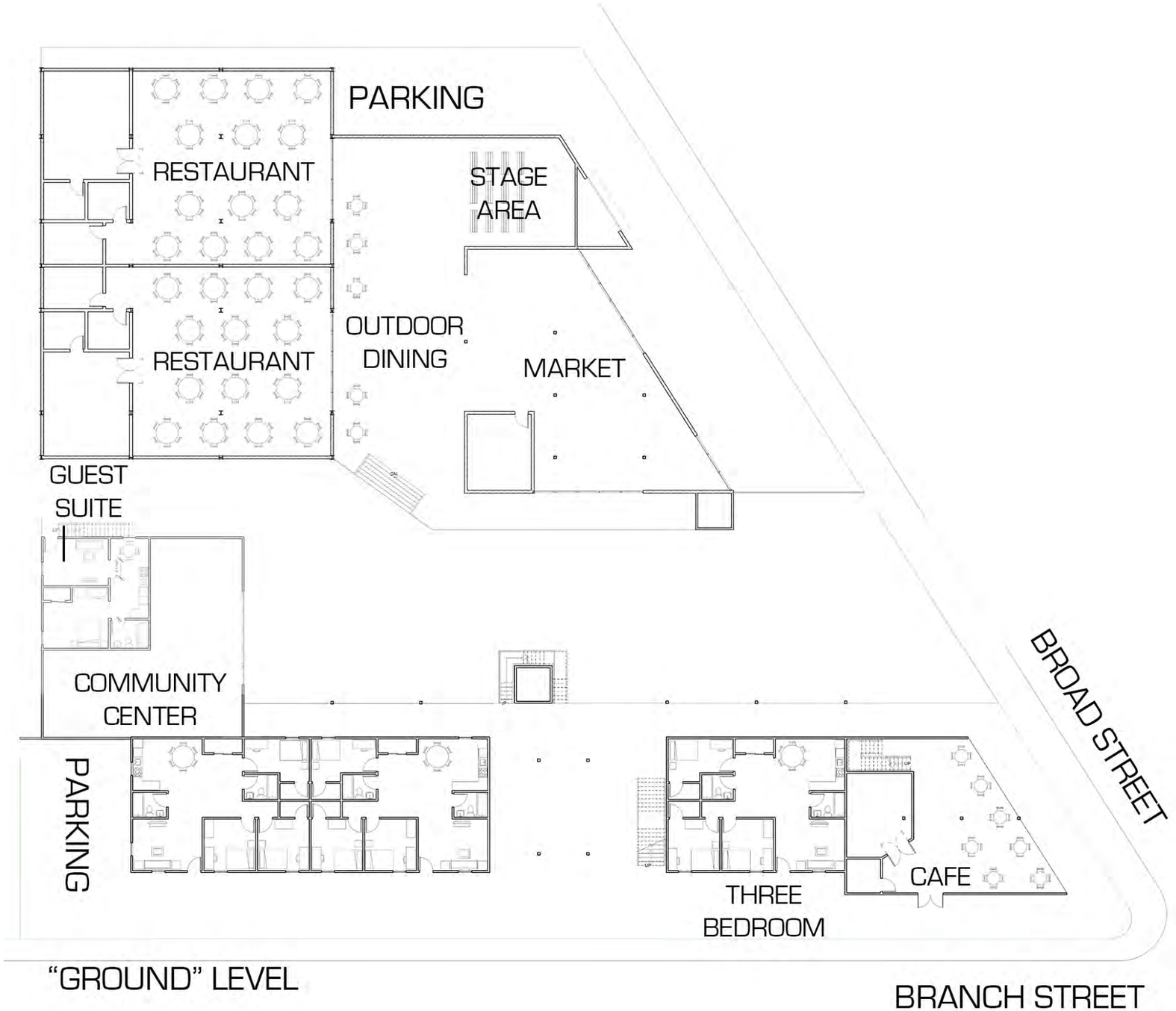
*** “Long-Term” bicycle parking is used by employees of commercial uses and by residents. Fully enclosed lockers are used to satisfy this need. Lockable rooms reserved for bicycle storage and secured parking areas managed by attendants are other acceptable forms. Bicycles shall be parked vertically or horizontally with at least the rear tire resting at floor level. Additionally, bicycle lockers or interior space within each dwelling or accessory structure have to be provided for the storage of at least two bicycles per unit



PROGRAM SUMMARY

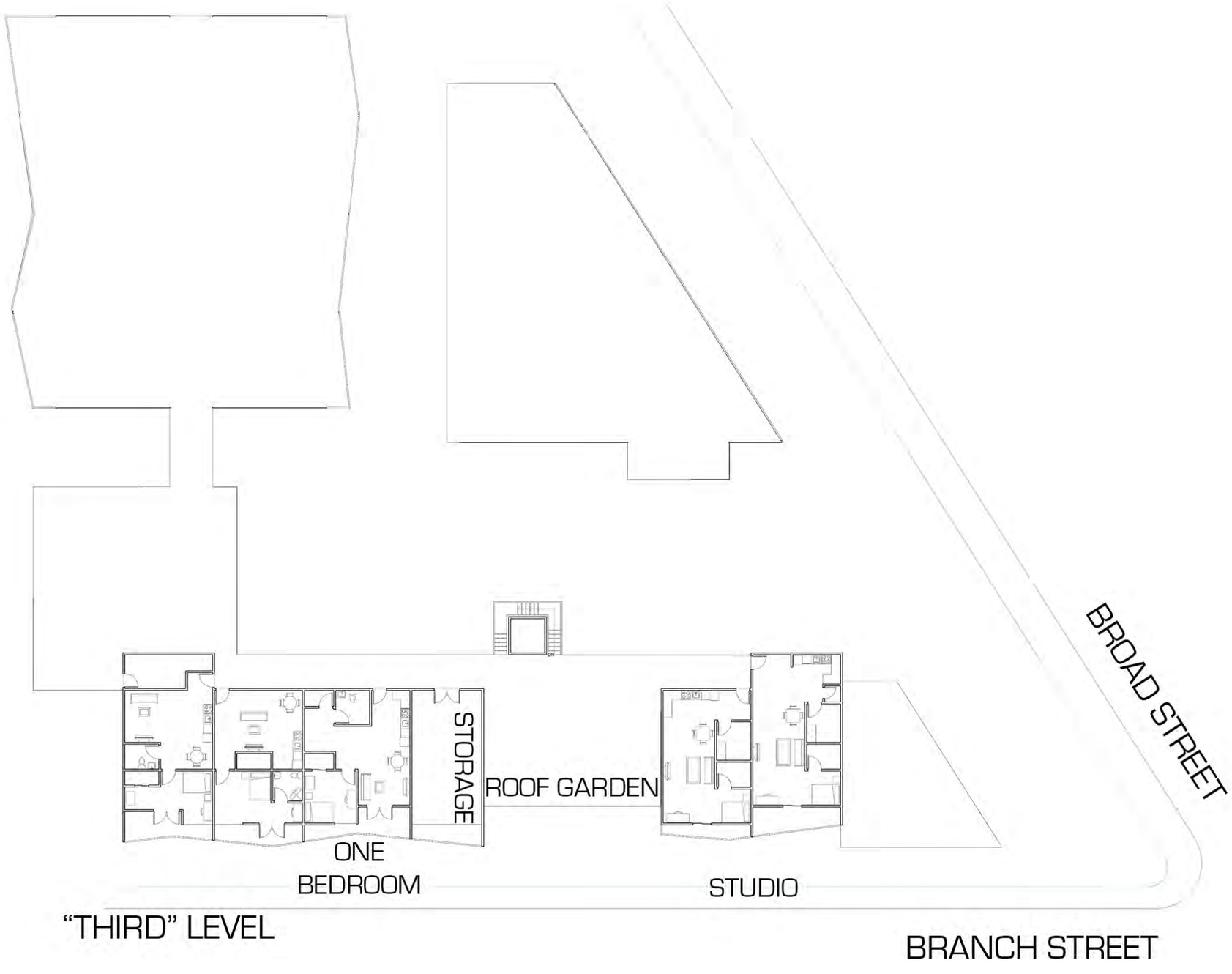


SITE PLAN | CIRCULATION



GROUND LEVEL

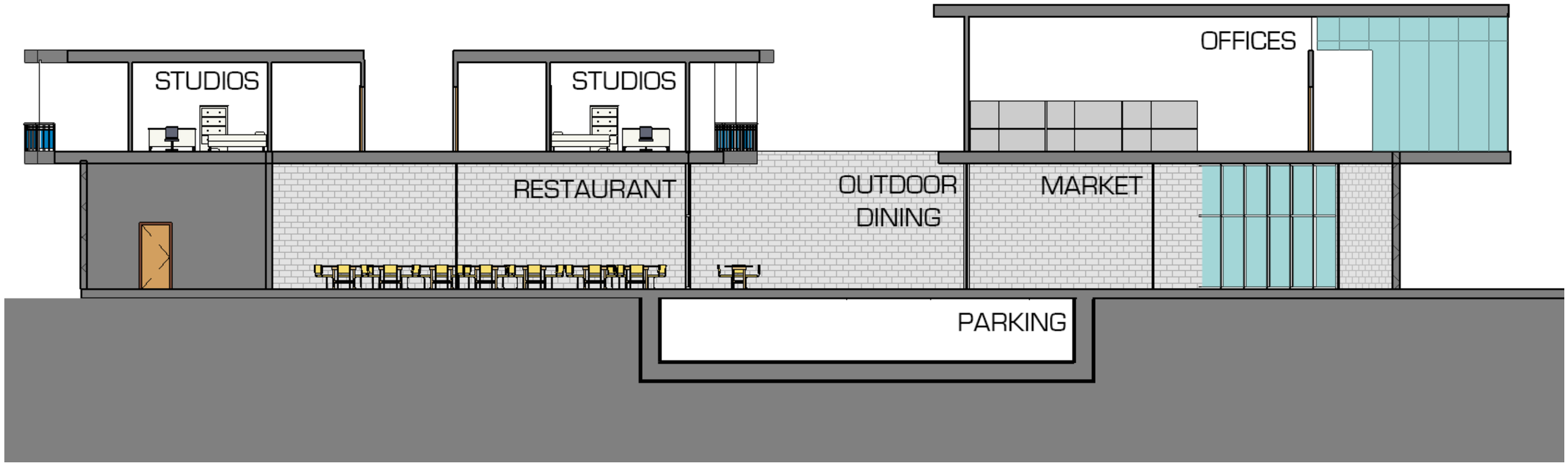
SECOND LEVEL


STORAGE
ROOF GARDEN
ONE
BEDROOM
STUDIO
BROAD STREET
"THIRD" LEVEL
BRANCH STREET

THIRD LEVEL

0’ 30’

15’ 45’



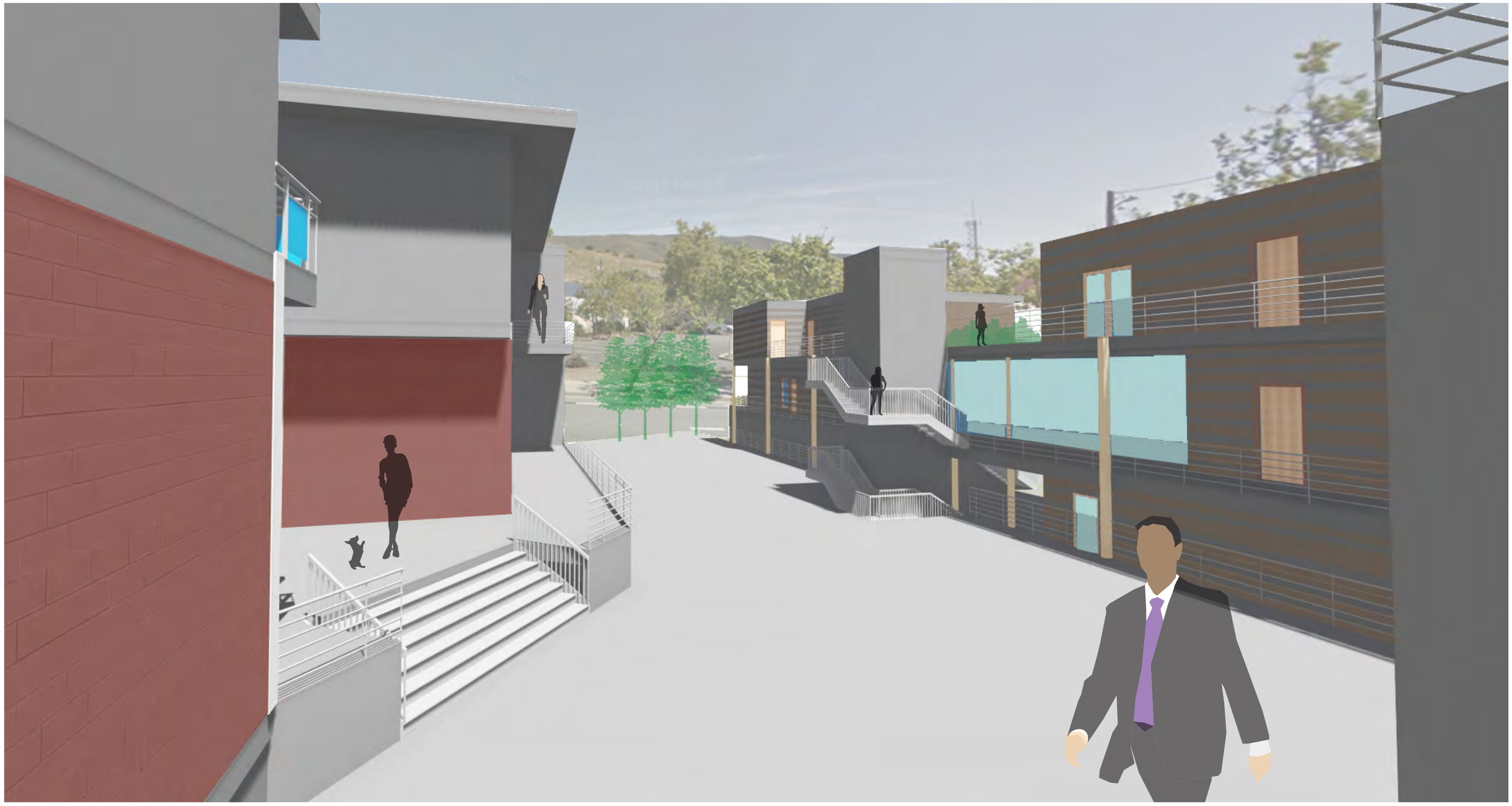
SECTION A-A

0’ 30’

15’ 45’

SECTION B-B

RESIDENTIAL ROOF GARDEN

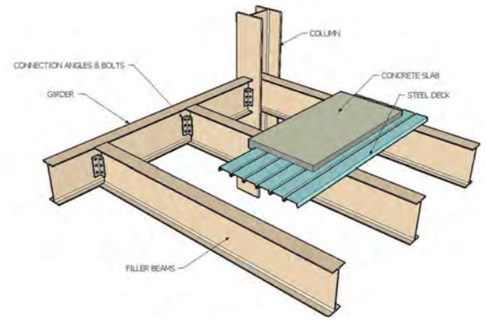


MID-LEVEL COURTYARD

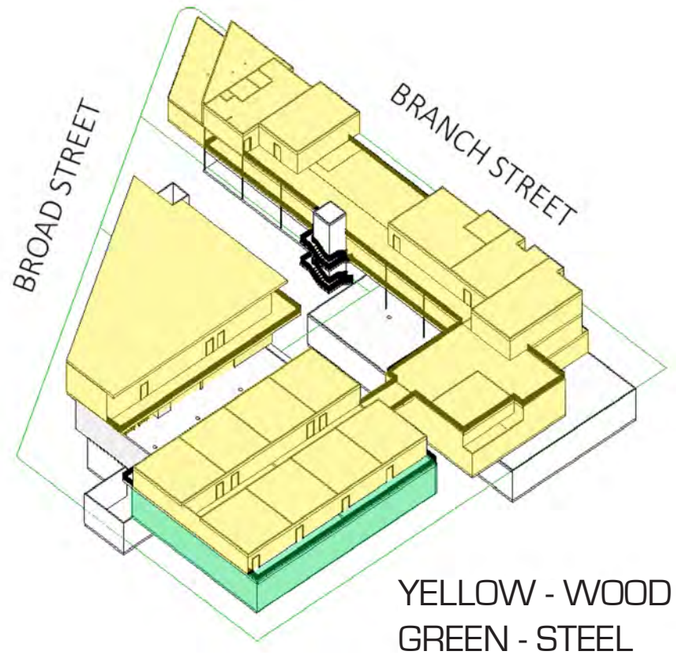
OUTDOOR PATIO DINING

STEEL

STEEL FRAMING WILL BE USED FOR COMMERCIAL AND OFFICE SPACE. IT WILL HAVE WIDE FLANGE BEAMS, GIRDERS, AND COLUMNS WITH BOLTS AND PLATES FOR CONNECTION



THERE WILL BE VERCO STEEL DECKING TOPPED WITH A 3" LIGHT WEIGHT CONCRETE SLAB WHICH WILL PROVIDE A SOUND/FIRE BARRIER. ALTHOUGH STEEL IS MORE EXPENSIVE AND REQUIRES SPECIAL SKILLS TO INSTALL, IT WILL ONLY BE USED FOR A SMALL PORTION OF THE PROJECT AND IS IMPORTANT FOR ACHIEVING THE DESIRED ARCHITECTURAL STYLE.
A LARGE PORTION OF STEEL IS REUSED AFTER A BUILDING IS TORN DOWN, MAKING IT SUSTAINABLE



YELLOW - WOOD
GREEN - STEEL

CONCRETE

CONCRETE WAS THE OBVIOUS CHOICE IN GRAVITY SYSTEM BECAUSE IT WILL BE UNDERGROUND, AND THE COLUMNS WILL BE HOLDING UP AND HELD UP BY LARGE CONCRETE SLABS. SO CONSTRUCTABILITY AND STRENGTH WISE IT IS THE ONLY MATERIAL THAT MAKES SENSE.

CMU

CMU BEARING WALLS WILL BE PAIRED WITH BOTH WOOD AND STEEL GRAVITY SYSTEMS WHERE THEY ARE ALREADY BEING USED FOR LATERAL SYSTEM

WOOD

WOOD FRAMING WILL BE USED FOR RESIDENTIAL AND OFFICE SPACE. IT WILL CONSIST OF A LIGHT FRAM WOOD SYSTEM WITH TJI JOISTS. COLLECTORS AND BEAMS (IF NEEDED) WILL BE PSL. BEARING WALLS WILL CARRY THE ROOF AND FLOOR LOADS.

WOOD FRAMING WAS CHOSEN FOR RESIDENTIAL, OFFICES, AND SMALLER COMMERCIAL BUILDINGS BECAUSE IT IS THE MOST COST EFFECTIVE.

ESPECIALLY FOR RESIDENTIAL, WOOD CONSTRUCTION IS ALSO THE 'WARMEST' MATERIAL COMPARED TO STEEL AND CONCRETE.

TIMBER IS ALSO THE BEST MATERIAL CONSTRUCTABILITY WISE. THEREFORE THERE WILL BE PLENTY OF WORKERS CAPABLE OF COMPLETING THIS PORTION OF THE PROJECT WITH LITTLE INSTRUCTION WHILE STILL PRODUCING QUALITY WORK. WOOD CAN ALSO BE REUSED, MAKING IT SUSTAINABLE

GRAVITY SYSTEM

CONFIGURATION

THE GRAVITY SYSTEMS WERE CONFIGURED BASED ON SPAN, POTENTIAL USE OF SPACE, AND SURROUNDING STRUCTURE.

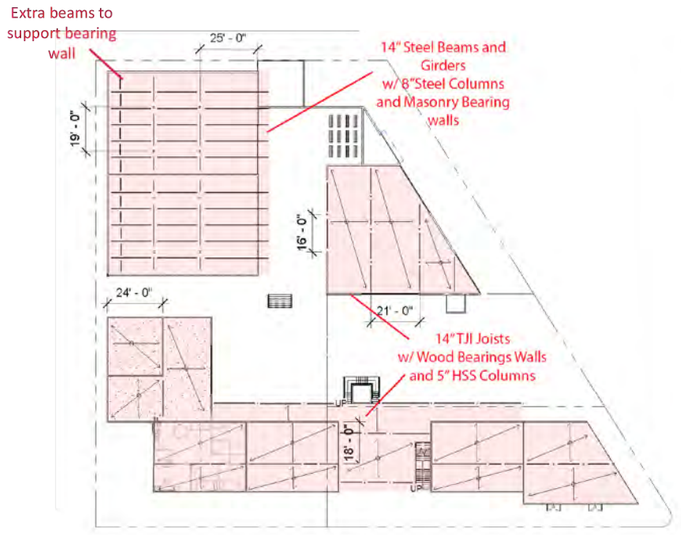
FORE THE RESIDENTIAL, BECAUSE THE INTERIOR AREAS ARE SO SMALL, BEARING WALLS WILL BE ON THE EXTERIOR OF EACH UNIT. THE TJI JOISTS WILL SPAN IN THE SHORTEST DIRECTION. FOR OFFICES, THERE WILL NEED TO BE A COUPLE COLUMNS ON THE LOWER FLOOR, WHICH THEN REQUIRES PSL BEAMS IN THE SHORTER DIRECTION, AND TJI JOISTS SPANNING THE LONGER DIRECITON. THIS IS TO REDUCE THE CEILING HEIGHT AS MUCH AS POSSIBLE.

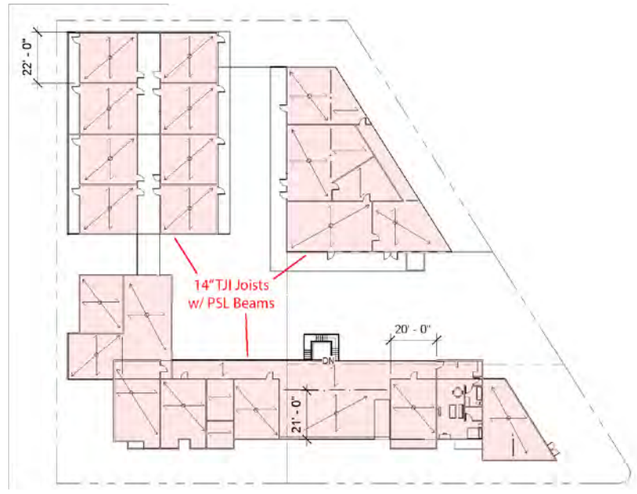
THE INTERIOR COLUMNS LINE UP WITH THE BEARING WALLS ABOVE TO REDUCE LOADING ON THE BEAMS AND GIRDERS. AGAIN, TO REDUCE CEILING HEIGHT, BEAMS WILL SPAN THE LONGER DIRECTIONS WHILE GIRDERS IN THE SHORTER DIRECTION. CMU BEARING WALLS ARE USED WHERE OPENINGS ARE NOT NEEDED

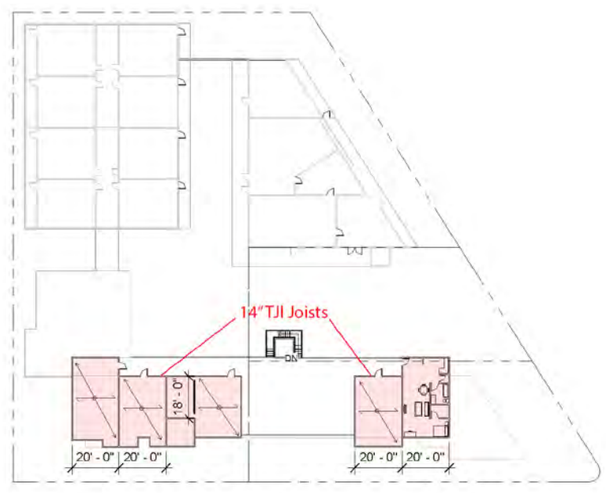
SIZING

A TYPICAL TJI JOIST (TJI 230 14”) IS USED FOR ALL THE RESIDENTIAL AND OFFICE SPACES UNLESS NOTED OTHERWISE. SIMPSON ITS HANGERS WILL SUPPORT JOISTS. WHEN COLUMNS ARE NEEDED, A HSS 4X4X1/4 STEEL COLUMN WILL BE USED

IN THE COMMERCIAL BUILDING, STEEL GIRDERS ARE W14X61 AND BEAMS ARE W14X34 WHILE COLUMNS ARE W8X31





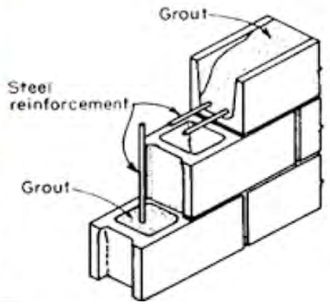


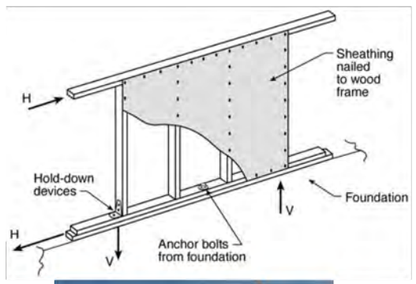
GRAVITY SYSTEM

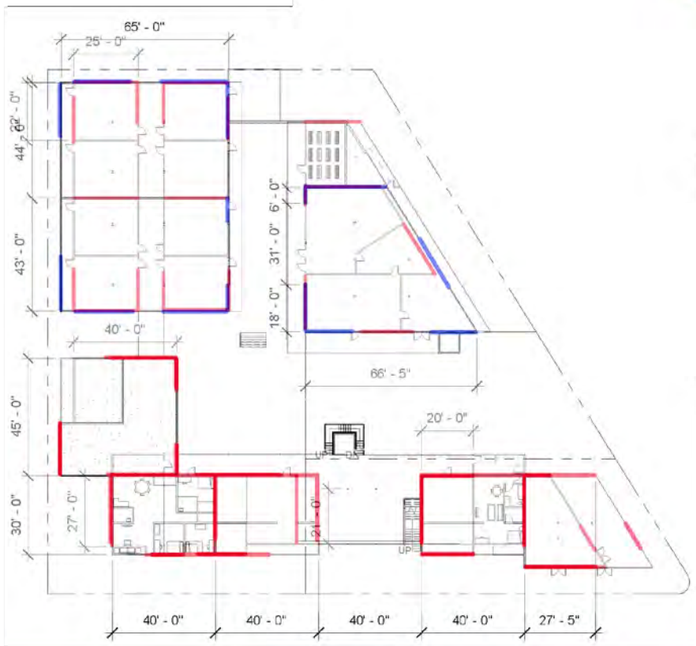
TIMBER SHEAR WALL (RED)

WOOD SHEAR WALLS INCLUDE 2X6 STUDS SPACED 16” O.C. WITH STRUCTURAL PLYWOOD SHEATHING WITH NAILING SPACED ACCORDING TO THE STRENGTH THAT IS NEEDED, STILL USING THE SAME 10D NAILS. AT EACH END OF EVERY SHEARWALL, THERE WILL BE HDU2 HOLD DOWNS

TIMBER SHEAR WALLS WILL BE USED IN ALL LIGHT FRAMED TIMBER BUILDINGS THAT ARE NOT IN NEED OF LARGE OPENINGS. BEARINGS WALLS WILL BE USED AT THE GRAVITY SYSTEM FOR MOST OF THE WOOD FRAMED BUILDINGS AND CAN DOUBLE AS SHEAR WALLS. OTHER OPTIONS WOULD BE MASONRY SHEAR WALLS, BUT WHEN THE LOAD IS NOT TOO HIGH AND WITH SMALLER OPENINGS.







MASONRY SHEAR WALL (BLUE)

MASONRY SHEAR WALLS WILL WORK WITH WOOD STRUCTURES TO CREATE A MORE SPACE EFFICIENT SHEAR WALL. BECAUSE THEY HAVE MORE STRENGTH PER FOOT, WE WOULD BE ABLE TO USE LESS WALL AND HAEV MORE OPENINGS. IT IS MADE UP OF 8” CMU WHICH IS REINFORCED BASED ON MINIMUM REQUIREMENTS AND CALCULATIONS

MASONRY SHEAR WALLS WILL BE USED WHEN TIMBER SHEAR WALLS ARE TOO LARGE, NOT STRONG ENOUGH, OR A COMBINATION OF THE TWO. MASONRY SHEAR WALLS HAVE A LOT OF STRENGTH COMPARED TO THE WEIGHT CONSTUCTION, ALLOWING THEM TO BE SMALLER IN WIDTH. THEY ALSO CAN BE ASTHETICALLY PLEASING, ESPECIALLY IN SLO AREA

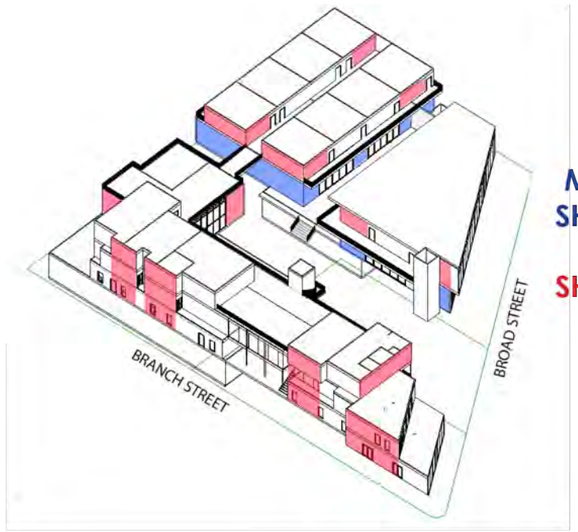
LATERAL SYSTEM

CONFIGURATION

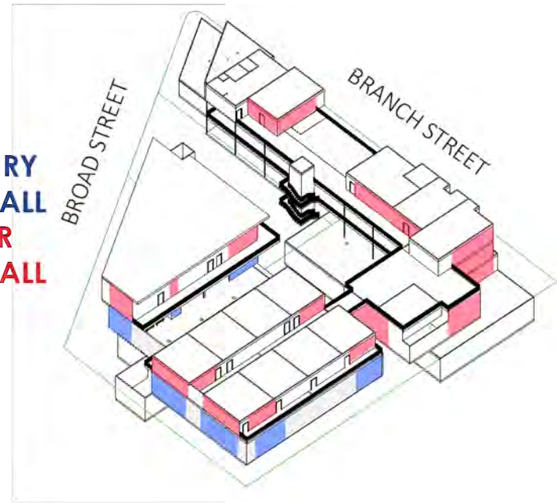
THE LATERAL SYSTEM WAS CONFIGURED BASED ON CENTER OF MASS AND RIGIDITY, OPENINGS, ASTHETICS, AND WALL SPANS.

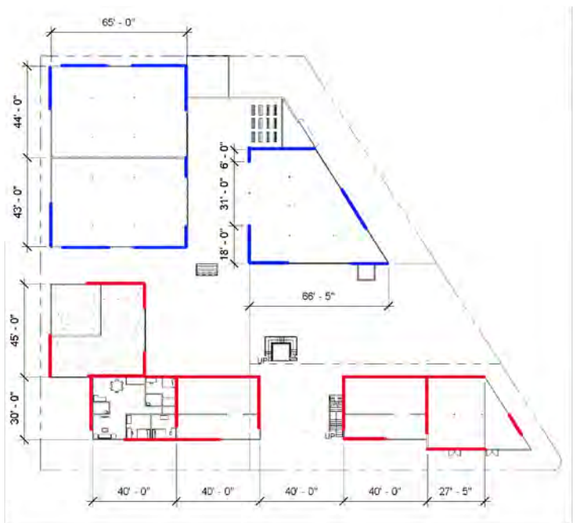
THE WOOD SHEARWALLS WERE PLACED WHERE THE WALL WOULD BE CONTINUOUS HORIZONTALLY AND VERTICALLY TO TRY AND AVOID EXCESS DRAG AND LOAD TRANSFER BEAMS. FOR THE RESIDENTIAL ABOVE THE COMMERCIAL AREA, THE SHEARWALLS LINE UP WITH SYSTEMS BELOW WHEN POSSIBLE. EXTERIOR SHEAR WALLS WILL NEED TO BE ADJUSTED BASED ON FINAL WINDOW AND DOOR PLACEMENTS

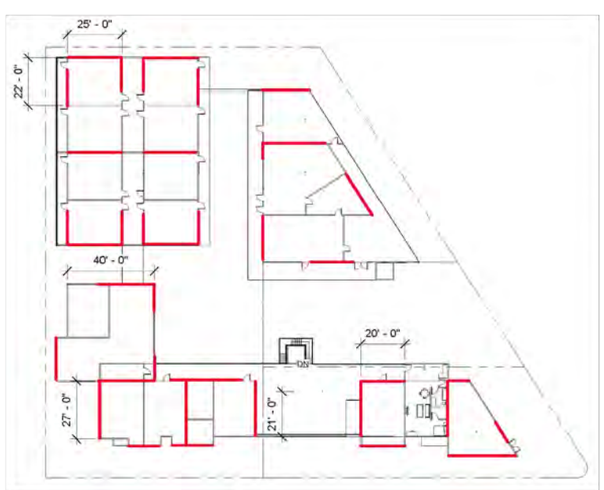
CMU SHEARWALLS ARE PLACED ALONG THE LOWER PORTION OF THE COMMERCIAL AND OFFICE BUILDING IN ORDER TO ALLOW LARGER OPENINGS. WE ARE PLANNING ON HAVING LARGE WINDOWS AND A GARAGE DOOR, AND THE CMU WALLS BEING MORE COMPACT WILL PROVIDE THE SPACE TO ACOOMODATE THAT

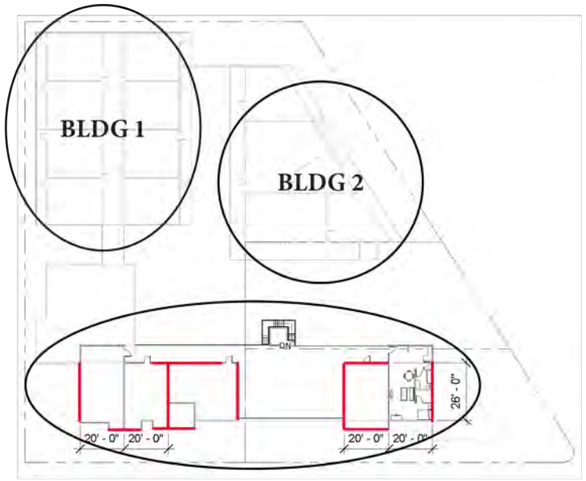


MASONRY SHEARWALL
TIMBER SHEARWALL









BLDG 3

SIZING

BLDG 1
- NEED 76' OF WOOD SHEAR WALL IN EACH DIRECTION
- NEED 93' OF MASONRY SHEAR WALL IN EACH DIRECTION

BLDG 2
- NEED 56' OF WOOD SHEAR WALL IN EACH DIRECTION
- NEED 44' OF MASONRY SHEAR WALL IN EACH DIRECTION

BLDG 3
- NEED 130' OF WOOD SHEAR WALL IN EACH DIRECTION

LATERAL SYSTEM

THE PARKING GARAGE WILL BE A REINFORCED TWO WAY CONCRETE STRUCTURE THE CONCRETE WILL BE REGULAR WEIGHT WITH A STRENGTH OF 4KSI WITH 60KSI REBAR FOR SHEAR AND TENSION REINFORCEMENT. A BASIC REPRESENTATION OF THE STRUTURAL LAYOUT IS SHOWN IN FIGURE 1.

THE PARKING IS UNDERGROUND, MAKIGN THE WALLS BEARING WALLS THAT WILL NEED TO SUPPORT THE SURROUNDING SOIL.

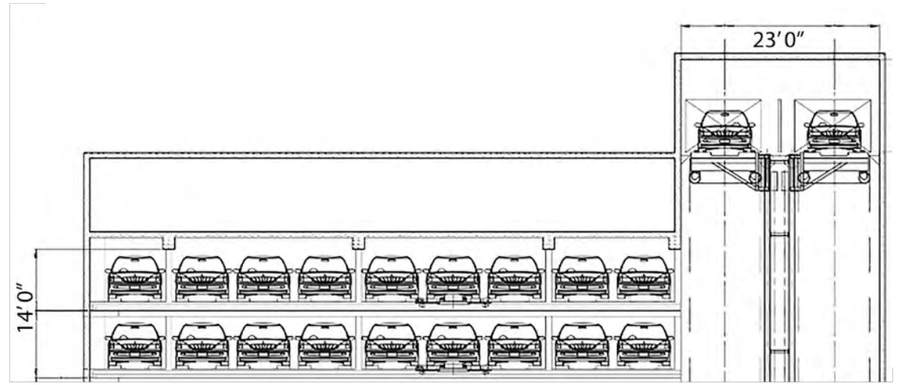
USERS WILL PARK THEIR CAR INTO A GARAGE LIKE FEATURE ABOVE GRADE; ONCE THEY HAVE ENTERED THEIR INFORMATION, THE CAR WILL BE PARKED COMPLETELY MECHANICALLY. THERE WILL BE TWO ELEVATORS AT EACH ENTRANCE SO PEOPLE CAN ENTER/EXIT WITH EAST. A SMALL STRUCTURE WILL HID THE MECHANICAL SYSTEM.

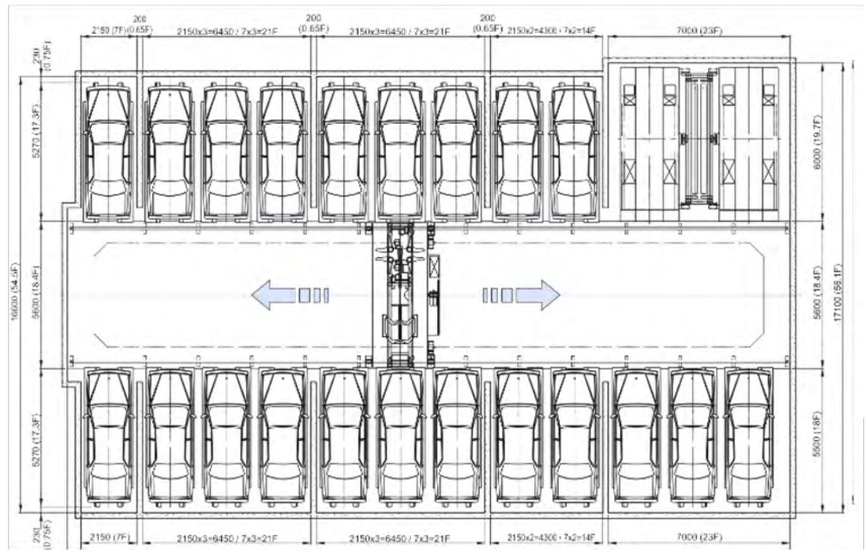
ONE WILL PARK THEIR CAR BY PULLING IN TO A STRCTURE SIMILAR TO FIGURE 2, AND WILL THEN LEAVE THEIR CAR AND RECEIVE A PARKING SLIP. THE CAR WILL THEN BE LOWERED INTO THE SYSTEM SHOWN IN FIGURE 3. ONCE THEY WANT TO RETRIEVE THE CAR, THEY WILL NEED TO RE-ENTER THE SLIP AND THE CAR RETURNS TO THE STRUCTURE IN FIGURE 2.

Figure 1


Figure 2

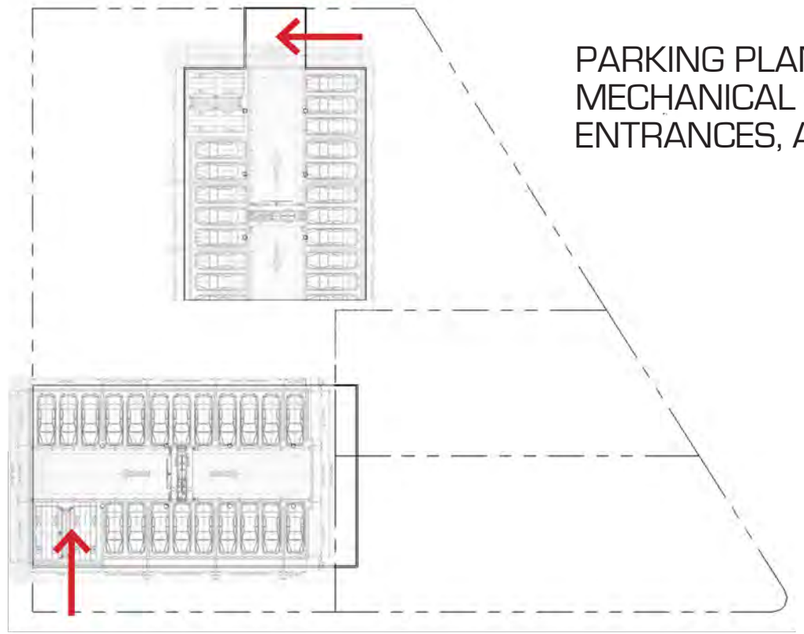

Figure 3



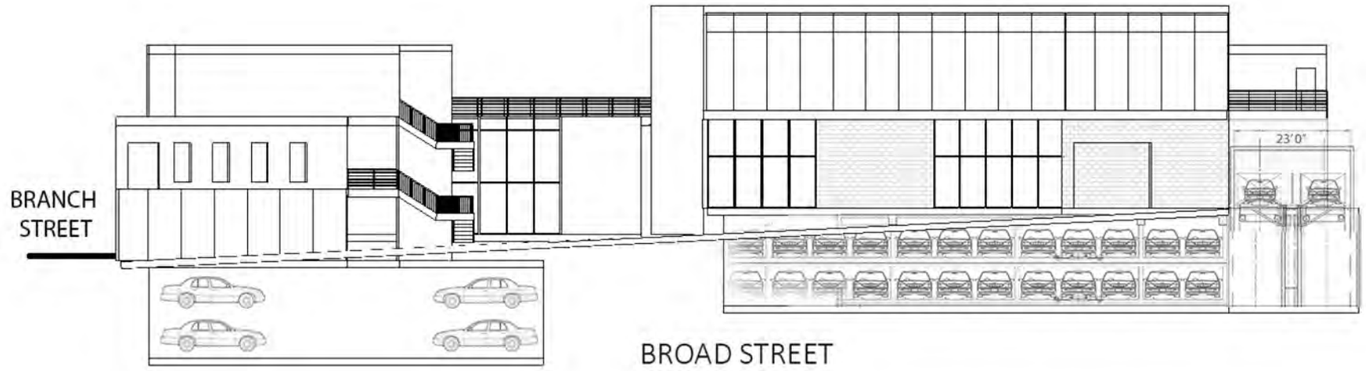


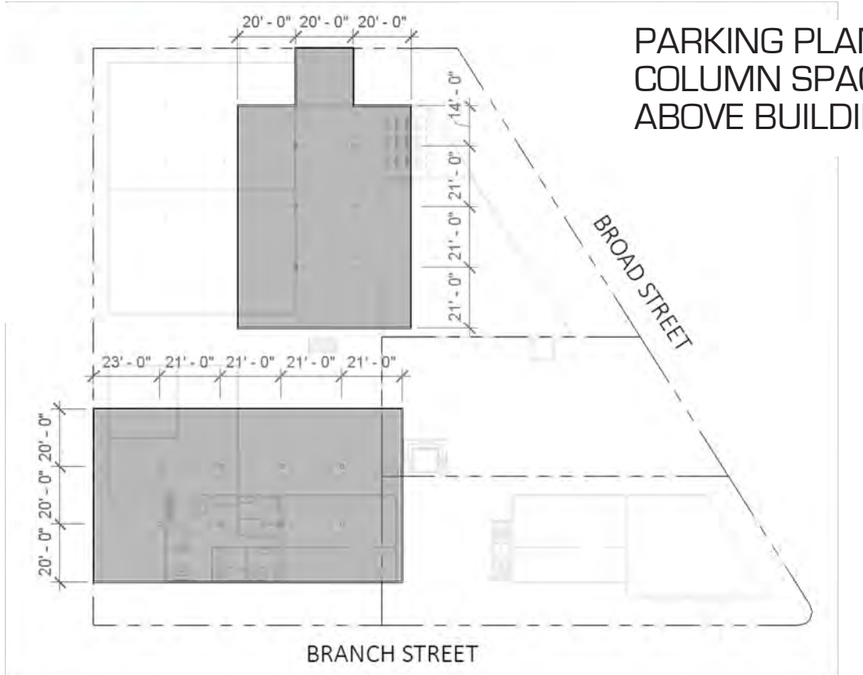
IN THIS FULLY SELF PARKING SYSTEM, EACH SPOT IS 7'0" by 18'-0" AND TWO LAYERS OF PARKING IS JUST UNDER 14' IN HEIGHT

PARKING SYSTEM



PARKING PLAN SHOWING
MECHANICAL SYSTEMS,
ENTRANCES, AND COLUMNS





PARKING PLAN SHOWING
COLUMN SPACING AND
ABOVE BUILDINGS

THE PARKING SYSTEM WAS SEPARATED INTO RESIDENTIAL AND COMMERCIAL TO TRY AND FACILITATE TRAFFICE AND KEEP THE RESIDENTIAL FEELING MORE PRIVATE.

THE COLUMNS IN THE COMMERCIAL PARKING ARE 18"X18" AND LINE UP WITH THE COLUMNS FROM THE STEEL STRUCTURE ABOVE, AND ALL THE OTHER PARKING COLUMNS ARE SPACED TO ALLOW THE MECHANICAL PARKING.

RESIDENTIAL PARKING SPOTS NEEDED: 28
COMMERCIAL PARKING SPOTS NEEDED: 64
TOTAL REQUIRED: 92

RESIDENTIAL PARKING SPOTS PROVIDED: 48
COMMERCIAL PARKING SPOTS PROVIDED: 44
TOTAL PROVIDED: 92

PARKING SYSTEM

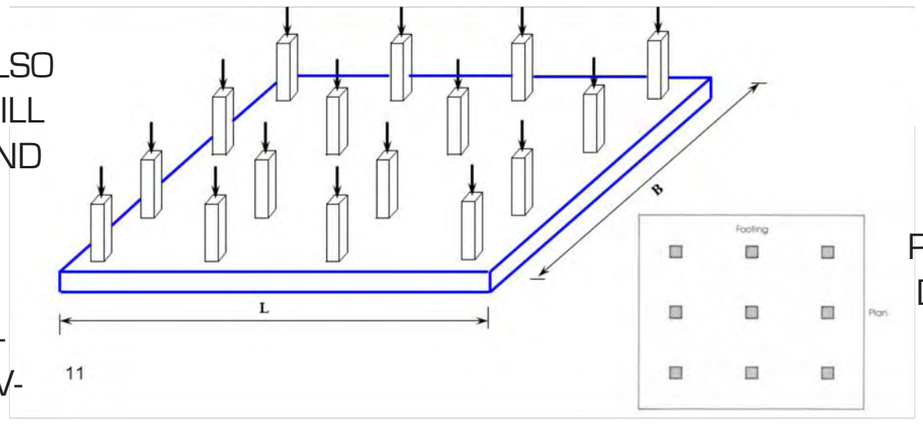
SELECTION

THE EXPANDING AND CONTRACTING NATURE OF THE CLAY SOIL ON THE SITE REMOVES PAD FOOTINGS AS AN OPTION FOR THE PROJECT. A QUICK CALCULATION CONCLUDED THAT THE PAD FOOTINGS WOULD BE SO LARGE BASED ON THE SITES POOR SOIL BEARING STRENGTH, THE PAD FOOTINGS WOULD NEARLY BE A MAT FOOTING.

PILES COULD WORK, BUT THEY WOULD HAVE TO BE PRE DRILLED BECAUSE DRIVEN PILES CAUSE LOUND NOISES AND HEAVY VIBRATIONS THAT MAY DISRUPT SURROUNDING HOMES AND BUSINESSES.

BECAUSE THE SITE MAY HAVE AN UNDERGROUND WATER TABLE, DRILLING MAY ALSO BE AN ISSUE BECAUSE THE WATER MAY FILL THE HOLE, REQUIRING MORE EUIPMENT AND LABOR.

THIS LEAVES MAT FOUNDATIONS , WHICH WILL REQUIRE EXCAVATION FOR THE UNGERDROUND PARKING AS WELL AS THE LEVELING OF THE SITE. THE MAT FOUNDTION WILL REISIST WATER PRESSURE IN THE SOIL WHILE ALSO BEING RELATIVELY SIMPLE/ CONSISTANT TO INSTALL.



DESCRIPTION

A MAT FOUNDATION IS A FOUNDATION SYSTEM THAT COVERS THE ENTIRE FOOTPRINT OF THE PROJECT RATHER THAN JUST BEING UNDER INDIVIDUAL COLUMNS. THE MAT FOUNDATION WILL HAVE 60 KSI STEEL REINFORCEMENT AND WILL BE AT LEAST ONE FOOT IN DEPTH.

WHERE THERE IS UNDERGROUND PARKING, THE FOUNDATION WILL SERVE AS A FLOOR SLAB FOR THE PARKING GARAGE, AND THE ROOF OF THE GARAGE WILL CONTINUE WITH THE ON GRADE MAT FOUNDATION.

LIKE THE REST OF THE PARKING SYSTEM, THE FOUNDATION WILL USE 4 KSI REGULAR WEIGHT CONCRETE.

SIMILAR TO A PAD FOOTING, MAT FOUNDATIONS TAKE THE POINT LOADS FROM INDIVIDUAL COLUMNS AND SPREAD THEM OUT IN ORDER TO NOT PUT TOO MUCH PRESSURE ON THE SOIL, AS IN THE DIGRAM BELOW. MAT FOOTINGS CAN BE SEEN AS PAD FOOTINGS THAT HAVE BEEN CONNECTED.

IF THE DEPTH OF THE TOP SLAB IS NOT ENOUGH TO RESIST PUNCHING SHEAR, EXTRA DEPTH AND OR REINFORCEMENT WILL BE ADDED AROUND THE COLUMN TO SLAB CONNECTION.

FOUNDATION SYSTEM

CONFIGURATION

THE FOUNDATION SYSTEM WAS COMPLICATED BY POOR SOIL BEARING PRESSURE, UNDERGROUND PARKING, AND A SLOPED SITE.

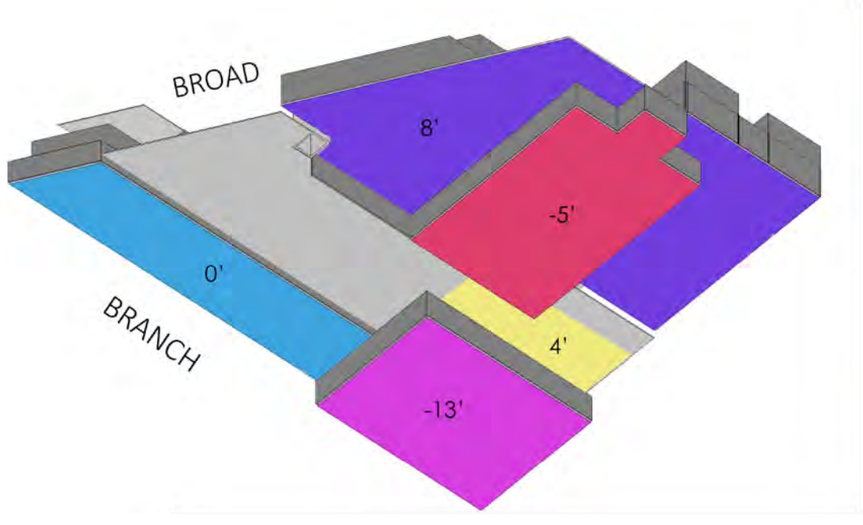
THE TWO PARKING GARAGES ENTRANCES ARE LEVEL WITH THE STREET, MAKING THEM 8' APART IN DEPTH. THE ROOF OF THE GARAGES SERVES AS A FOUNDATION FOR THE BUILDING ABOVE. TO TRY AND SOFTEN THE GRADE CHANGE BETWEEN BUILDINGS ON OPPOSITE SIDES OF THE SITE, THE RESIDENTIAL COMMUNITY CENTER WILL BE IN BETWEEN THE TWO, ALONG WITH THE LANDSCAPE IN FRONT OF IT (SHOWN IN YELLOW).

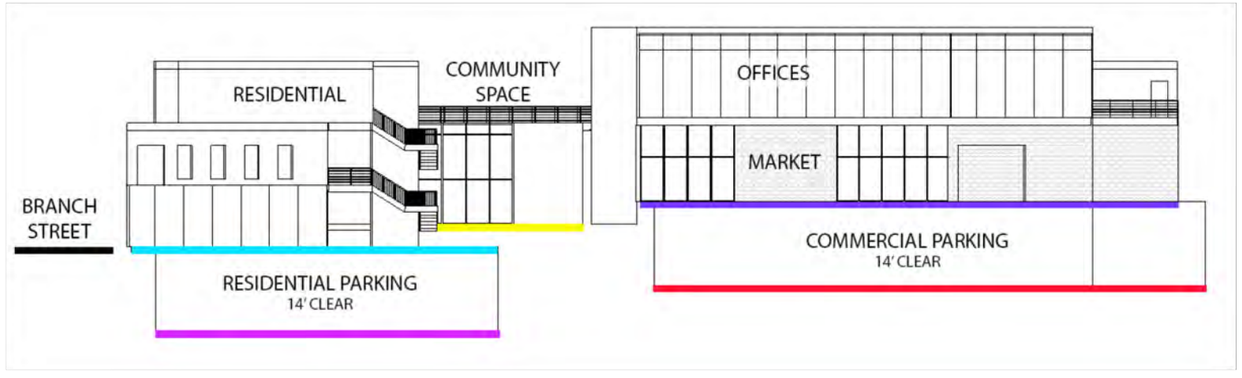
MAT FOUNDATION

THE FOUNDATION THICKNESS IS BASED OFF OF PUNCHING SHEAR FROM THE COLUMNS THAT FRAME INTO IT. TO FIND THIS, I TOOK THE COLUMN WITH THE MOST WEIGHT FROM EACH MAT TO FIND A THINKNESS FOR EACH INDIVIDUAL MAT. THIS WILL HOPEFULLY AVOID HAVING UNNEEDED CONCRETE. THE THICKNESS NEEDED WAS 15".

PARKING CEILING/SLAB

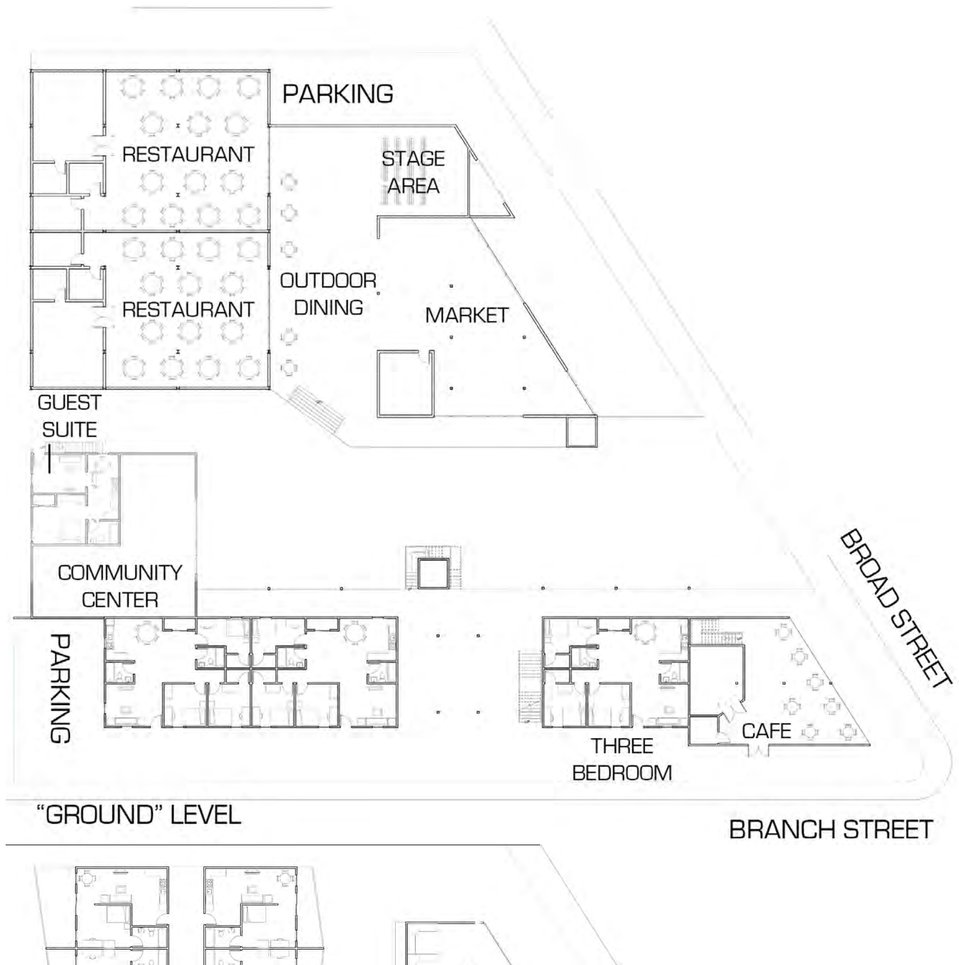
THE CEILING OF THE PARKING STRUCTURE DOUBLES AT A FLOOR FOOR INDOOR AND OUTDOOR SPACES. IT WILL BE A TWO WAT SLAB WITH 18" CONCRETE COLUMNS SPACED AT 21' SUPPORTING IT. ASSUMING A SLAB OF 12" WILL SUPPORT THE DEAD AND LIVE LOAD FROM THE BUILDINGS ABOVE MEANS I DO NOT NEED TO DO EXTRA CHECKS FOR A-TYPICAL COLUMNS AND BEARING WALLS THAT IT SUPPORTS. THE ROOF SLAB WILL BE 12".

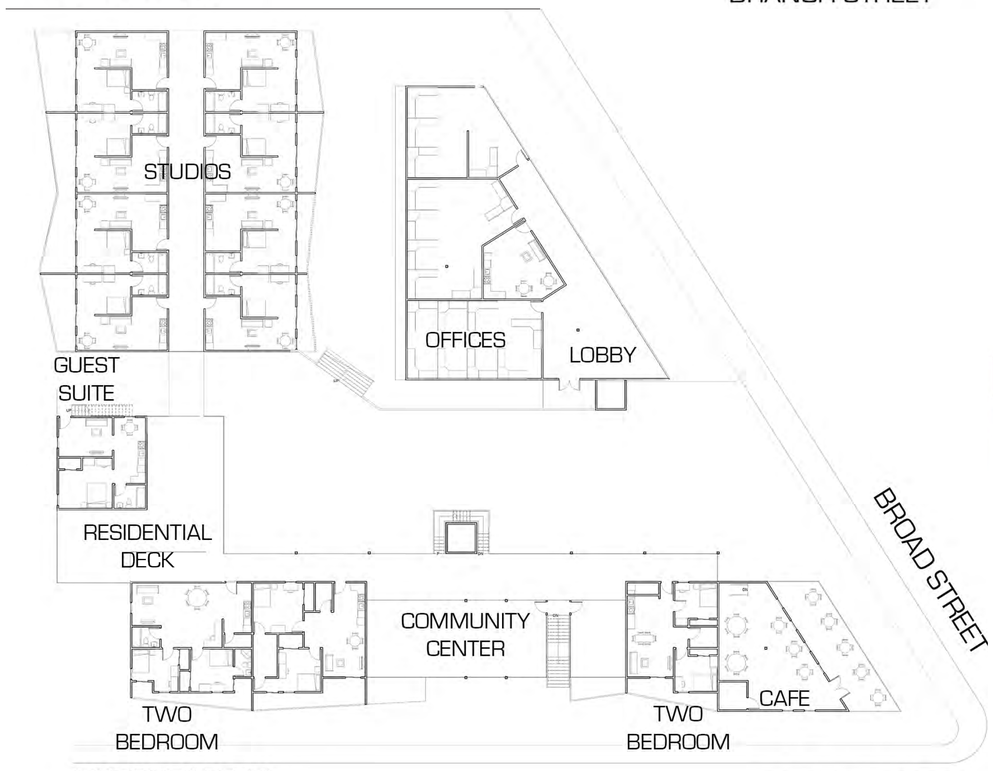


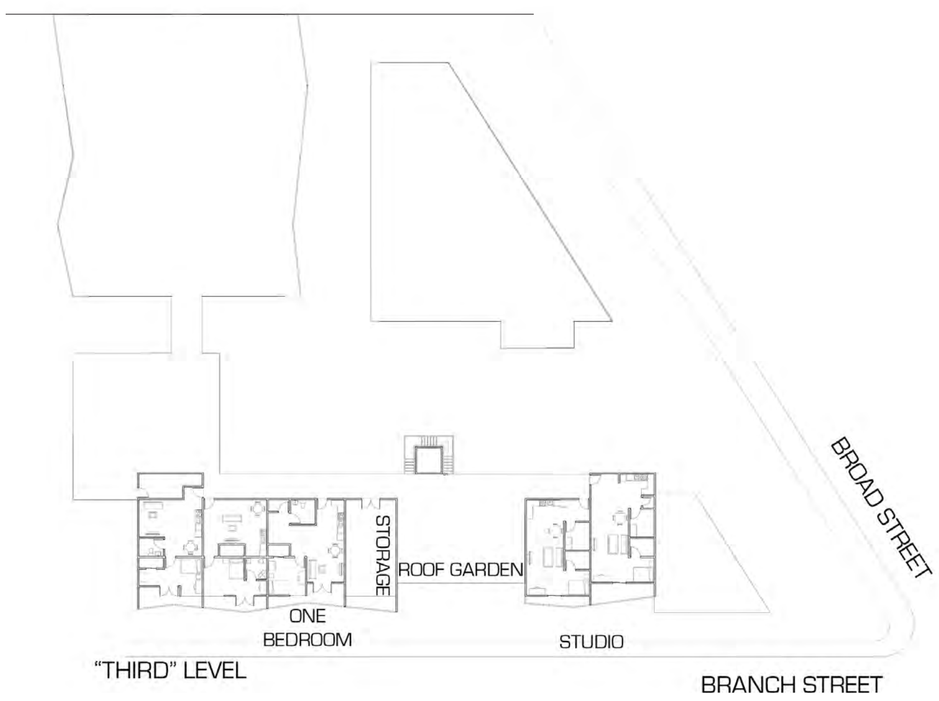


FOUNDATION SYSTEM

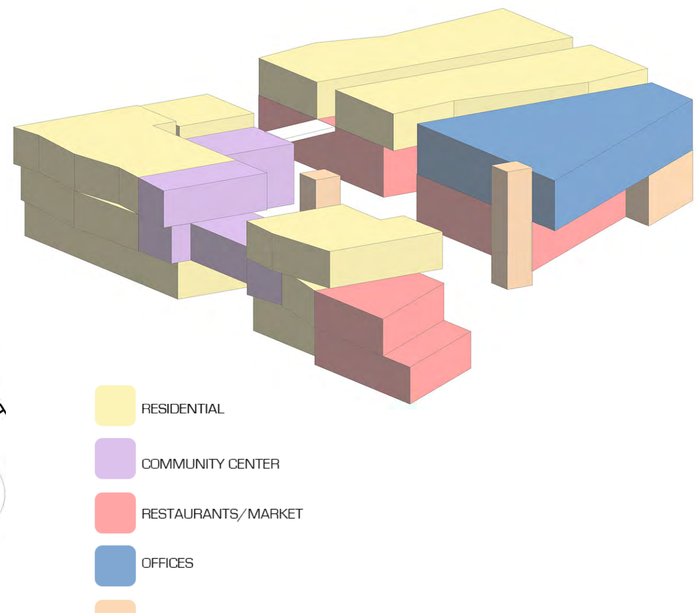
2115 BROAD ST

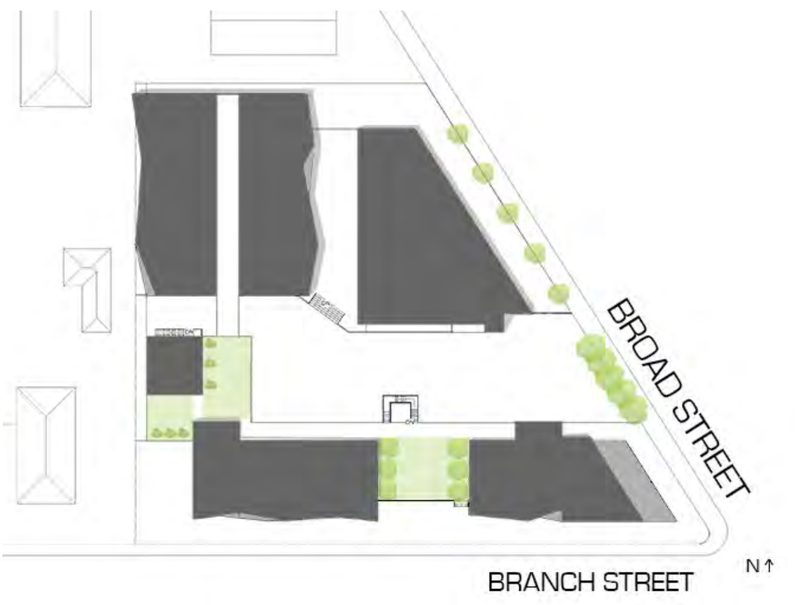






THE SOUTH BROAD STREET AREA HAS BEEN DESCRIBED AS A NEIGHBORHOOD IN TRANSITION WITH FUNKY, DIVERSE, AND/OR DILAPIDATED CULTURE DUE TO THE MIX OF OLDER COMMERCIAL AND RESIDENTIAL BUILDINGS AND UNDERUTILIZED PROPERTIES. IN ORDER TO CREATE AN ENVIRONMENT IN WHICH PEOPLE FELT SAFE FROM THE BUSY BROAD STREET TRAFFIC AS WELL AS BELONGING TO THE ECLECTIC ENVIRONMENT OF SAN LUIS OBISPO, RESIDENTIAL AND COMMERCIAL USES ARE CONNECTED BY A COMMON COURTYARD THE ENCOURAGES CROSS CIRCULATION BETWEEN BOTH SIDES. OUTDOOR PATIO DINING AREAS AND A SMALL PERFORMANCE STAGE ALLOWS FOR AN OPPORTUNITY TO CONNECT WITH THE SITE AND RETAIN VISITORS. GROUND LEVEL MARKET OPENS INTO IN THE COURTYARD TO BECOME A FARMER'S MARKET FOR THE RESTAURANTS AND LOCAL RESIDENTS.

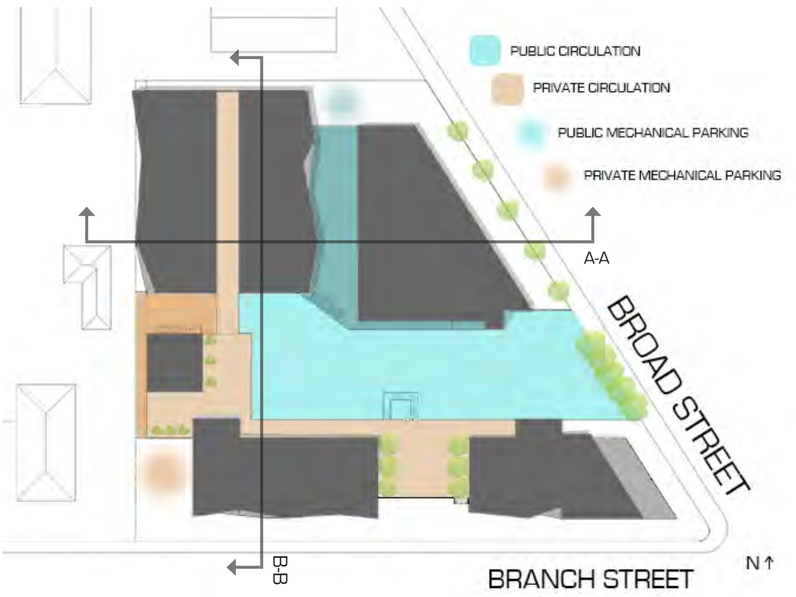




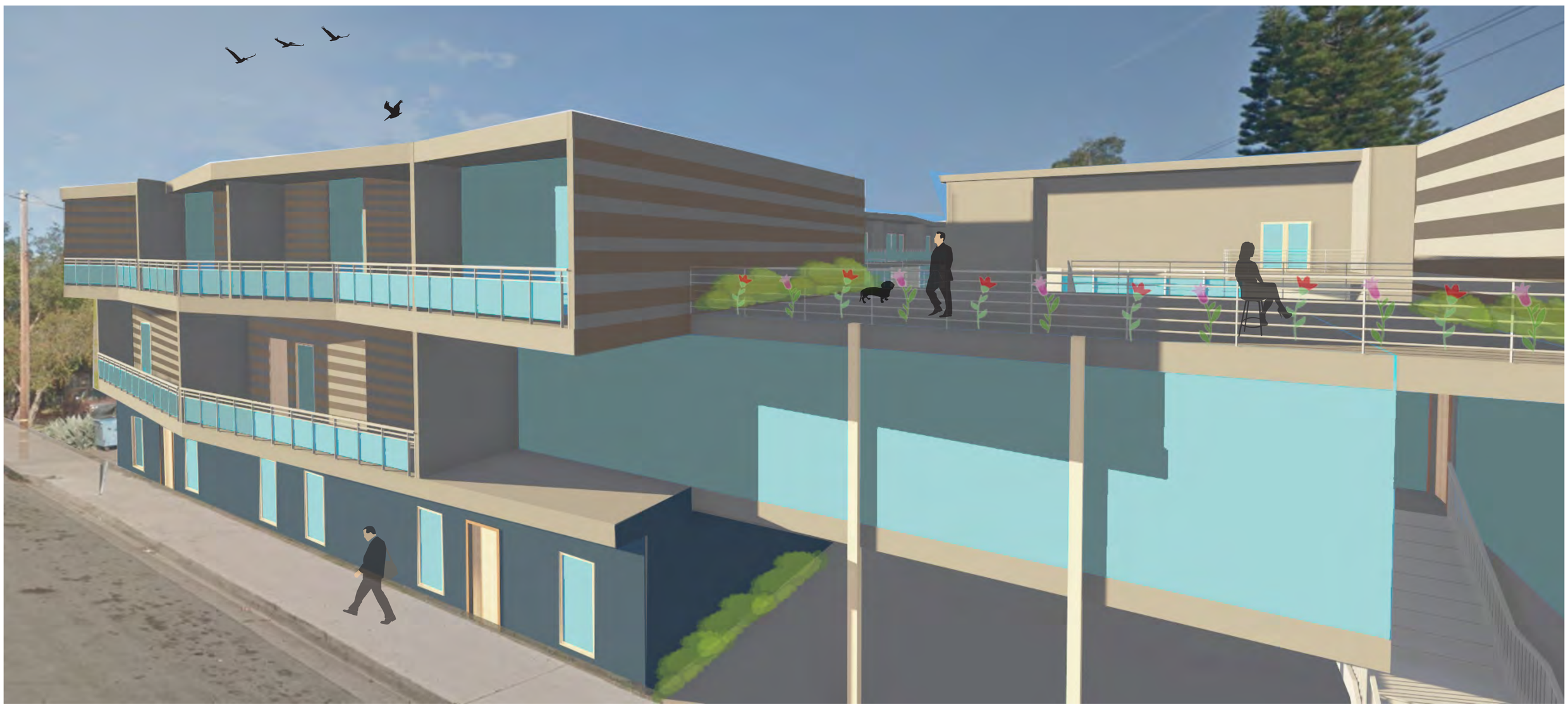
(5) ONE BEDROOM
(3) TWO BEDROOM
(3) THREE BEDROOM
(8) STUDIO UNITS
(3) OFFICES
(2) RESTAURANTS
(1) CAFE
(1) MARKET
(1) RESIDENTIAL MECHANICAL PARKING
(1) COMMERCIAL MECHANICAL PARKING

PROGRAM AXONOMETRIC

SITE PLAN



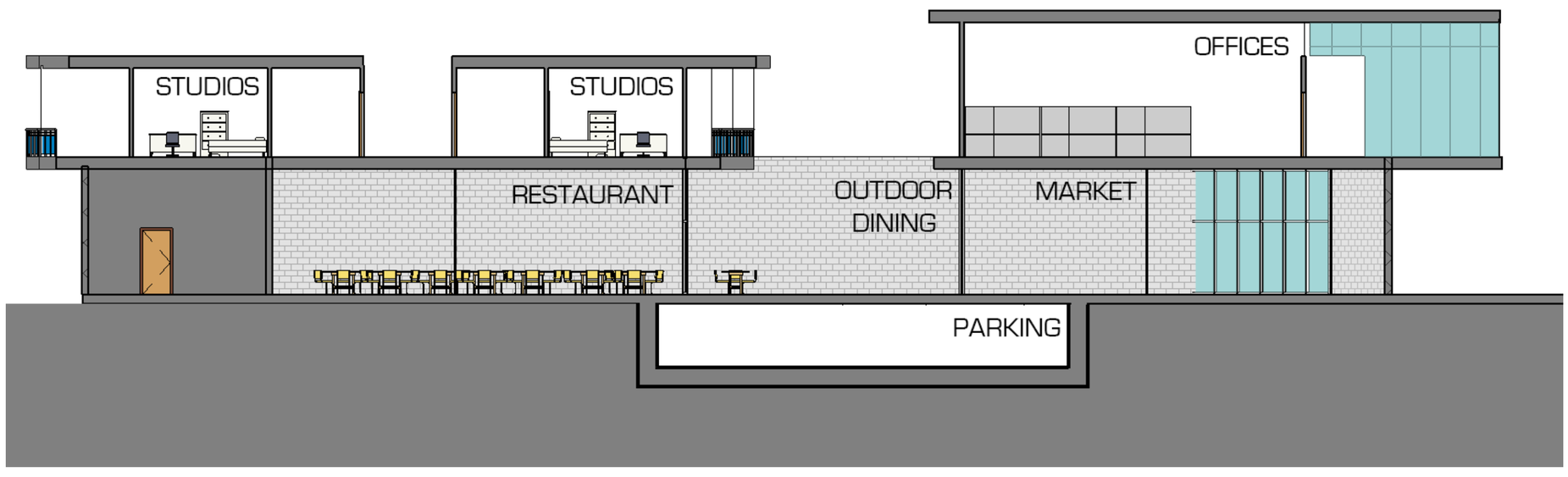
CIRCULATION



BRANCH STREET - RESIDENTIAL

INNER COURTYARD

OUTDOOR DINING PATIO



SECTION A-A

SEPARATE MECHANICAL PARKING AVAILABLE FOR BOTH RESIDENTIAL AND COMMERCIAL PURPOSES.

RESIDENTIAL UNITS ARE ALONG BRANCH STREET AND ABOVE RESTAURANTS; OFFICES ARE ABOVE THE MARKETPLACE OVERLOOKING THE OUTDOOR DINING PATIO

SECTION B-B

JENNY NGUYEN | MADISON BUSBY | 2115 BROAD STREET | SAN LUIS OBISPO

ARCH 453 | ARCE 415 | STACEY WHITE | BRENT NUTALL

FINAL REVIEW

GRAVITY

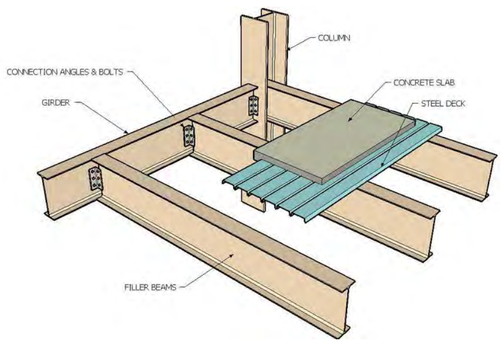
WOOD FRAMING DESCRIPTION

Wood framing will be used for a majority of the site. It will consist of a light frame wood system with joists. Joists will be spaced between 16" and 24" and topped with a plywood sheathing diaphrag Collectors and beams (if needed) will be PSL.
Bearing walls will be made up of 2X6 sawn lumber spaced at 16" with plywood sheathing, base p and double top plates. Connections will be made with 10d nails for sheathing and 16d otherwise, Simpson connections for beam to wall.

STEEL FRAMING DESCRIPTION

Steel framing will be used for commercial and office space. It will have wide flange beams, girder columns with bolts and plates for connections. Wide flanges will be A992 50 ksi steel.
There will be Verco Steel decking topped with a 3" light weight concrete slab which will provide c sound/fire barrier.

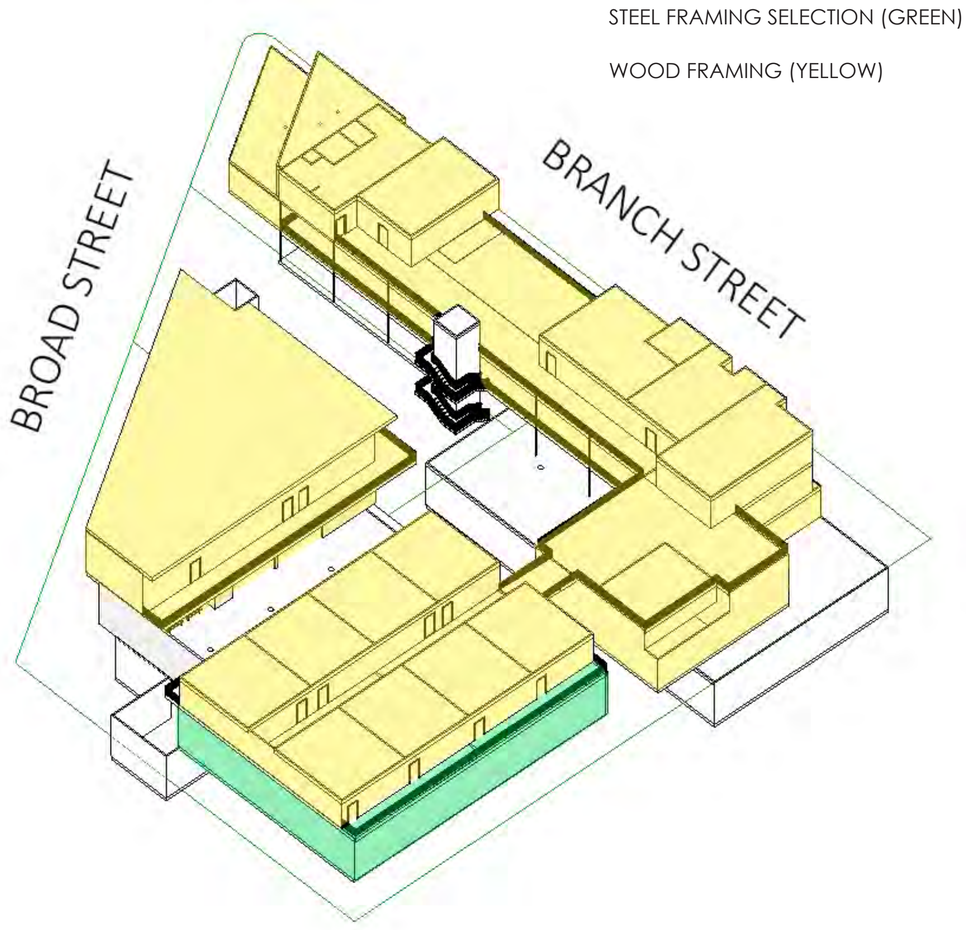
Example of Steel Framing



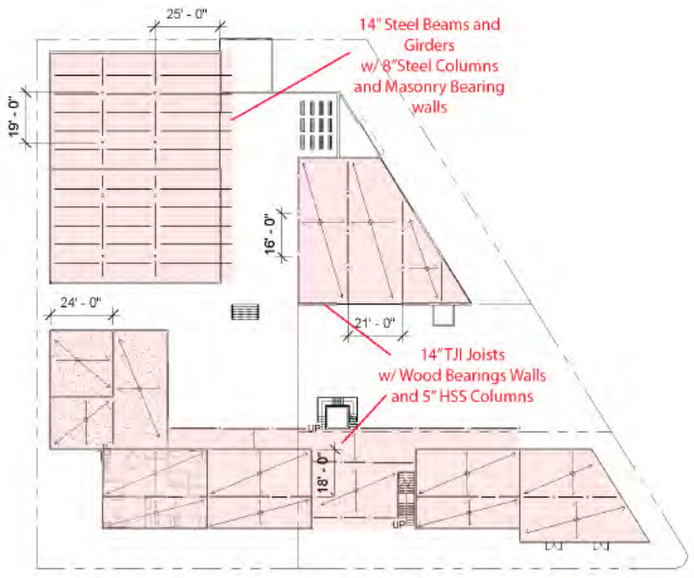
Example of TJI Framing

STEEL FRAMING SELECTION (GREEN)

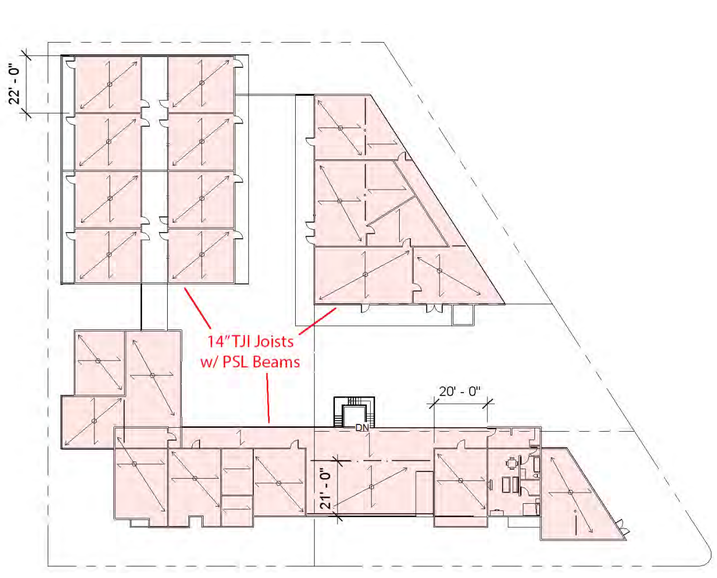
WOOD FRAMING (YELLOW)



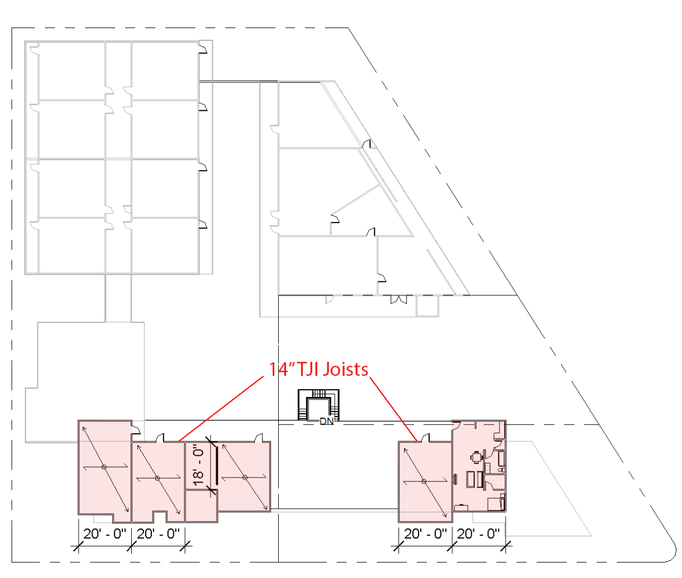
FIRST FLOOR FRAMING



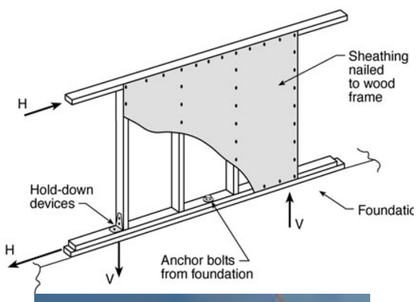
SECOND FLOOR FRAMING

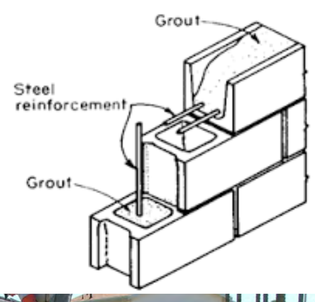


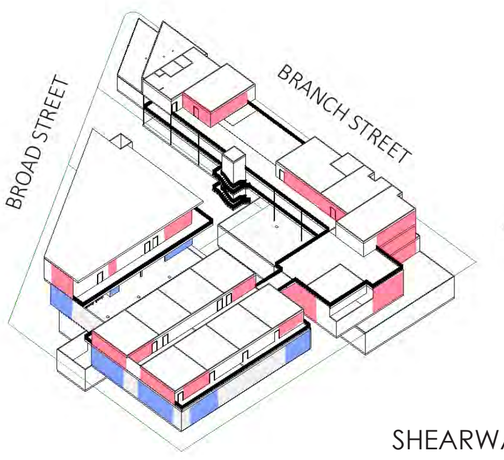
THIRD FLOOR FRAMING

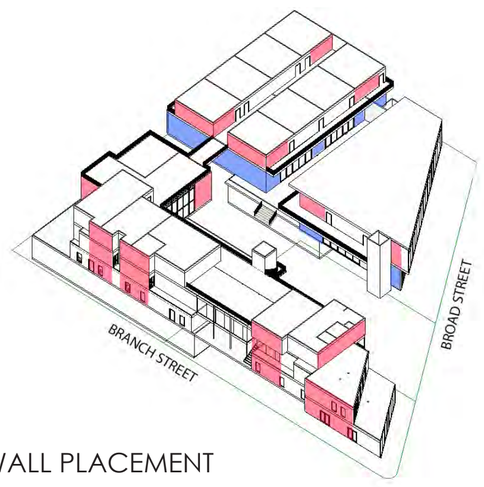


LATERAL

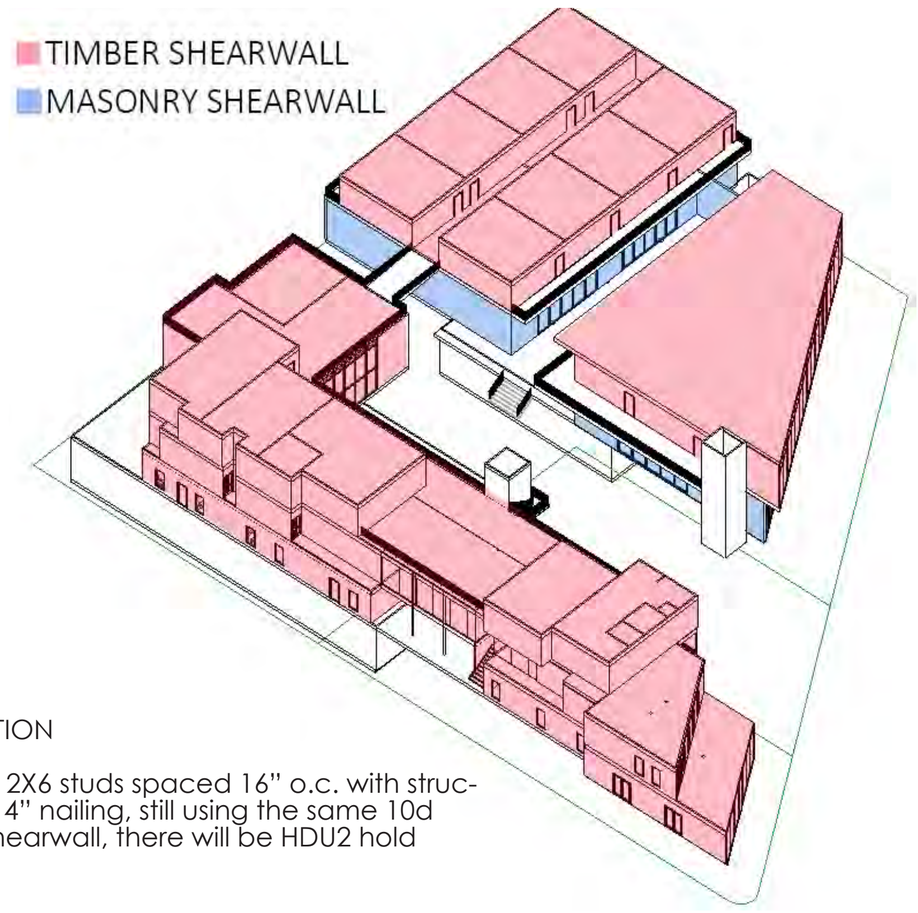








SHEARWALL PLACEMENT

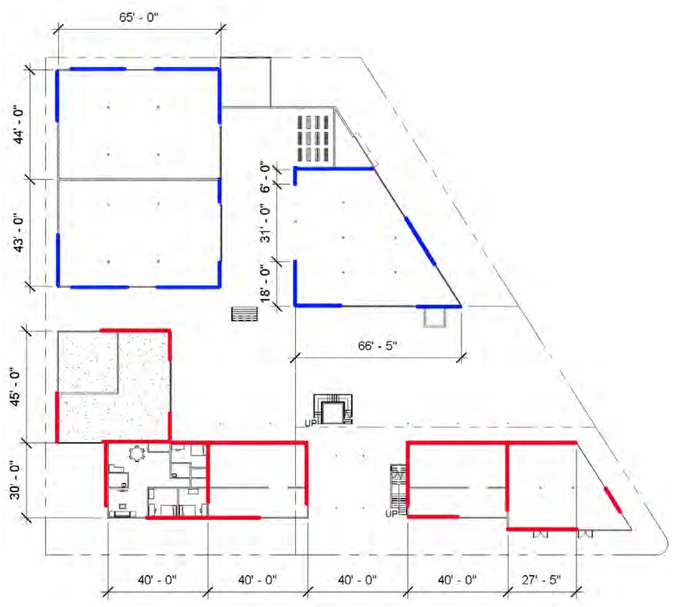


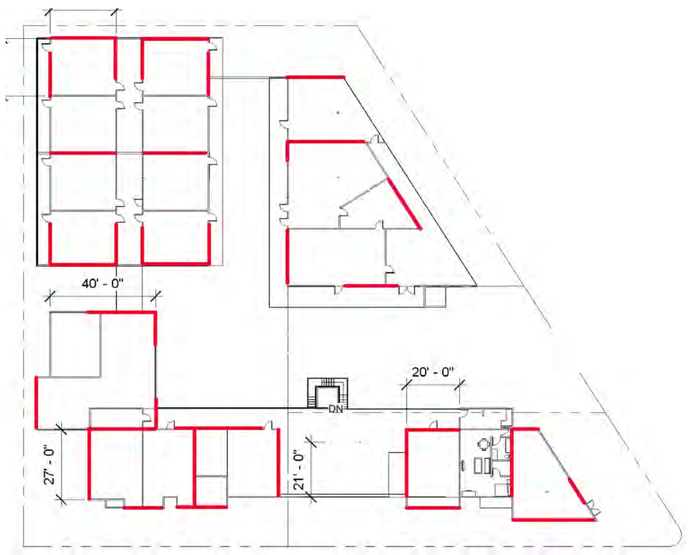
TIMBER SHEAR WALL DESCRIPTION

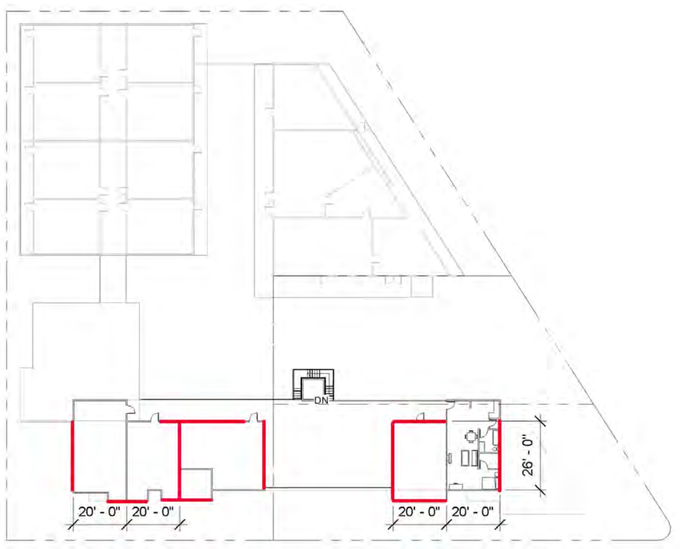
Wood shear walls will include 2X6 studs spaced 16" o.c. with structural plywood sheathing and 4" nailing, still using the same 10d nails. At each end of every shearwall, there will be HDU2 hold downs.

MASONRY SHEAR WALL DESCRIPTION

Masonry shear walls will work with wood/steel structures to create a more space-efficient shearwall. Because they have more strength per foot, we would be able to use less wall and have more openings than a wood shearwall. It is made up of 8" CMU which is reinforced based on minimum reqirements and calculations.

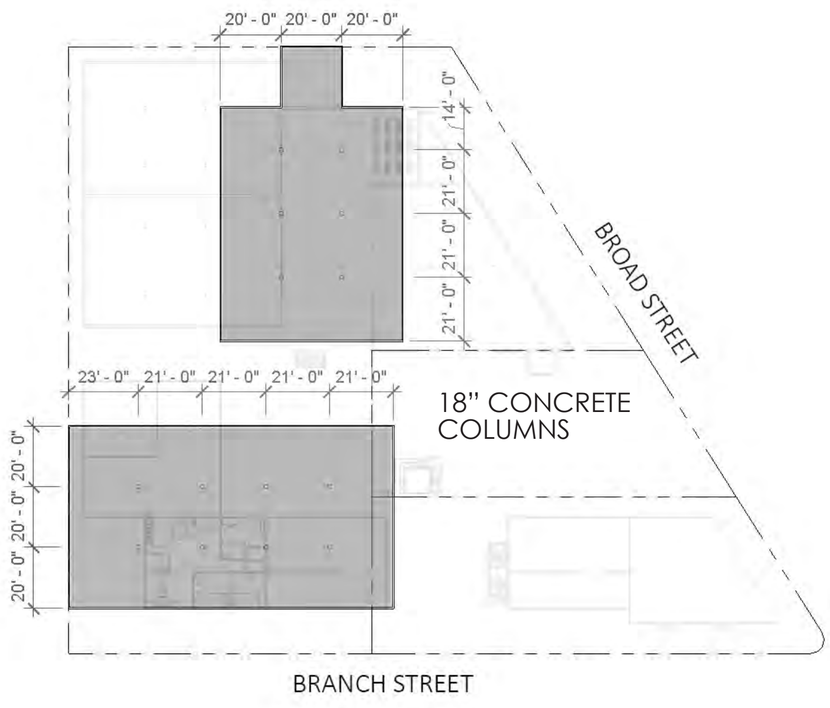




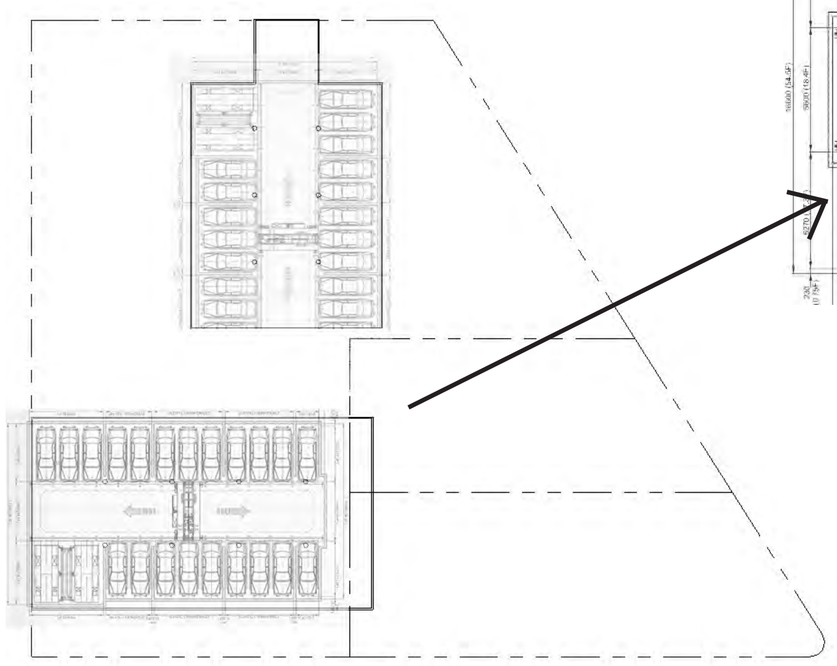


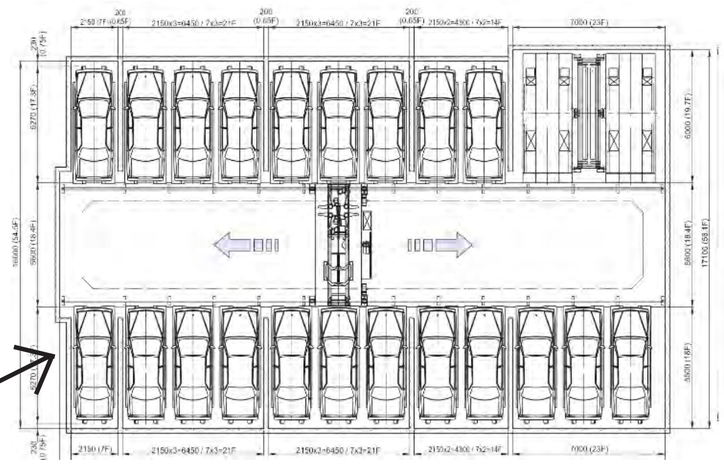
PARKING

Parking Plan showing column soacing, and above buildings



Parking Plan showing machinical system and columns





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TOTAL REQUIRED: 92

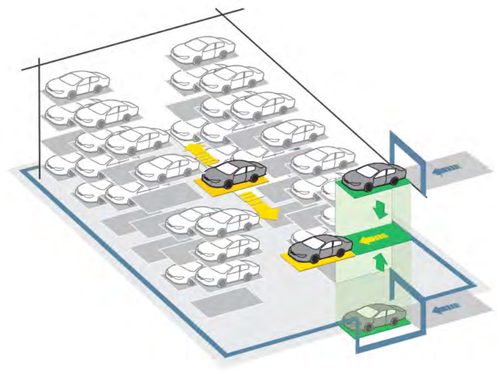
RESIDENTIAL PARKING SPOTS PROVIDED: 48
COMMERCIAL PARKING SPOTS PROVIDED: 44
TOTAL PROVIDED: 92

The parking system was separated into residential and commercial to try and facilitate traffic and keep the residential feeling more private.

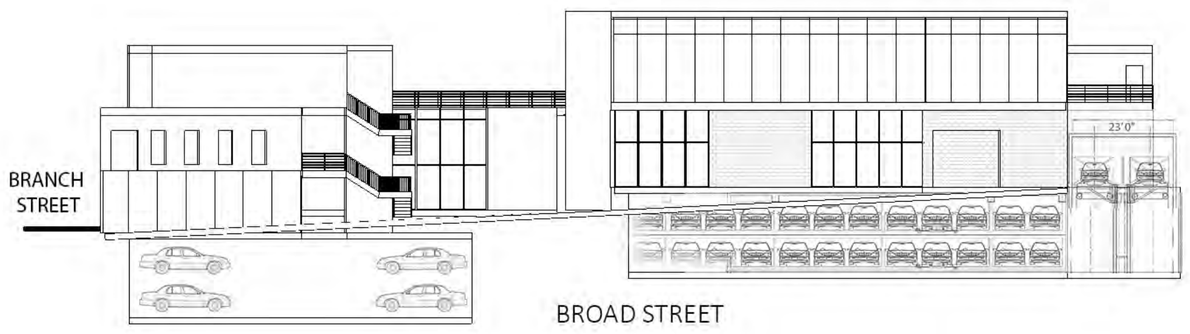
The driver pulls into a residential garage like structure and leaves the car. They then either take a ticket or enter a pin (for residential) and the car will be lowered and parked mechanically. Once below the ground, the car is led down the middle isle and parked on either side and on one of two levels. The entrances are two cars wide to allow two cars to enter/exit at the same time.

The columns in the comercial parking are spaced to allow two or three spots to be uninterupted.

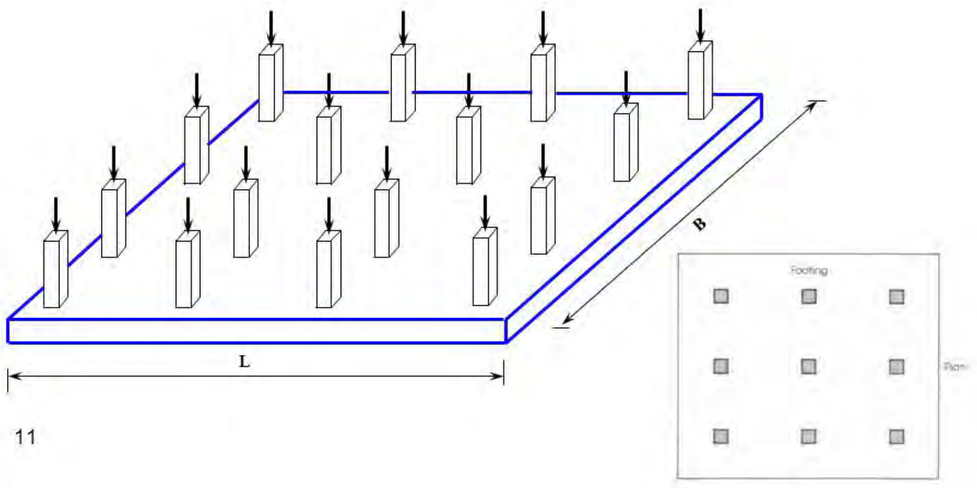
The parking is underground, making the walls bearing walls that will need to support the surrounding soil.

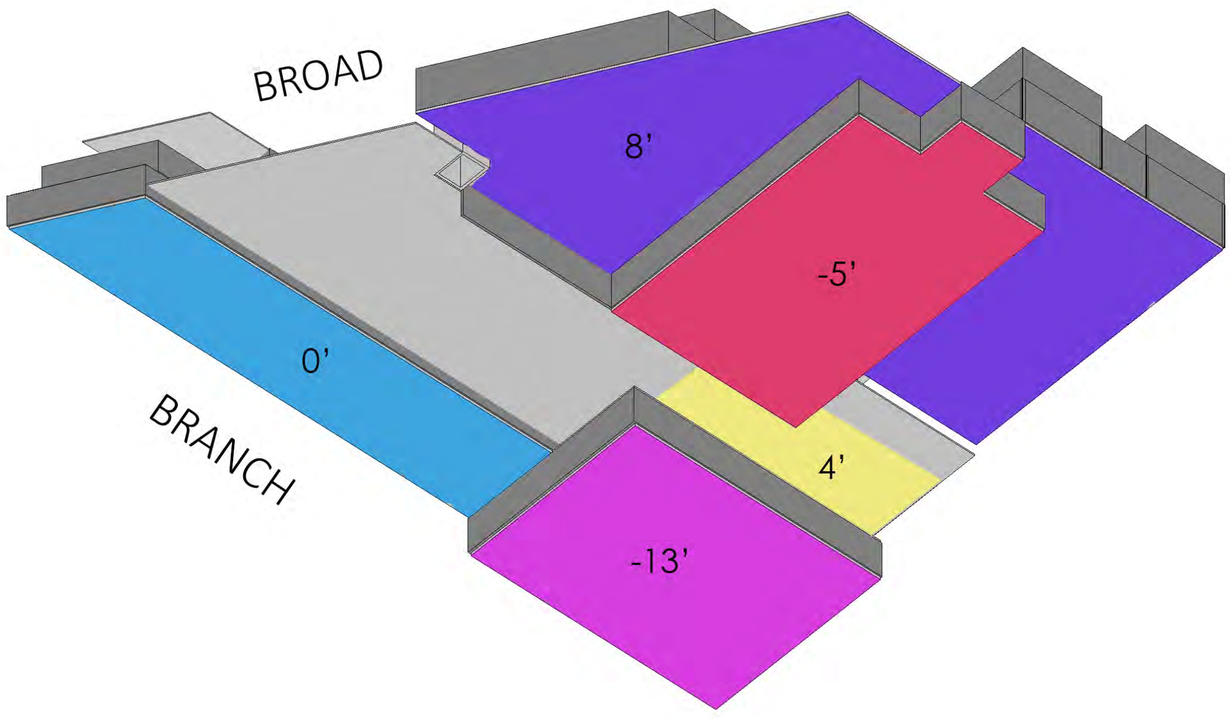


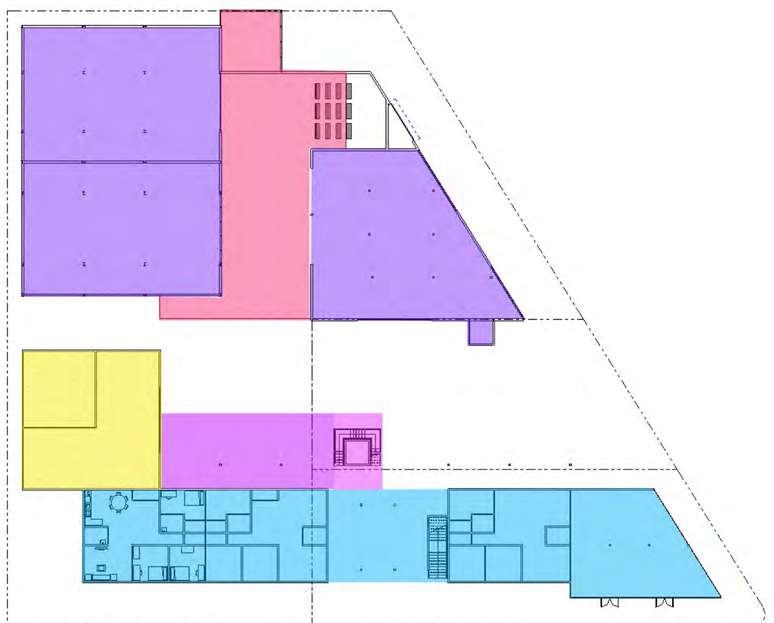
Parking Elevation



FOUNDATION







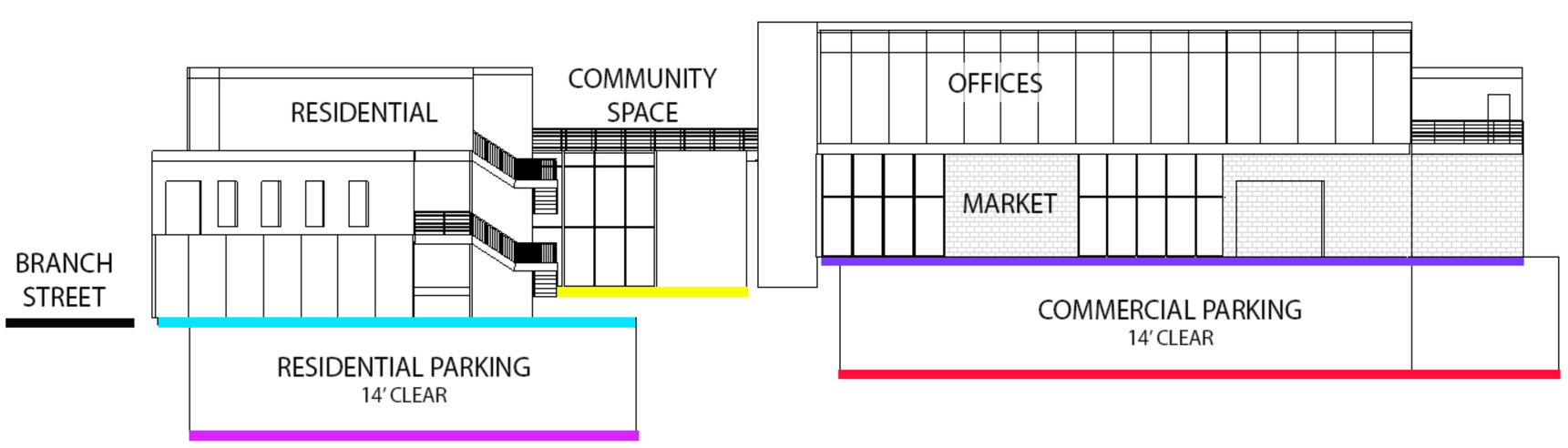
FOUNDATION DESCRIPTION

A mat foundation is a foundation system that covers the entire footprint of the project rather than just being under individual columns. The mat foundation will have 60 ksi steel reinforcement (similar to Figure 1) and will be at least one foot in depth.

Where there is underground parking, the foundation will serve as a floor slab for the parking garage, and the roof of the garage will continue with the on grade mat foundation.

Like the rest of the parking system, the foundation will use 4 ksi regular weight concrete.

Similar to a pad footing, mat foundations take the point loads from individual columns and spread them out in order to not put too much pressure on the soil, as in the digram above. Mat footings can be seen as pad footings that have been connected.



JENNY NGUYEN | MADISON BUSBY | 2115 BROAD STREET | SAN LUIS OBISPO
ARCH 453 | ARCE 415 | STACEY WHITE | BRENT NUTALL

FINAL REVIEW

BROAD STREET PLAZA

STRUCTURAL DOCUMENTS

ARCHITECTS AND ENGINEERS

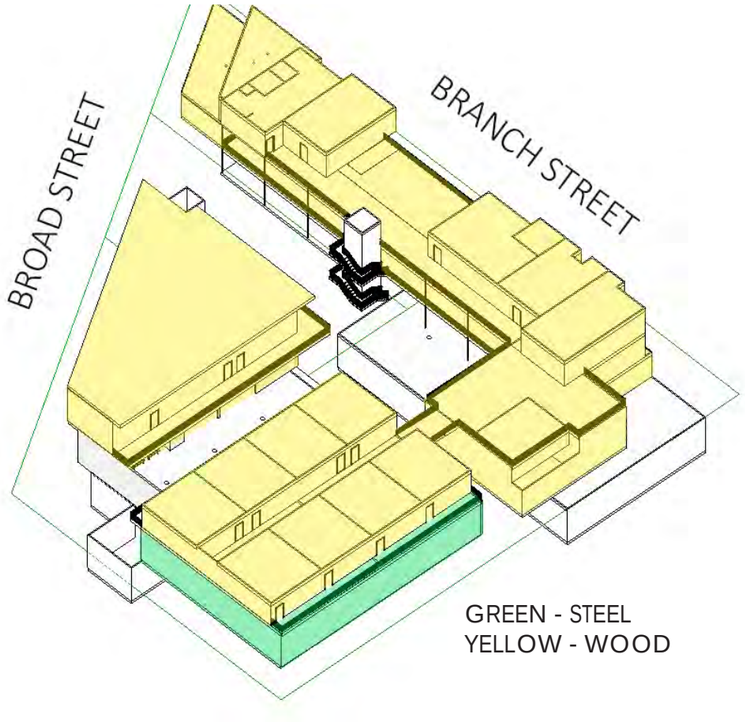
MADISON BUSBY + JENNIFER NGUYEN

(DESCRIPTION) GRAVITY SYSTEM

WOOD

Wood framing will be used for residential and office space. It will consist of a light frame wood system with TJI joists. Joists will be spaced between 16" and 24" and topped with a plywood sheathing diaphragm. Collectors and beams (if needed) will be PSL.

Bearing walls made up of 2X6 sawn lumber spaced at 16" with plywood sheathing, base plates, and double top plates. Connections will be made with 10d nails for sheathing and 16d otherwise, and Simpson connections for beam to wall.



GREEN - STEEL
YELLOW - WOOD

CONCRETE

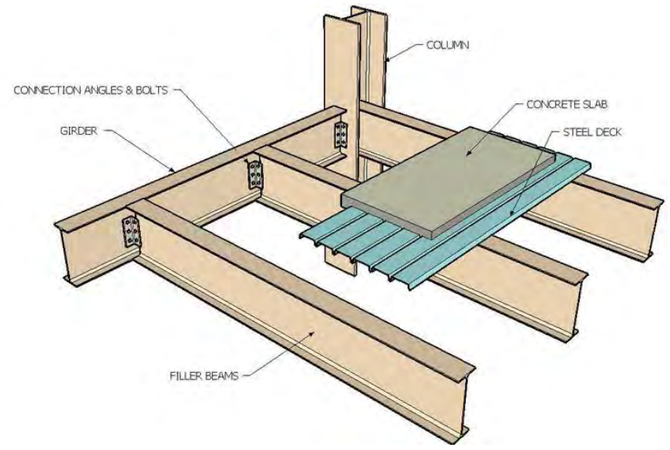
Reinforced concrete will be used for the underground parking and for the foundation of the building.

CMU

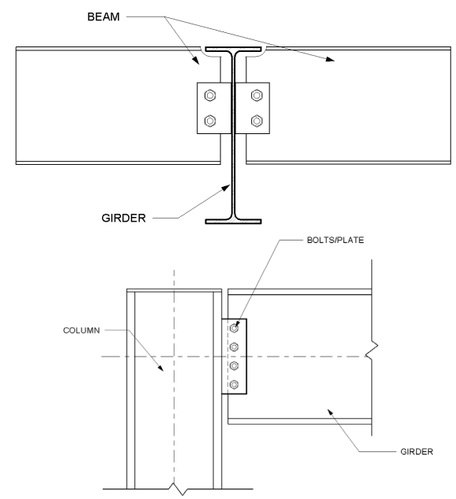
CMU bearing walls will be paired with both wood and steel gravity systems where they are already being used for the lateral system

STEEL

Steel framing will be used for commercial and office space. It will have wide flange beams, girders, and columns with bolts and plates for connections. Wide flanges will be A992 50 ksi steel.



There will be Verco Steel decking topped with a 3" light weight concrete slab which will provide a sound/fire barrier.



(SELECTION) GRAVITY SYSTEM

STEEL FRAMING

Steel framing will be used in the larger commerical buildings which require long spans and an architectural desire for a more industrial feel. Steel will also allow for larger and more open indoor to outdoor flow, which is an important component of our courtyard. The beam spans are ~30', and the girder spans are ~ 25' which would be possible with wood, but would require a much larger structural system , or possibly wood trusses.

Although steel is more expensive and requires special skills to install, it will only be used for a small portion of the project and is imopartant for achieving the desired architectural style.

Steel is also less flamable, which may benefit the the industrial kitchen to residential connection. In addition, a large portion of steel is reused after a building a torn down, making it sustainable.

WOOD FRAMING

Wood framing was chosen for residential, offices, and smaller commercial buildings because it is the most cost effective. For an example building (shown below) the cost of structrual elements for a steel building were 43% higher than those of a wood framed building.

Especially for residential, wood construction is also the most "warmest" material, unlike the industrial feel of steel and concrete. Some of the wood will be exposed to give this effect.

Timber is also the best material construcability wise. Therefore there will be plenty of workers capable of completing this portion of the project with little instruction while still producing quality work. Wood can also be reused, making it sustainable.

A small amount of heavy/engineered lumber will be used for larger spans/architectural appeal in the residential common area.

Component/Trade	Total Material Cost from Builder's Invoices	
	Steel House	Wood House
Framing Materials	$ 9,618.26	$ 7,125.51
Fasteners	$ 961.40	$ 247.02
Total	$ 10,580	$ 7,372

PARKING - CONCRETE

Concrete was the obvious choice for the parking gravity system because it will be underground, and the columns will be holding up and held up by large concrete slabs. So constructibilty and strength wise it is the only material that makes sense.

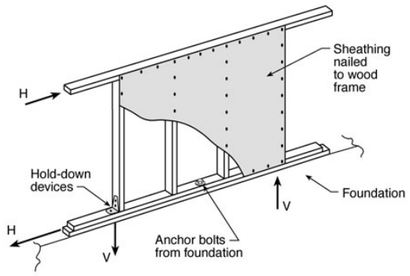
Concrete is not very reusable in general, but it can absorb heat during the day and release it at night, possibly being a sustainable heat source.

Concrete also is the most sturdy of the materials, which will help prevent vibrations from the machanical parking. This is important because it is the foundation of every other building.

(DESCRIPTION) LATERAL SYSTEM

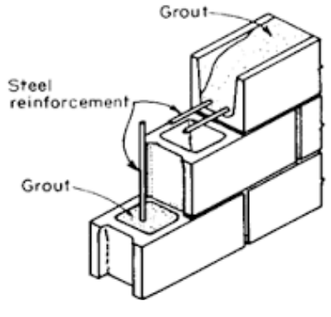
TIMBER SHEAR WALL (RED)

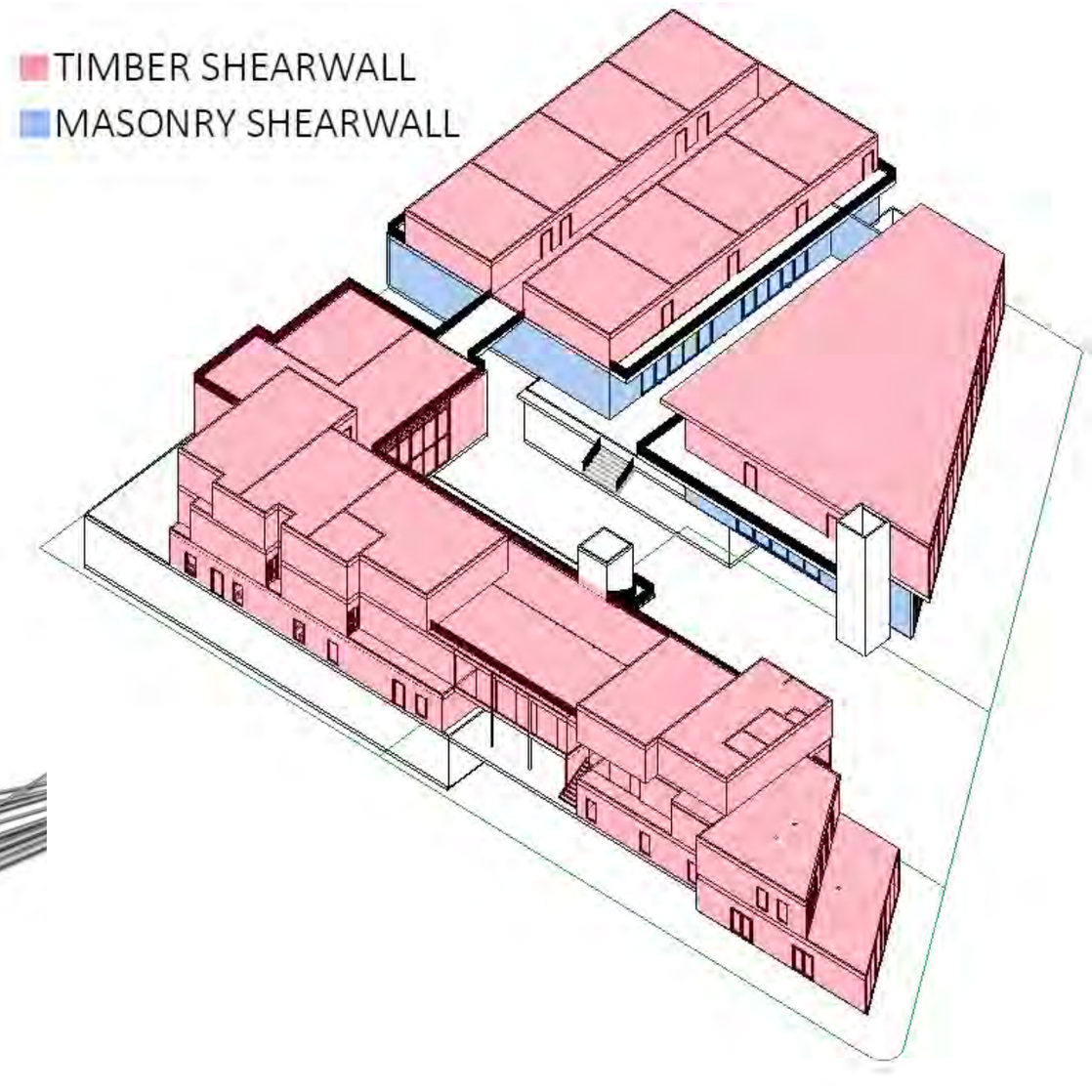
Wood shear walls will include 2X6 studs spaced 16" o.c. with structural plywood sheathing with nailing spaced according to the strength that is needed, still using the same 10d nails. At each end of every shearwall, there will be HDU2 hold downs.



MASONRY SHEAR WALL (BLUE)

Masonry shear walls will work with wood structures to create a more space-efficient shearwall. Because they have more strength per foot, we would be able to use less wall and have more openings. It is made up of 8" CMU which is reinforced based on minimum reqirements and calculations.





(SELECTION) LATERAL SYSTEM

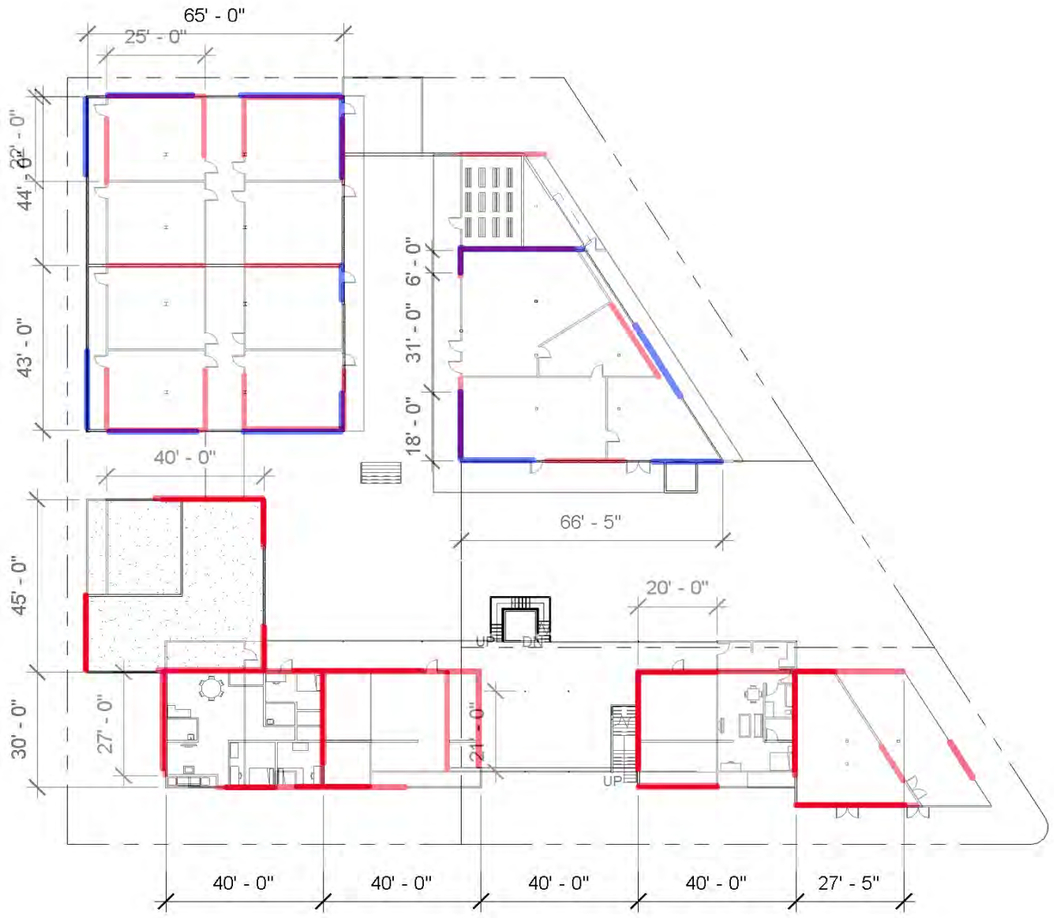
TIMBER SHEAR WALL

Timber shear walls will be used in all light framed timber buildings that are not in need of large openings. Bearing walls, which will be used as the gravity system for most of the wood framed buildings, can double as shear walls. The other option would be masonry shear walls, but when the loading is not too high and there are only smaller openings, wood shear walls are the best looking, easiest to build, and the most cost effective. I could have also chosen to use cold formed steel instead of wood, but price and popularity in the area made wood my top choice.

MASONRY SHEAR WALL

Masonry shear walls will be used when timber shear walls are too large, not strong enough, or a combination of the two. Masonry shear walls have a lot of strength compared to the weight of wood construction, allowing them to be smaller in width. They also can be asthetically pleasing, especially in the area. Masonry shearwalls were also chosen for the steel construction in place of braced frames or moment frames because of cost, asthetics, and continuity through the site.

The image below shows the three stories of lateral system layered to show how they line up vertically and horizontally.



(DESCRIPTION) FOUNDATION SYSTEM

Foundation System

A mat foundation is a foundation system that covers the entire footprint of the project rather than just being under individual columns. The mat foundation will have 60 ksi steel reinforcement and will be at least one foot in depth.

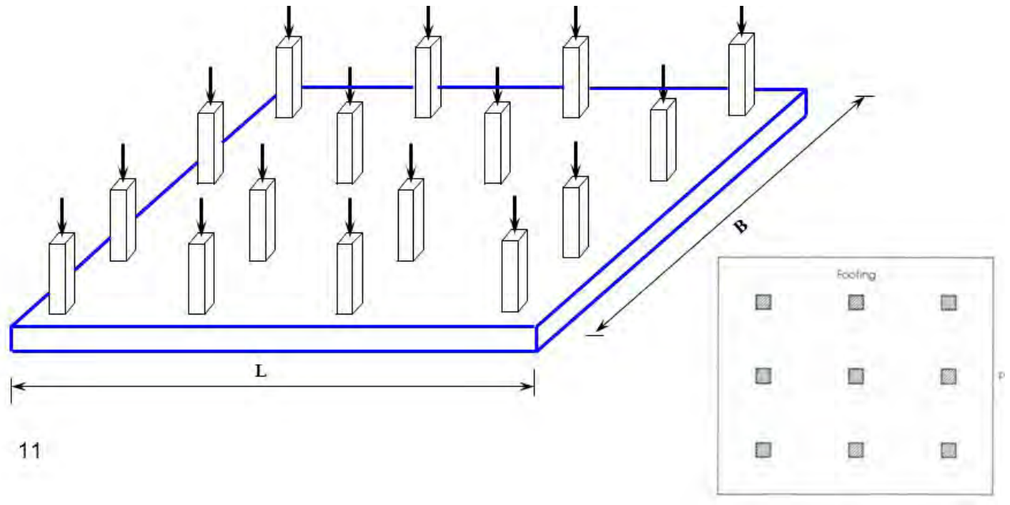
Where there is underground parking, the foundation will serve as a floor slab for the parking garage, and the roof of the garage will continue with the on grade mat foundation.

Like the rest of the parking system, the foundation will use 4 ksi regular weight concrete.

Similar to a pad footing, mat foundations take the point loads from individual columns and spread them out in order to not put too much pressure on the soil, as in the digram below. Mat footings can be seen as pad footings that have been connected.

If the depth of the top slab is not enough to resist punching shear, extra depth and or reinforcement will be added around the column to slab connection.

Similar to a pad footing, mat foundations take the point loads from individual columns and spread them out in order to not put too much pressure on the soil, as in the digram below. Mat footings can be seen as pad footings that have been connected.



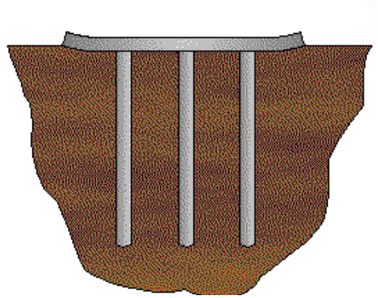
(SELECTION) FOUNDATION SYSTEM

The expanding and contracting nature of the clayey soil on the site removes pad footings as an option for the project. Besides that, a quick calculation concluded that the pad footings would be so large based on the sites poor soil bearing strength, the pad footings would nearly be a mat footing.

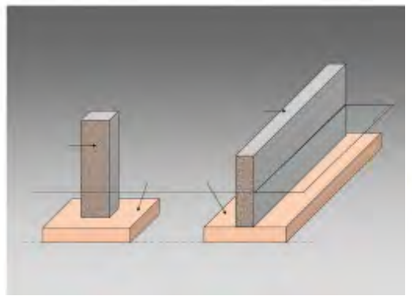
Piles could work, but they would have to be pre drilled because driven piles cause lound noises and heavy vibrations that may disrupt surrounding homes and businesses.

Because the site may have an underground water table, drilling may also be an issue because the water may fill the hole, requiring more euipment and labor.

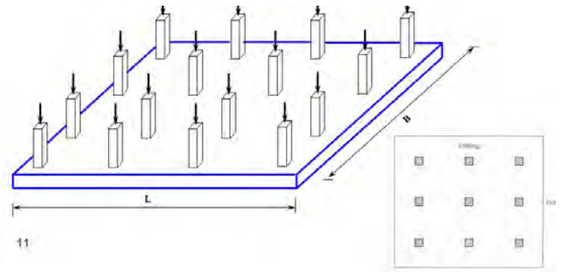
This leaves mat foundations , which will require excavation for the ungerdround parking as well as the leveling of the site. The mat foundtion will reisist water pressure in the soil while also being relitively simple/consistant to install.



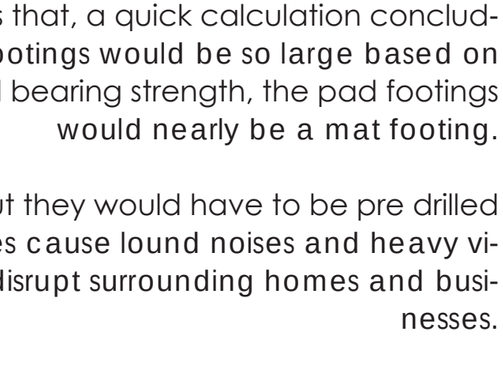
PILES

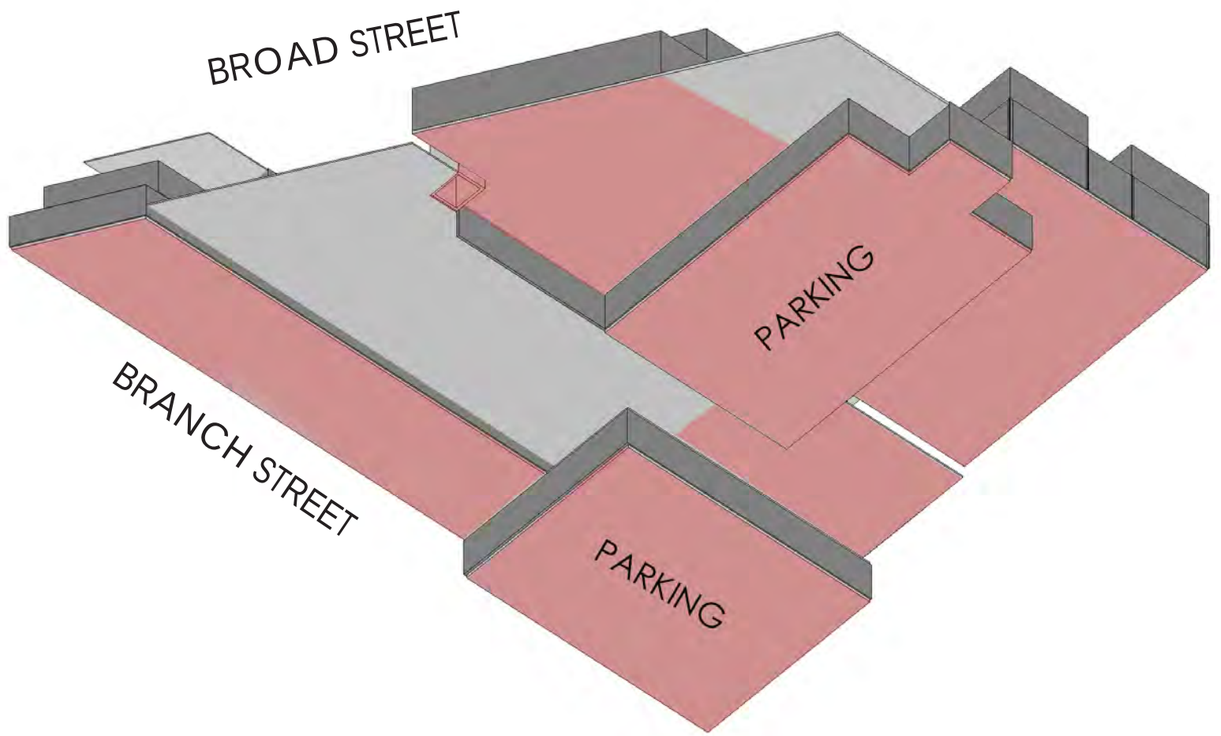


PAD FOOTING



MAT FOUNDATION





(DESCRIPTION) PARKING SYSTEM

The parking garage will be a reinforced concrete structure with a two way system. The concrete willl be regular weight with a strength of 4 ksi with 60 ksi rebar for shear and tension reinforcement. A basic representation of the structural layout is shown in Figure 1.


Figure 1

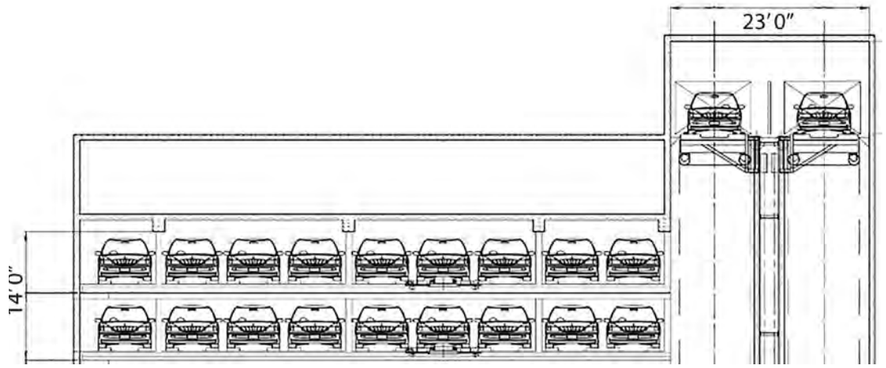
The parking is underground, making the walls bearing walls that will need to support the surrounding soil.

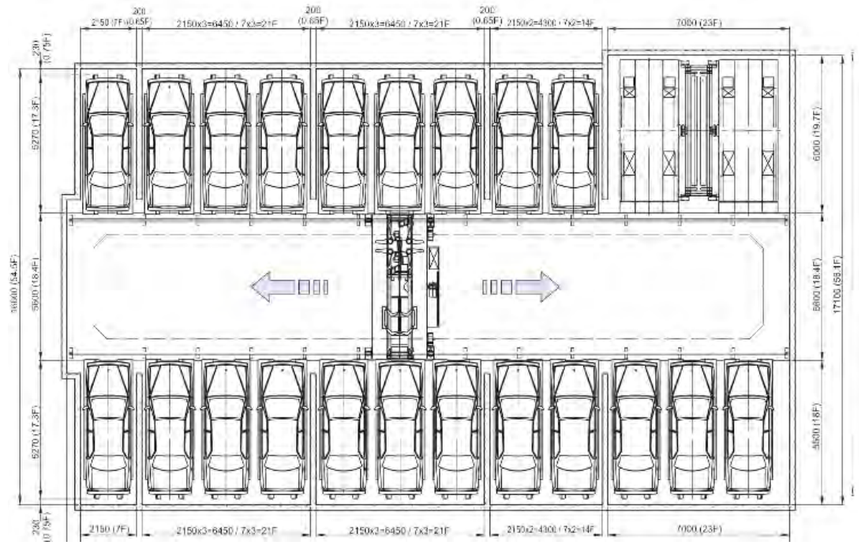
Users will park their car into a garage-like feature above grade, and once they have entered their information, the car will be parked completely mechanically. There will be two elevators at each entance so people can enter/exit with ease. A small structure will hide the mechanical system.


Figure 2

One will park their car by pulling into a structure similar to Figure 2, and will then leave thier car and recieve a parking slip. Their car will then be lowered into the system shown in Figure 3. Once they want to retrieve thier car, they re enter the slip and the car returns to the structure in Figure 2.


Figure 3





RED - MAT FOUNDATION

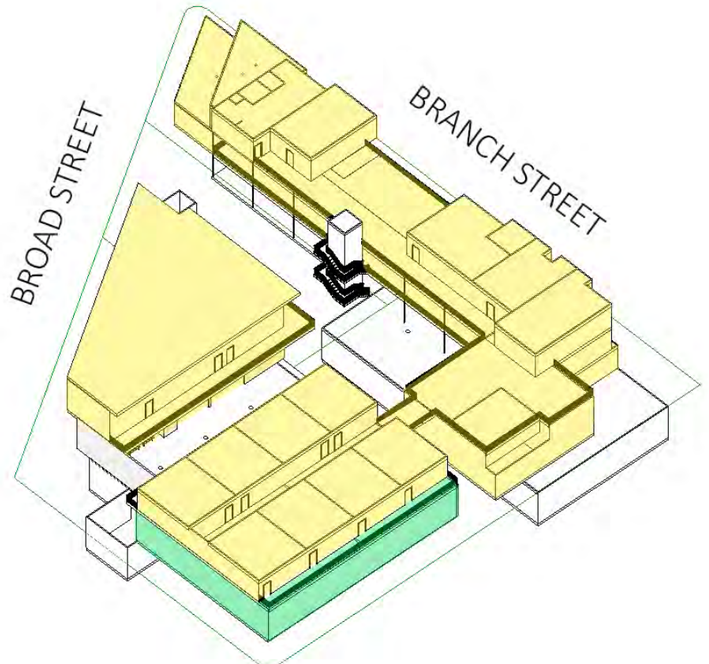
(CONFIGURATION) GRAVITY SYSTEM

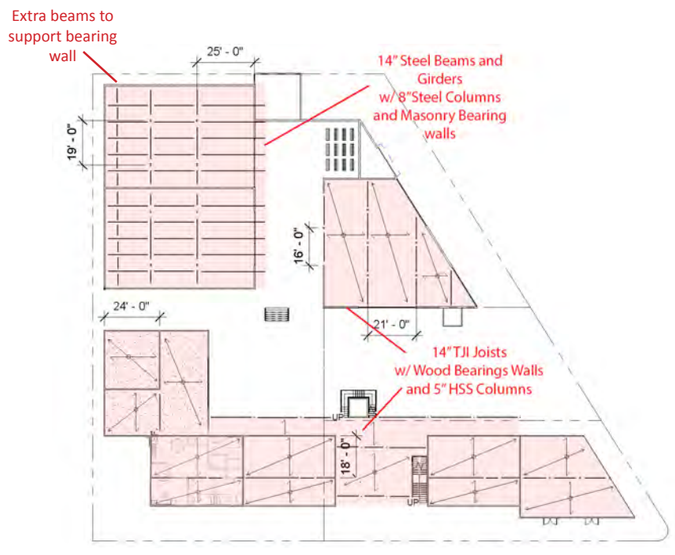
The gravity systems were configured based on span, potential use of space, and surrounding structure.

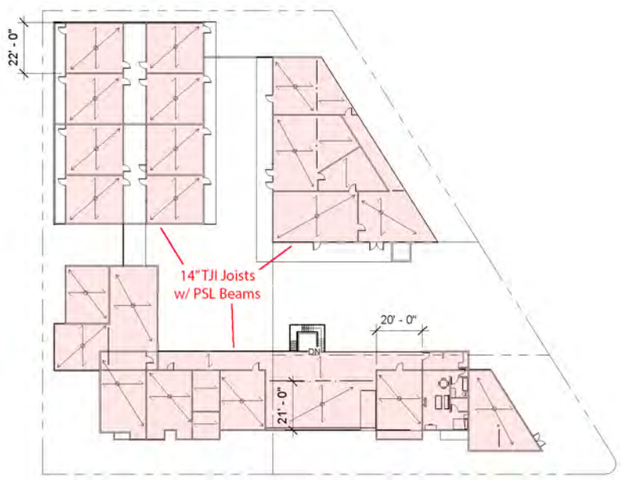
For the residential, because the interior areas are so small, bearing walls will be on the exterior of each unit. The TJI joists will span in which ever direction is the shortest. For the offices, there will need to be a couple columns on the lower floor, which then requires PSL beams in the shorter direction, and TJI joist spanning the longer direction. This is to reduce the ceiling height as much as possible.

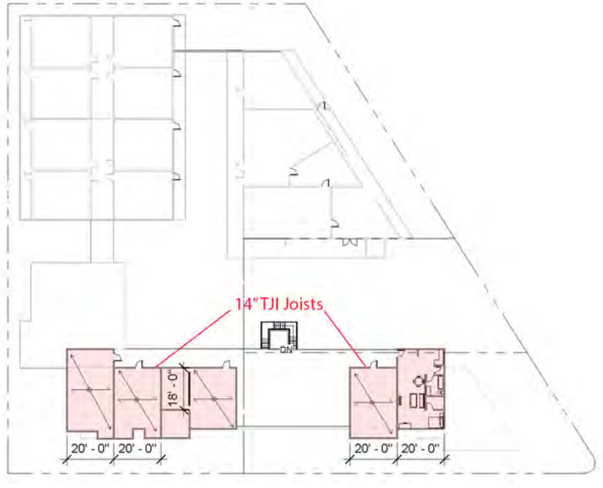
For the commercial buildings there are columns spaced ~15' so that the braced frames are mort efficient. The interior columns line up with the bearing walls above to reduce loading on beams and girders. Again, to reduce ceiling height, the beams will span in the longer direction while the girders span the shorter span.

The CMU/concrete is being used only for the elevator, parking structure, and bearing walls.



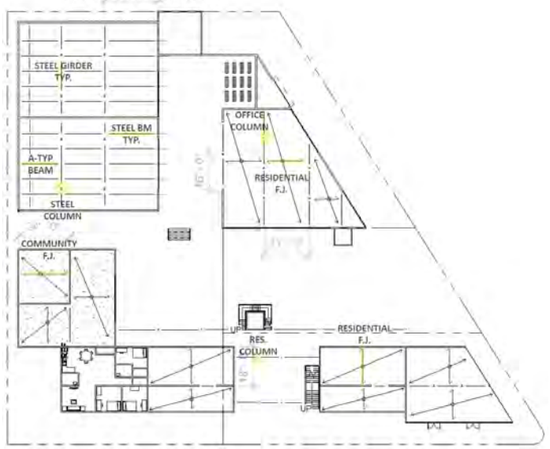




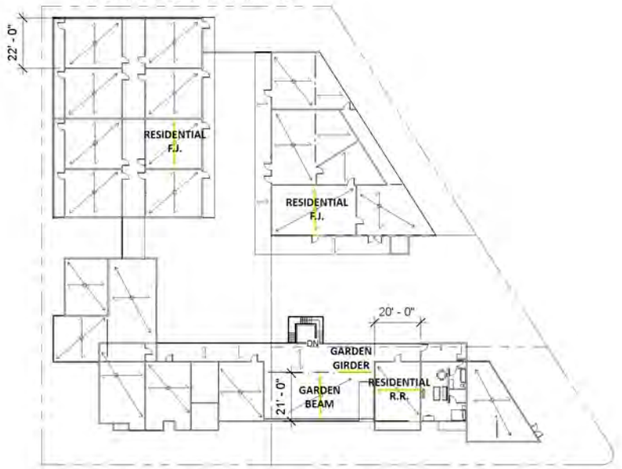


(SIZING) GRAVITY SYSTEM

FIRST FLOOR FRAMING



SECOND FLOOR FRAMING



RESIDENTIAL FLOOR JOIST

DL: 33 PSF
LL: 40 PSF

TRIB WIDTH: 16"

$W = (33\ PSF + 40\ PSF)\ \frac{16"}{12"} = 97\ PLF$

MAX SPAN = 20'

$M_{max} = \frac{Wl^2}{8} = 4850\ \#'$

$V_{max} = \frac{Wl}{2} = 970\ \#$

TJI 230 14"

M = 8490 #'
V = 2190 #

RESIDENTIAL GARDEN FLOOR JOIST

DL: 33 PSF + 40 PSF
LL: 40 PSF

TRIB WIDTH: 16"

$W = (73 + 40\ PSF)\ \frac{16"}{12"} = 150\ PLF$

MAX SPAN: 15'

$M_{max} = \frac{Wl^2}{8} = 4218\ \#'$

$V_{max} = \frac{Wl}{2} = 1125\ \#$

TJI 210 14"

M = 4490 #'
V = 1945 #

RESIDENTIAL ROOF RAFTER

DL: 20 PSF
LL: 20 PSF

TRIB WIDTH: 18"

$W = (20\ PSF + 20\ PSF)\ \frac{24"}{12"} = 80\ PLF$

MAX SPAN: 20'

$M_{max} = \frac{Wl^2}{8} = 3000\ \#'$

$V_{max} = \frac{Wl}{2} = 800\ \#$ WILL NOT CONTROL ✗

$C_d = 1.25$
$C_F = 1.0$
$C_r = 1.15$

$F'_b = 1000 \cdot C_d \cdot C_F \cdot C_r = 1437.5\ PSI$

$f_b = \frac{M}{S} = \frac{M_{max} \cdot 12}{S} \leq 1437.5$

$S \geq 25\ in^3$

2X12 DF #1 @ 18"

OR

TJI 230 14" @ 24"

COMMUNITY CENTER FLOOR JOIST

DL: 33 PSF
LL: 40 PSF

SPACING: 12" O.C.

$W = (33+40)1' = 73\ PLF$

$V = \frac{Wl}{2} = 876\ \#$
$M = \frac{Wl^2}{8} = 5256\ \#'$

TJI 360 14" M = 7335 #'

RESIDENTIAL | GARDEN GIRDER

DL: 33 PSF + 40 PSF
LL: 40 PSF

TRIB WIDTH: 15'

$W = (73\ PSF + 40\ PSF)\ 15' = 1.7\ KLF$

MAX SPAN: 15'

$V = \frac{Wl}{2} = 12.75\ K \leq 18945\ \#$
$M = \frac{Wl^2}{8} = 47.8\ K' \leq 54325\ \#'$

USE 2.0E 7"X14" PSL

RESIDENTIAL | OFFICE COLUMN

DL: 33 PSF
LL: 40 PSF

TRIB AREA: 15' X 20' = 300 FT²

$P = (1.2 \cdot 33 + 1.6 \cdot 40)\ 300 = 31.1\ K$

USE HSS COLUMN

l_b = 15' max

HSS 4X4X $\frac{1}{4}$

Design Properties (100% Load Duration)

Depth	TJI®	Basic Properties: Joist Weight (lbs/ft)	Maximum Resistive Moment[1] (ft-lbs)	Joist Only EI x 10⁶ (in.²-lbs)	Maximum Vertical Shear (lbs)	Reaction Properties: 1¾" End Reaction (lbs)	3½" End Reaction (lbs)	3½" Intermediate Reaction (lbs): No Web Stiffeners	3½" Intermediate Reaction (lbs): With Web Stiffeners[2]	5¼" Intermediate Reaction (lbs): No Web Stiffeners	5¼" Intermediate Reaction (lbs): With Web Stiffeners[2]
9½"	110	2.3	2,500	157	1,220	910	1,220	1,935	N.A.	2,350	N.A.
	210	2.6	3,000	186	1,330	1,005	1,330	2,145	N.A.	2,565	N.A.
	230	2.7	3,330	206	1,330	1,060	1,330	2,410	N.A.	2,790	N.A.
11⅞"	110	2.5	3,160	267	1,560	910	1,375	1,935	2,295	2,350	2,705
	210	2.8	3,795	315	1,655	1,005	1,460	2,145	2,505	2,565	2,925
	230	3.0	4,215	347	1,655	1,060	1,485	2,410	2,765	2,790	3,150
	360	3.0	6,180	419	1,705	1,080	1,505	2,460	2,815	3,000	3,360
	560	4.0	9,500	636	2,050	1,265	1,725	3,000	3,475	3,455	3,930
14"	110	2.8	3,740	392	1,860	910	1,375	1,935	2,295	2,350	2,705
	210	3.1	4,490	462	1,945	1,005	1,460	2,145	2,505	2,565	2,925
	230	3.3	4,990	509	1,945	1,060	1,485	2,410	2,765	2,790	3,150
	360	3.3	7,335	612	1,955	1,080	1,505	2,460	2,815	3,000	3,360
	560	4.2	11,275	926	2,390	1,265	1,725	3,000	3,475	3,455	3,930

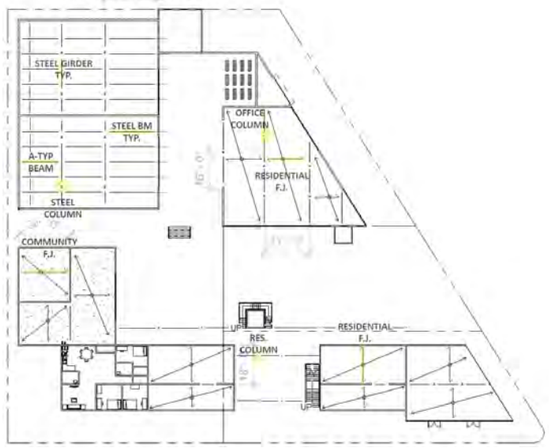
Allowable Design Properties[1] (100% Load Duration)

Grade	Width	Design Property	Depth: 4⅛"	5¼"	5¼" Plank Orientation	7¼"	8¾"	9¼"	9½"	11¼"	11⅞"	14"	16"	18"	20"
TimberStrand® LSL															
1.3E	3½"	Moment (ft-lbs)	1,735	2,685	1,780	4,550	6,335	7,240		10,520					
		Shear (lbs)	4,340	5,455	1,925	7,190	8,555	9,175		11,155					
		Moment of Inertia (in.⁴)	24	49	20	111	187	231		415					
		Weight (plf)	4.5	5.6	5.6	7.4	8.8	9.4		11.5					
1.55E	1¼"	Moment (ft-lbs)						4,950	5,210	7,195	7,975	10,920	14,090		
		Shear (lbs)						3,345	3,435	4,070	4,295	5,065	5,785		
		Moment of Inertia (in.⁴)						115	125	208	244	400	597		
		Weight (plf)						5.1	5.2	6.2	6.5	7.7	8.8		
	3½"	Moment (ft-lbs)						9,905	10,420	14,390	15,955	21,840	28,180		
		Shear (lbs)						6,690	6,870	8,140	8,590	10,125	11,575		
		Moment of Inertia (in.⁴)						231	250	415	488	800	1,195		
		Weight (plf)						10.1	10.4	12.3	13	15.3	17.5		
Microllam® LVL															
2.0E	1¼"	Moment (ft-lbs)		2,125		3,555		5,600	5,885	8,070	8,925	12,130	15,555	19,375	23,580
		Shear (lbs)		1,830		2,410		3,075	3,160	3,740	3,950	4,655	5,320	5,985	6,650
		Moment of Inertia (in.⁴)		24		56		115	125	208	244	400	597	851	1,167
		Weight (plf)		2.8		3.7		4.7	4.8	5.7	6.1	7.1	8.2	9.2	10.2
Parallam® PSL															
2.0E	3½"	Moment (ft-lbs)						12,415	13,055	17,970	19,900	27,160	34,955	43,665	
		Shear (lbs)						6,260	6,430	7,615	8,035	9,475	10,825	12,180	
		Moment of Inertia (in.⁴)						231	250	415	488	800	1,195	1,701	
		Weight (plf)						10.1	10.4	12.3	13.0	15.3	17.5	19.7	
	5¼"	Moment (ft-lbs)						18,625	19,585	26,955	29,855	40,740	52,430	65,495	
		Shear (lbs)						9,390	9,645	11,420	12,055	14,210	16,240	18,270	
		Moment of Inertia (in.⁴)						346	375	623	733	1,201	1,792	2,552	
		Weight (plf)						15.2	15.6	18.5	19.5	23.0	26.3	29.5	
	7"	Moment (ft-lbs)						24,830	26,115	35,940	39,805	54,325	69,905	87,325	
		Shear (lbs)						12,520	12,855	15,225	16,070	18,945	21,655	24,360	
		Moment of Inertia (in.⁴)						402	500	831	977	1,601	2,389	3,402	
		Weight (plf)						20.2	20.8	24.6	26.0	30.6	35.0	39.4	

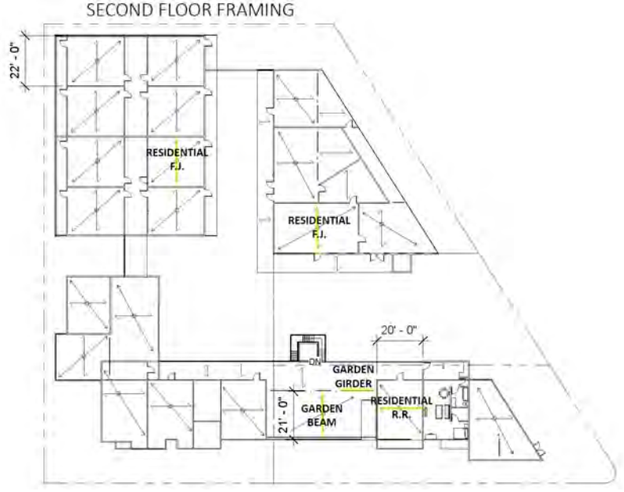
(1) For product in beam orientation, unless otherwise noted.

(SIZING) GRAVITY SYSTEM

FIRST FLOOR FRAMING



SECOND FLOOR FRAMING



COMMERCIAL STEEL BEAM

DL: 76 PSF + 20 PSF (TIMBER)
LL: 40 PSF

TRIB WIDTH: 6'

$w = (96\ PSF^{1.2} + 40\ PSF^{1.6})\ 6' = 1075\ PLF$

MAX SPAN: 30'

$M_{max} = \frac{wl^2}{8} = 120.9\ K'$

$\phi M_n = 205\ K'$

W 14X 34

FROM TABLE 3-10

A-TYP. STEEL BM (BEARING WALL ABOVE)

$w = 1075\ PLF + (20\ PSF \cdot 11' + 400\ PLF) = 1.7\ KLF$

max span = 30'

$M_{max} = \frac{wl^2}{8} = 191.3\ K'$

$\phi M_n = 204\ K'$

W14X34 ← same as typ. beam

COMMERCIAL STEEL GIRDER

DL: 78PSF + 20 PSF (TIMBER)
LL: 40 PSF LL reduced = 30 PSF

TRIB WIDTH: 35'

$w = (98\ PSF^{1.2} + 30\ PSF^{1.6})\ 35' = 5.8\ KLF$

MAX SPAN: 20'

$M_{max} = \frac{wl^2}{8} = 290\ K'$

W14X61 $\phi M_n = 298\ K' > 290 K'$

FROM TABLE 3-10

COMMERCIAL STEEL COLUMN

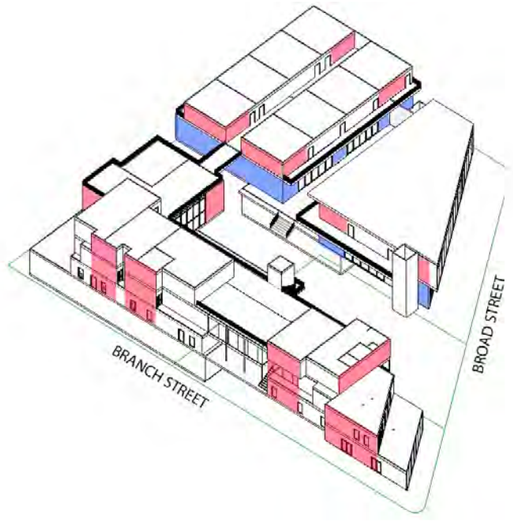
DL = 80 PSF + 20 PSF (WOOD)
LL = 40 PSF LLR = 30PSF

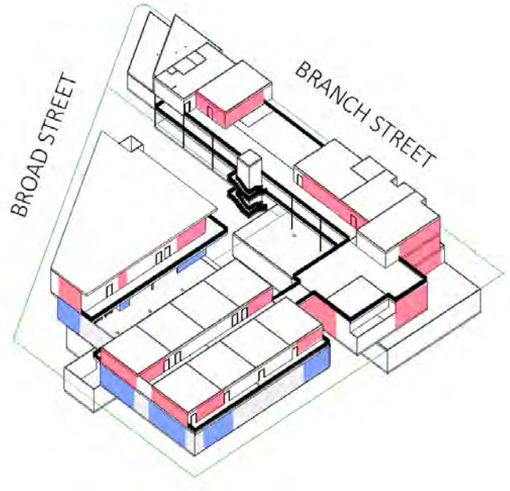
TRIB AREA = 35' · 25' = 875 ft²

$P = 875\ ft^2\ (100\ PSF^{1.2} + 30 PSF^{1.6}) = 147.0\ K$

W8X31

(CONFIGURATION) LATERAL SYSTEM





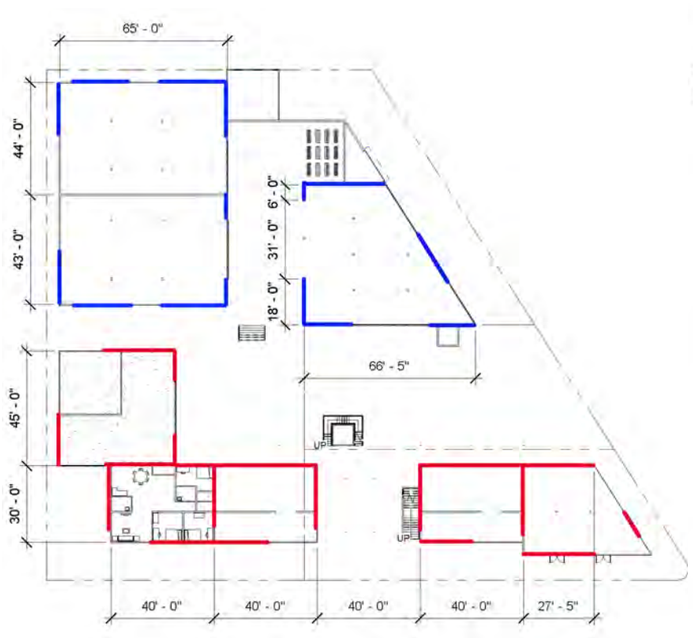
The lateral system was configured based on center of mass/rigidity, openings, asthetics, and span of wall.

The wood shearwalls were placed where the wall would be continuous horizontally and vertically to try and avoid exess drag and load transfer beams. For the residential above the commercial area, the shearwalls line up with systems below when possible. Exterior shearwalls will need to be adjusted based on final window/door placement.

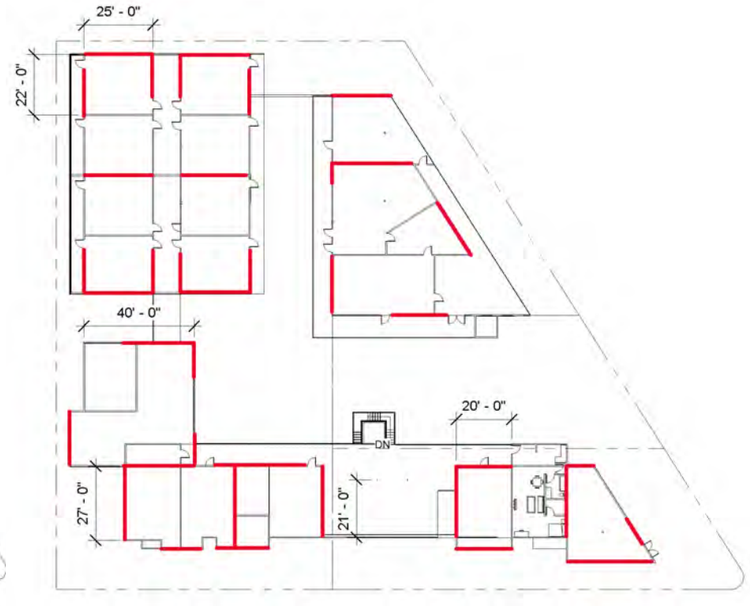
CMU shearwalls are placed along the lower portion of the commercial/office building in order to allow for larger openings. We are planning on having large windows and a garage door, and the CMU walls being more compact will provide the space for that.

MASONRY SHEARWALL
TIMBER SHEARWALL

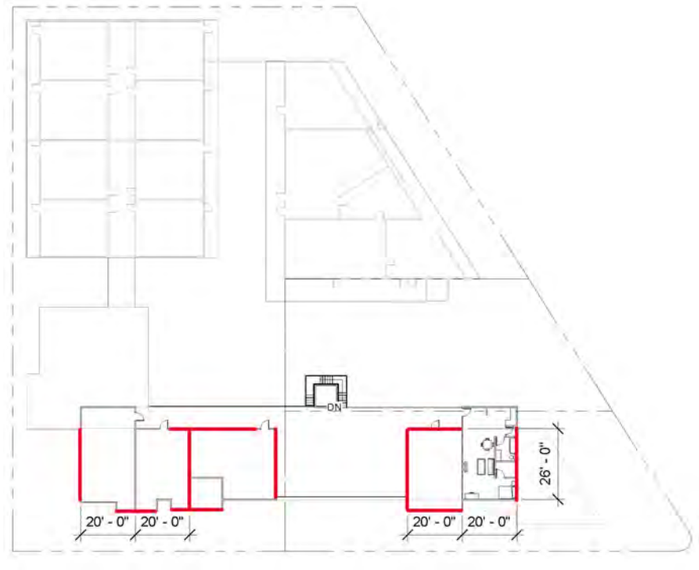
FIRST FLOOR



SECOND FLOOR



THIRD FLOOR



(SIZING) LATERAL SYSTEM

COMMERCIAL SHEARWALLS $V_b = 85.5K$

$\phi V_n = \phi(2.25 A_n \sqrt{f'_m} + 0.25 P_u) + \phi(0.5 A_v f_y d/b)$

$\phi 85.5 = 0.8(2.25(\frac{7\frac{5}{8}"}{12} \cdot l)\sqrt{1500} + 0.25(94K)$ ← SELF W.

$49.2K = 0.044l$

$l = 93'$ masonry SW E.W.

OFFICE SHEARWALLS

WOOD: 2" — 32.5' ~ 33' each way $V_b = 28.3K$

3" — 41.9' ~ 42'

4" — 55.5' ~ 56'

6" — 83.2' ~ 84'

MASONRY: building height = 27' $V_b = 30.8K$

$0.25 < h/d < 4.0$

$27/4. =$ 6.75' min length

$\phi V_n = \phi(2.25 A_n \sqrt{f'_m} + 0.25 P_u) + \phi(0.5 A_v f_y d/b)$ SELF WEIGHT

$\phi 30.8 = (0.8)[2.25(\frac{7\frac{5}{8}"}{12"} \cdot l)\sqrt{1500} / 1000] + [0.8 \cdot 0.25 \cdot 30K]$

$23.44K = 0.044l$

$l = 44'$ masonry SW E.W.

RESIDENIAL ABOVE COMMERCIAL SW

wood structural panels 15/32"

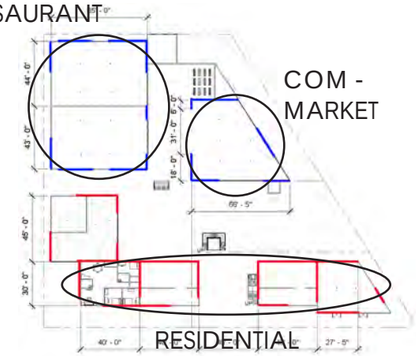
$V_b = 38.7K$

4" w/ 10d nails — 1020 PLF/2 = 510 PLF

$38.7K / 0.51 KLF = 75.9' \sim 76'$ EACH WAY

2 seperate buildings → 38' each way

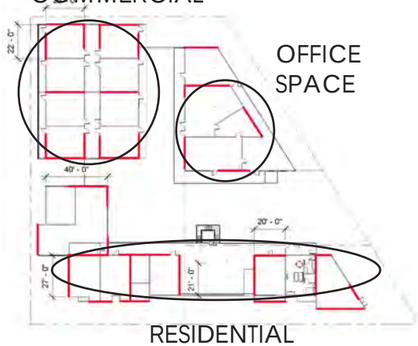
COM - RESAURANT



COM - MARKET

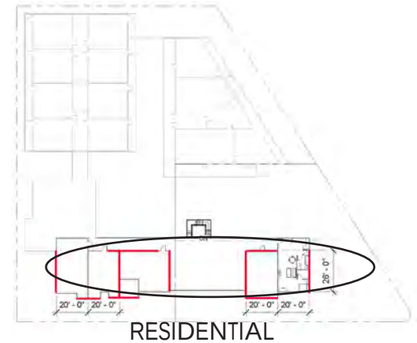
RESIDENTIAL BUILDING

RESIDENTIAL ABOVE COMMERCIAL



OFFICE SPACE

RESIDENTIAL BUILDING



RESIDENTIAL BUILDING

RESIDENTIAL WOOD SHEARWALL

wood structural panels 15/32"

10d nails, panel edge spacing:

2" — 1740 PLF/2 = 870 PLF

3" — 1330 PLF/2 = 675 PLF

4" — 1020 PLF/2 = 510 PLF

6" — 680 PLF/2 = 340 PLF

Base shear = 63.5K

2" — 73' ~ 75' each way

3" — 95.4' ~ 100'

4" — 124.5' ~ 130'

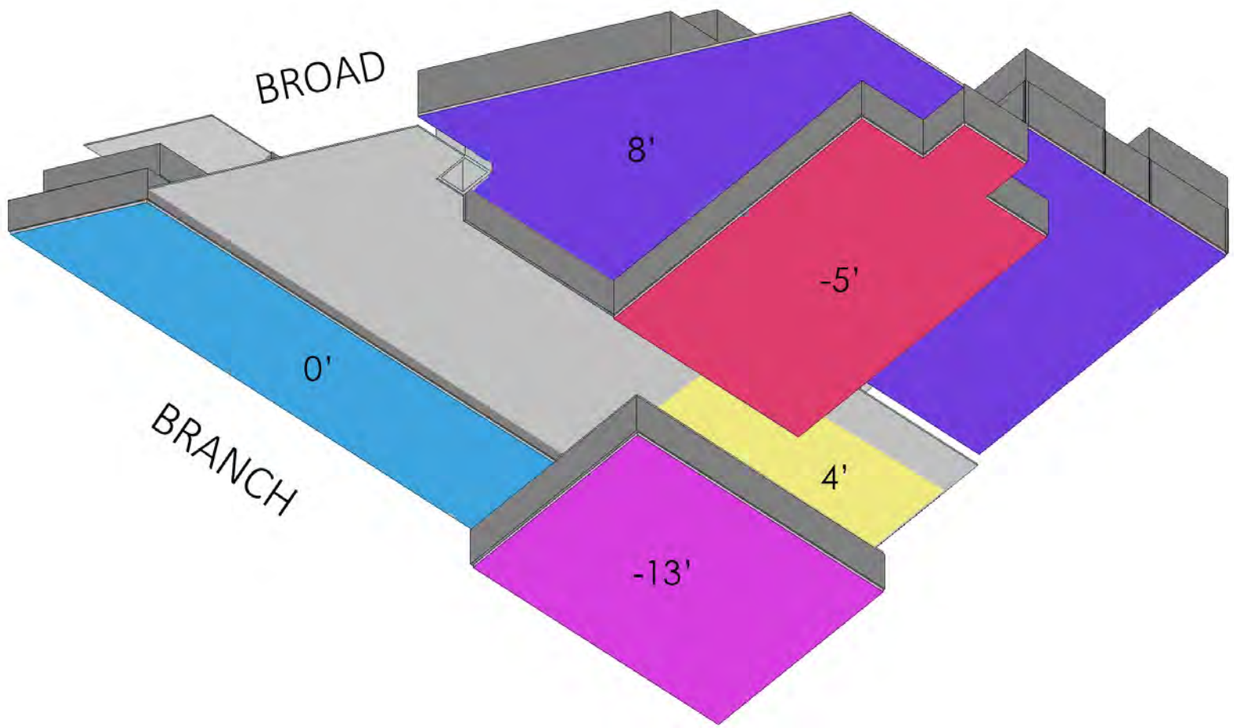
6" — 186.8' ~ 190'

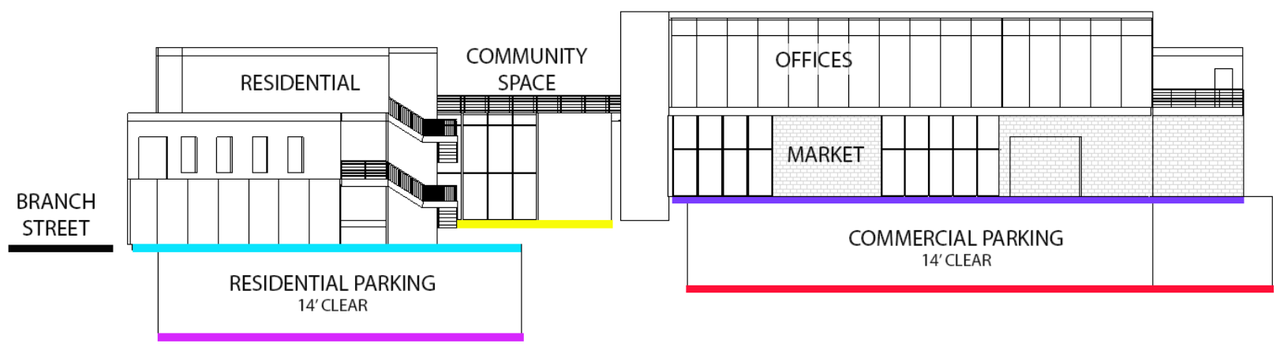
RESIDENTIAL BUILDING	130' WOOD SW E.W.
RESIDENTIAL ABOVE COMMERCIAL	76' WOOD SW E.W.
OFFICE SPACE	56' WOOD SW E.W.
COMMERCIAL - MARKET	44' MASNORY SW E.W.
COMMERCIAL - RESAURANT	93' MASONRY SW E.W.

(CONFIGURATION) FOUNDATION SYSTEM

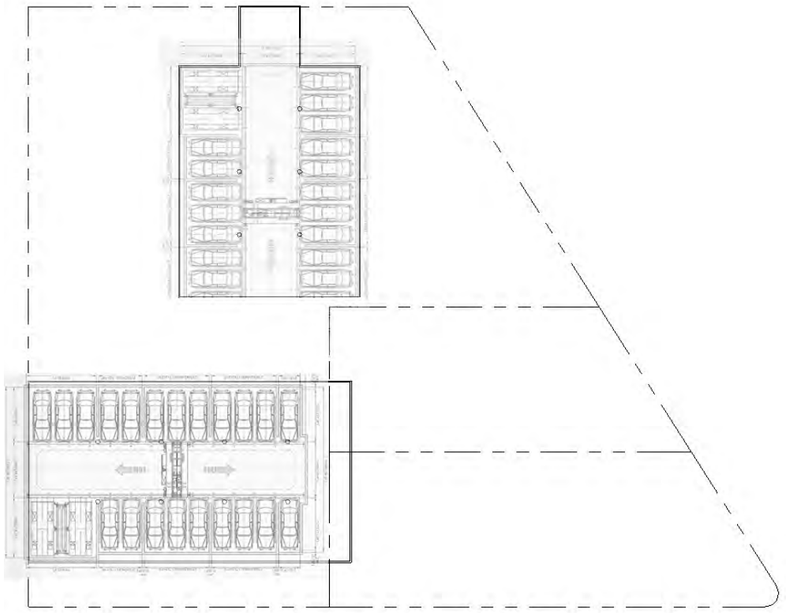
The foundation system was complicated by poor soil bearing pressure, underground parking, and a sloped site.

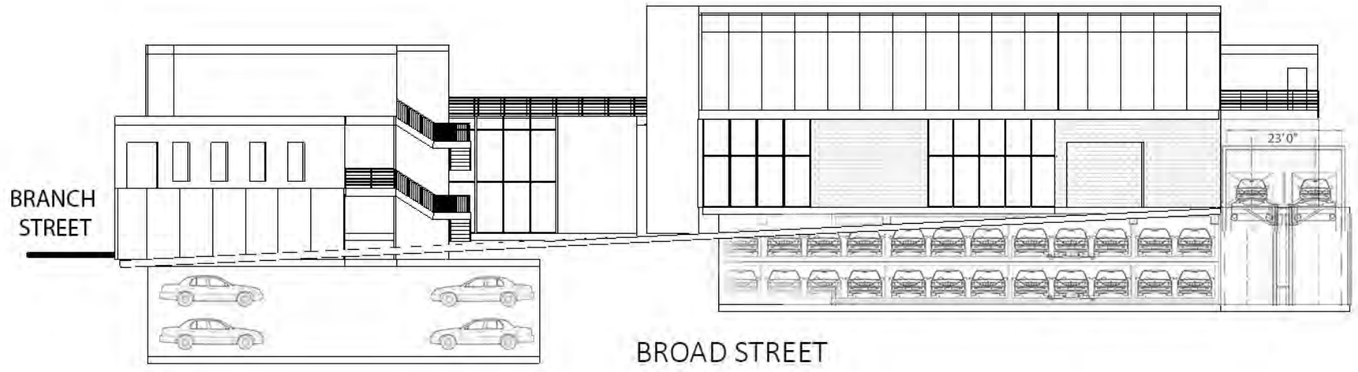
The two parking garages entrances are level with the street, making them 8' apart in depth. The roof of the garages serves as a foundation for the building above. To try and soften the grade change between buildings on opposite sides of the site, the residential community center (yellow) will be in between the two, along with the landscape in front of it. Where parking can not be the building foundation, a mat foundation will take shape of the footprint of the building (purple and blue). The parking garages will also have thier own mat foundations (pink and maroon).

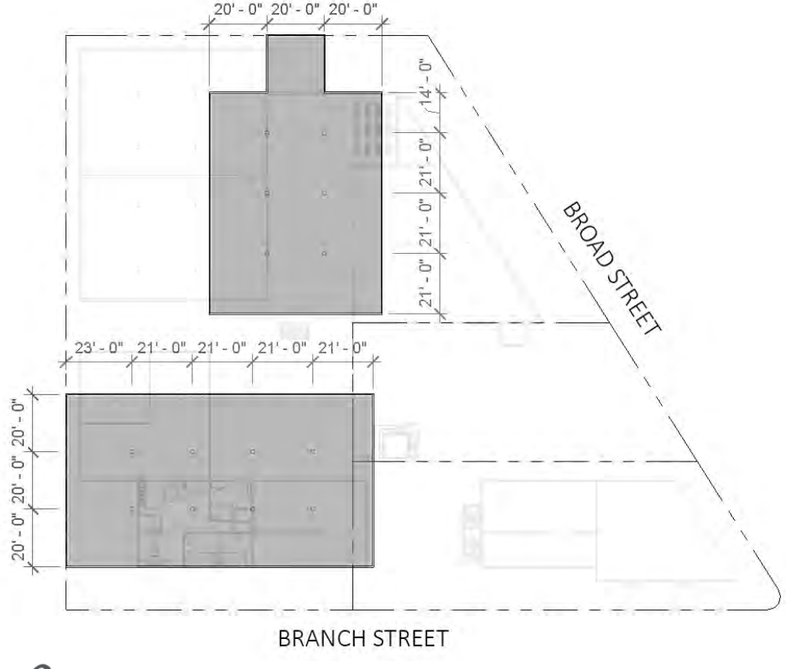




(CONFIGURATION) PARKING SYSTEM







The parking system was separated into residential and commercial to try and facilitate traffic and keep the residential feeling more private.

The parking system is two layers of cars, each 7' tall and 7' wide. Bcause of this sizing, the columns were spaced at either 21' or 14' so as not to obstruct any openings.

The parking was meant to line up underneith buildings in order to reduce foundation area (parking ceiling could double as building foundation), but this was compromised in order to push the parking closer to the street to avoid wasting space.

The driver pulls into a residential garage like structure and leaves the car. They then either take a ticket or enter a pin (for residential) and the car will be lowered and parked mechanically. Once below the ground, the car is led down the middle isle and parked on either side and on one of the two levels. The entrances are two cars wide to allow one car to enter/exit at the same time.

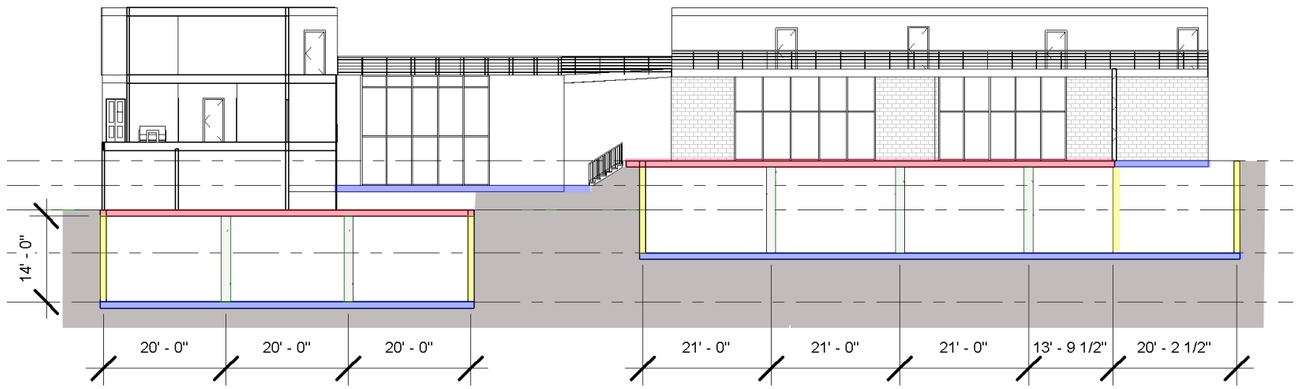
(SIZING) FOUNDATION SYSTEM

MAT FOUNDATION

The foundation thickness is based off of punching shear from the columns that frame into it. To find this, I took the column with the most weight from each mat to find a thinkness for each individual mat. This will hopefully avoid having un-needed concrete.

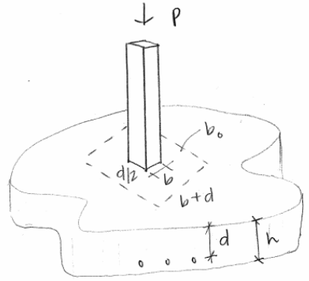
PARKING CEILING/SLAB

The ceiling of the parking structure doubles at a floor foor indoor and outdoor spaces. It will be a two wat slab with 18" concrete columns spaced at 21' supporting it. Assuming a slab of 12" will support the dead and live load from the buildings above means I do not need to do extra checks for a-typical columns and bearing walls that it supports.



MAT FOOTING DEPTH

PUNCHING SHEAR $V_c = 4\sqrt{f'_c}\, b_o d$



$b = 18"$

$\phi V_c = 4\sqrt{f'_c}\,(b+d)4 \cdot d$

$P = 210K + (18^2/12^2 \cdot 15' \cdot 150PCF)$
$= 215K$

$0.75(215{,}000) \leq 4\sqrt{1500}\,(18"+d)4 \cdot d$

$161{,}250 \leq 154.9(18"+d) \cdot 4 \cdot d$

$d = 12"$: $223{,}050 \# > 161K$

$h = 12" + 2"\ \text{COVER} = 1'2"$

CEILING OF PARKING

MIN THICKNESS = $l_n/36 = 21' \cdot 12"/36 = 7"$

USE 12" 2WAY SLAB [TABLE 8.3.1.1]

PARKING CONCRETE COLUMN

FROM STEEL COLUMN P = 147 K

12" CONCRETE SLAB = 150 PCF (20' · 21') = 63K

P = 210K

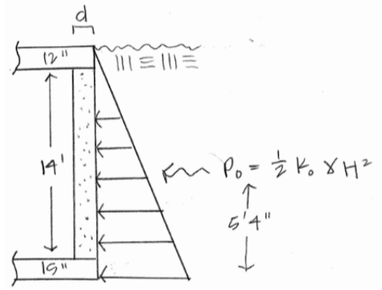
$\phi P_o = 0.85 f'_c A_c + A_s f_y$

$0.65(210{,}000\#) = 0.85(4000)\, A_c$

$A_c = 40.15\ in^2$ $\quad b = 6.33\ in$

USE 18" X 18" COLUMNS

PARKING BEARING WALLS



$P_o = \frac{1}{2}(1.0)(100\,PCF)(16')^2$

$= 25.6\ K$ (PLF of wall)

min depth = $l/16 = 14'/16 = 10.5"$

min reinf. = $\frac{Mu}{\phi f_y (d - 9/2)}$

$Mu = (25.6K)(5.3')(10.6')/16'$
$= 90\ K'$

$d - \frac{a}{2} = 0.95(10.5" - 2.5")$
$= 7.6"$

$A_s\ min = \frac{90 \cdot 12"}{.85(60)(7.6")} = 2.9\ in^2$

Made to (2) #8 PLF $A_s = 1.58\ in^2$

$1.58\ in^2 = \frac{90 \cdot 12"}{0.85(60)(d)}$ $\quad d = (13.4" + 2.5")/0.95 = 16.7"$

d = 18"